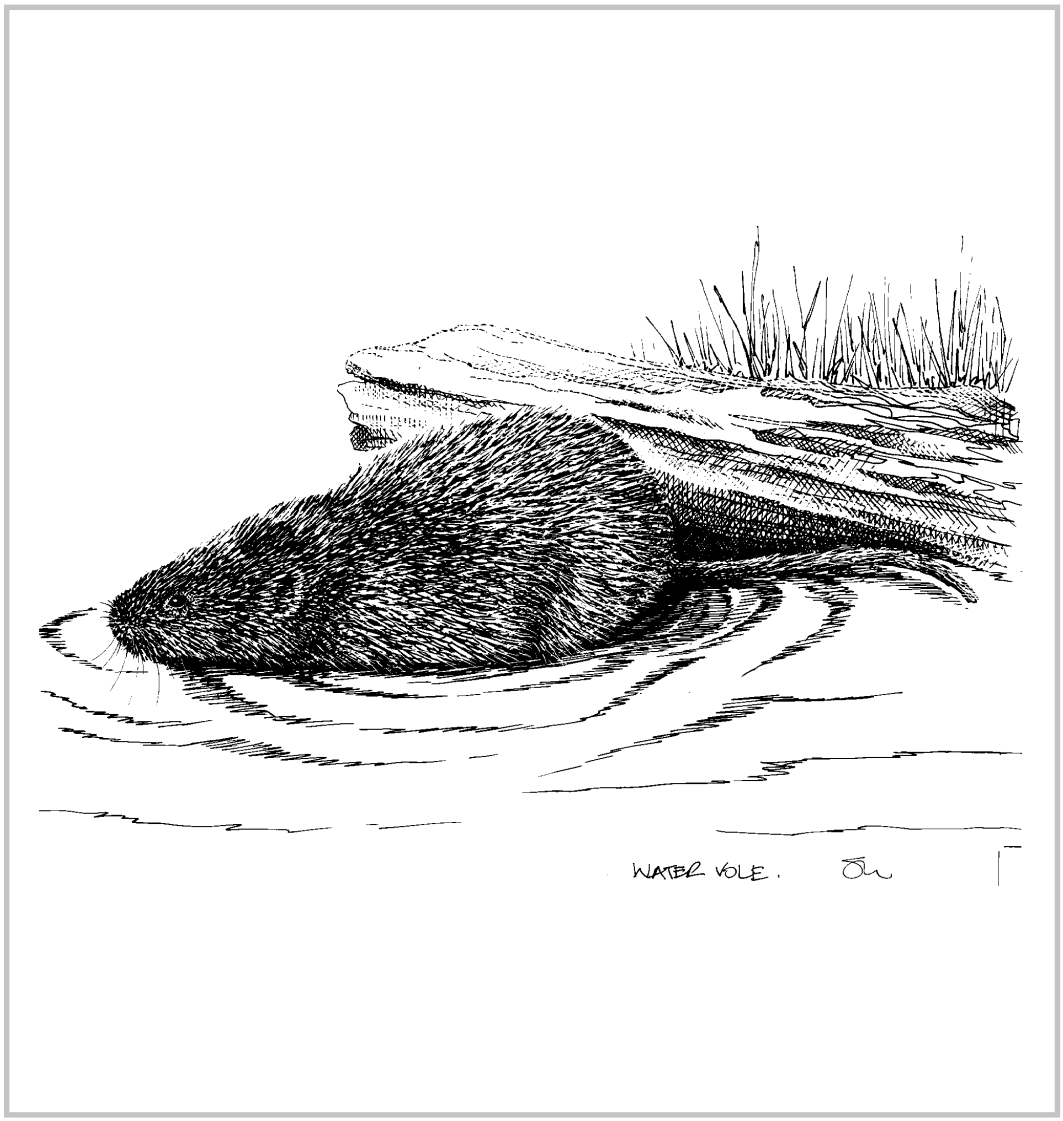
ENGLISH NATURE

Water vole mitigation techniques

A questionnaire research project

No. 415 - English Nature Research Reports



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No 415

Water Vole Mitigation Techniques
A Questionnaire Research Project

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I would also like to thank the various organisations that participated in the study, and gave permission for use of their pictures and drawings. I trust that all the inclusions in this study have represented individual case studies properly.

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Contractual details

Summary: 1,392 questionnaires were forwarded to a broad range of organisations likely to be involved with water vole mitigation. The collated results examined 290 replies, from which mitigation was then assessed, through telephone calls and some site visits. Mitigation is divided into Direct and Indirect impacts. The types of mitigation found were Exclusion, Habitat Creation and Enhancement, Alteration to Plans, Changes to Management, Relocation. Methodologies have been developed which provide both detailed and broad guidelines for future development and management works.

Project Clients:

English Nature,	**Environment Agency** Regions:	**British Waterways**,
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Objectives: Collect collate and report on water vole mitigation techniques being employed throughout England and Wales.

Provide mitigation methodologies for as many different circumstances as possible.

Definitions: **Mitigation**, for the purposes of this report, is where negative impacts on water vole populations have been identified and procedures have been put in place to minimise these impacts. The impacts can be as a result of development operations which disturb water vole habitat either indirectly or directly. Equally, some mitigation techniques have been employed to cater for land management operations.

1. Background

This study was commissioned directly in response to concern over the dramatically declining water vole *Arvicola terrestris* population in the UK, as described by Strachan and Jefferies 1993 and Strachan *et al.* 2000 (see 2.1 below). While the main cause of the water vole's decline is thought to be the expansion of and subsequent threat from predation by the introduced American mink *Mustela vison* (e.g. Strachan and Jefferies 1996, Barreto *et al.* 1998), major concern is also that the problem could be compounded by other factors such as insensitive development and land management. Strachan *et al.* 2000 conclude that the decline of water vole populations in Britain has been in progress for much of this century, and that such a long-term decline is due to extensive habitat and environmental changes.

1.1 Water vole decline

The 1989-1990 National Water Vole Survey (Strachan and Jefferies 1993) estimated a 94% loss of water vole sites over the course of the 20th Century, based on historical records in the literature and a survey of random sites throughout Britain. As a result of the water vole's recorded decline, the species was listed as a national priority for conservation, on the Short List (globally threatened or rapidly declining species in the UK) of the National Biodiversity Action Plan (BAP) (HMSO 1995).

The most recent national survey of water voles, carried out in 1996-1998, resurveyed the sites surveyed in 1989-1990, and compared the results (Strachan *et al.* 2000). The latest survey recorded an even greater loss of water vole sites than the previous survey, estimating the rate of loss of water vole sites, up to autumn 1998 at 89%. This makes the prediction of 94% loss over the 20th Century, made by the 1989-1990 survey, to be not only possible but very likely. In addition to this, not only was there a decline in the number of sites, but the number of latrines recorded at each site, which is indicative of the number of animals in each population, had also decreased. This is the most rapid decline experienced by any British mammal during the 20th Century (Mammal Society 1999) and, although the total pre-breeding population of water voles in Britain was estimated at 2.3 million in 1995 (Harris *et al.* 1995), the rate of loss raises the need for immediate conservation action.

It was further estimated that, if the decline of the water vole continues at the current rate of loss, water voles could be extirpated from much of its former range in Britain by the year 2003. The publication of these latest National Water Vole Survey results has brought about widespread conservation action across Britain. The UK Water Vole Steering Group published a National Species Action Plan in 1997 that identified a series of actions that were necessary to assist in the conservation of this species. Through the delivery of local Biodiversity Action Plans local County-wide surveys are being undertaken, key populations are being identified, nature conservation management strategies are being amended and consideration is being given to methods of mink control.

However, land management for flood defence or recreation (for example), and development affecting water vole habitat, will continue and in many cases temporary or permanent habitat loss is unavoidable. It is therefore important to include a review of the methods of management and development in context with damage to water vole populations, and seek ways in which these can be adapted to be less detrimental to water vole populations, and thus contribute to efforts to reduce the species' decline.

With the right approach, the impacts to water vole populations from such potentially damaging operations can be reduced significantly, and in some circumstances can even contribute to enhancing and extending water vole habitat. Where impacts cannot be avoided, appropriate mitigation can be adopted as part of a development/ management package, to either eliminate unnecessary habitat loss or degradation, or to reduce such effects to a minimum.

1.2 Water vole legislation

Legislation has been introduced to counter the species' decline and support its recovery, through the Wildlife and Countryside Act 1981 (as amended 1998, Countryside & Rights of Way Act 2000). This legislation, together with the Department of the Environment's Planning Policy Guidance Note No. 9 (PPG9), provides planning authorities with the opportunity to place conditions on developers prior to works starting, and this can take the form of suitable mitigation. Equally, awareness of the species' decline and the new legislation has moved larger authorities, such as the Environment Agency and British Waterways, to re-address the way in which they carry out their land management duties, and in some cases the way in which they guide developments affecting water courses. The Environment Agency for example controls developments affecting watercourses and can require certain conditions to be met before granting Land Drainage Consent. This is also the case for Internal Drainage Boards where they are responsible for a particular stretch of water.

Special protection was afforded to the water vole in the 1998 Quinquennial Review of the Wildlife and Countryside Act 1981, thus including the water vole in Schedule 5 of the Act in respect of Section 9(4) only. This gives the water vole legal protection, making it illegal to intentionally or recklessly:

- Damage, destroy or obstruct access to any structure or place a water vole uses for shelter or protection;
- Disturb a water vole whilst it occupies such a place.

Importantly, this legislation will not provide licences for the intentional destruction of water vole burrows (or disturbing an animal while occupying its place of shelter) for development or management/maintenance operations. It is not the purpose of the legislation to prevent these operations, and a defence is built into Section 10 of the Act, requiring that "reasonable" steps are taken to avoid unnecessary damage. It is within this context that **mitigation** should be planned in agreement with Statutory Agencies.

The Department of Environment Planning Policy Guidance Note No.9 on Nature Conservation (PPG9) states that the presence of a protected species (e.g. water vole) is a material consideration. The recommendations to planning authorities are that consideration should be given to planning conditions to account for the protection of a protected species, and often, mitigation will be as a direct result of such a Condition or Obligation.

It is the responsibility of the developer/manager to ensure that they carry out operations lawfully, by providing appropriate mitigation and in liaison with the relevant statutory agency.

The protected status of the water vole has resulted in a better understanding of the ecology of the species through new research. This has been a rapid learning curve with advice on water

vole conservation and mitigation techniques being brought together in the Water Vole Conservation Handbook (Strachan 1998). Since that publication many more projects have been carried out allowing for a better understanding of the possible mitigation techniques. It is the aim of this study to bring together the experiences of various organisations in providing mitigation for water vole populations under threat, and for those experiences, both successful or otherwise, to be disseminated as widely as possible.

1.3 Aims of the study

1.3.1 The prime aim of the study is to provide guidance to others on water vole mitigation methods. This has been complicated by the range of different factors and conditions under which water vole populations are threatened. However, it has been possible to provide advice which will be relevant to a range of different situations, providing good practice guidelines and in some cases definitive methodologies.

1.3.2 A secondary aim has been to report on the experiences of others, to provide examples of where different methodologies have worked, and where lessons have been learned. It is important to note that many organisations were restricted by client confidentiality, and as such have provided details anonymously. Many examples presented in this study therefore concentrate on the details of mitigation rather than the specific location and company involved.

1.3.3 A further aim has been to assess the success of different mitigation methods. This aim can only be subjectively presented since in nearly all cases monitoring has not been completed (and in some was not carried out). There is much that we yet do not know about the implications of some of the methods that are discussed below, and only with further analysis of monitoring results can we gauge success and failure.

1.3.4 It is also important to note that this report does not make any decision about "when" to mitigate, but rather, assumes that a particular development/project must go ahead, for whatever reason, and that mitigation will be a necessary part of the project.

1.3.5 Finally, this study does not provide methods for translocation, although the section does discuss known principles and where details of other projects have been provided then these have been discussed. This form of mitigation is currently under intensive research by the Environment Agency.

2. Research Methods

The following methods were employed in compiling this study.

2.1 Questionnaire

A questionnaire (see Appendix 1) was developed to gain the initial overview of "who was doing what". This was forwarded to 1,392 recipients, in local authorities, consultancies, statutory agency regional and headquarter offices, large companies likely to be involved with this type of activity, architects and voluntary organisations such as the Wildlife Trusts. The questionnaire was deliberately short, with the intention of avoiding long-winded analysis

which might not have been completed by recipients. A full list of organisations contacted has been appended in Appendix II.

2.2 Collation of Results

The questionnaires that were returned were then studied and positive returns were catalogued. Positive returns included actual work in progress, planned work and work that had been carried out in the past.

2.3 Telephone enquiries

Positive returns from the questionnaire survey were then followed up by telephone calls to ascertain the nature of the project. This was particularly useful in then deciding which project would merit a site visit.

2.4 Site visits

A small number of projects that were deemed suitable were then visited and the individual interviewed. Projects were selected to represent as many different habitats and different types of impacts as possible. Photographs were taken to show different aspects of the projects. British Waterways were also interviewed, and comments from Rob Strachan of the Environment Agency were sought on many occasions.

3. Results

A total of 1,392 questionnaires were forwarded, and an organisation list has been appended (Appendix II). The response was encouraging, with 290 or 20.83% return rate. Of these responses, 50 records (17.2%) were classed as positive, as shown in Table 1 below.

Table 1: Positive Responses

Organisation	Extent of impact on population	Development type	Mitigation
ADAS Environmental	<50%	Road and housing development	Strimming to exclude, habitat enhancement in adjacent areas (e.g. removal of shading)
Amphibian Reptile & Mammal Conservation Ltd	<50%	Road embankment safety works	Re-alignment of proposed access road to avoid water vole habitat
Anglesey County Council	>50%	Road Construction	Exclusion and habitat creation
Babtie Environmental	Minimal	Flood alleviation and bank works	Bank stabilisation using woven willow.
Beds, Cambs, Northants & Peterborough Wildlife Trust	100%	Ditch clearance and revetment	Gaps introduced to allow voles to re-burrow into banks.
Bexley London Borough Council	<50%	Pipeline and industrial estate development	Application unsuccessful
BHWB	Minimal	Road widening	Alteration of plans to avoid water voles and habitat restoration
Bracknell Forest (Borough) Unitary Authority	<50%	Pipeline construction	Exclusion by strimming and restoration
Braintree District Council	N/a	Golf course construction	Amendment to Plans
Bridgenorth District Council	N/a	Reconstruction of fishing lake	Amendment to plans
Cheshire Wildlife Trust	<50%	Business Park development	Habitat creation in advance of works to extend current habitat
Chris Blandford Associates	<50%	Road building	Habitat creation in advance of works, exclusion and trapping.
Clerk to Newark Area IDB	various	Ditch maintenance	Avoid intensive vegetation cutting where water voles are present.
Countryside Council for Wales - Bangor	Various	Road developments	Habitat creation prior to and during development
Derbyshire Wildlife Trust		Pipeline crossing	Plans altered to avoid water voles
Eastleigh Borough Council	Minimal (20%/annum)	Ditch management	Staged ditch clearance (40m stretches)
EMEC Ecology	various	Pipeline crossing, boreholing, road construction	Exclusion, habitat creation and monitoring
English Nature - Grantham	100%	Marina development	Habitat creation in advance of development, exclusion and trapping, continued habitat maintenance until habitat matures.
English Nature - Taunton	<50%	Flood alleviation	Exclusion (March) and improvement of adjacent unsuitable habitat.

Table 1: Positive Responses (cont.)

Organisation	Extent of impact on population	Development type	Mitigation
English Nature - Three Counties	100%	Pipeline/ditch works	New habitat provision as compensation
English Nature (Berkshire)	minimal	River bank modification and canal lock and bridge construction	Habitat improvement in advance of works
Environment Agency – Dorset	<50%	Bank stabilisation	Habitat creation in advance of development, exclusion and some trapping.
Environment Agency - Newcastle upon Tyne	N/a	River bank maintenance	Re-scheduling of grass cutting, avoiding known key population sites.
Environment Agency - Shrewsbury	Minimal	Canal bank stabilisation	Provision of suitable substrate to increase burrowing for water voles
Environment Agency - Swansea	>50%	Ditch clearance/maintenance	Fencing to encourage habitat development and habitat creation through dry ditch clearance.
Environment Agency - Tewkesbury	Minimal	Urban river rehabilitation and creation of millennium green	Channel design aimed at water vole habitat improvement.
Environment Agency – Wales	Minimal	Road widening scheme	Creation of new water vole habitat
Environment Agency (Bangor)	<50%	Ditch clearance	Wooden boarding for bank protection had holes drilled for water voles.
Environment Agency, Exeter	<50%	Flood bank strengthening and raising	Exclusion through mowing, habitat enhancement on opposite bank, and upstream and downstream.
Environment Agency, Penrith	various	Routine bank and channel maintenance	Mowing only by hand, lower bank untouched (possible mow in winter), channel vegetation hand-cut, retain strip of marginal vegetation (continual).
Environment Agency, Staffs	Minimal	Habitat enhancement	Habitat improvement
Environment Agency, Nottingham	100%	Regrading of river bed	Habitat creation, relocation of voles
Epping Forest District Council	Minimal	Bank restoration	Alteration to plans to completely avoid water vole population
Fawside Foundation	>50%	River erosion	Staged works, with habitat enhancement
Grantham Brundell & Farran IDB	Minimal	Ditch maintenance	Timed for winter to avoid breeding season, sludge deposited away from banks, bank face and top not disturbed.
Gwynedd (County) Unitary Authority	<50%	Road and rail construction	Exclusion
Land Use Consultants	To b e decided	Ditch clearance	Habitat creation and possibly future translocation.

Table 1: Positive Responses (cont.)

Organisation	Extent of impact on population	Development type	Mitigation
Norfolk Wildlife Trust	<50%	Ditch maintenance	Slubbing of vegetation and deposition of silt avoids water vole populations directly, and where they are present works carried out on alternate sides in 50m sections.
Oxford City Council	<50%	Various	Exclusion
Peak District National Park Authority	<50%	Ditch clearance	Timed works outside breeding season, bunding to improve and impound water levels and scrapes created adjacent to site
RPS Group Plc	Minimal	Light industrial development	Retention of buffer strips
Rushmoor Borough Council	100%	Realignment and naturalisation of canalised river banks	Plans altered to reline only one side of channel, visible burrows untouched, infilling limited to level of burrow entrances.
Staffordshire Wildlife Trust	Minimal	Proposed road scheme	Habitat creation/relocation of voles/restoration
Stevenson and Wheeler	unknown	Pipeline construction	
Suffolk Wildlife Trust	Minimal	Road construction	Culvert design to be water vole friendly
Surrey Wildlife Trust	Minimal	River bridge construction	Alteration to design required a wide span bridge to avoid impact
Tendring Hundred Water Services Ltd	Minimal	Ditch maintenance	Vegetation clearance to a minimum, debris removal by hand.
Thames Water	<50%	Flood Alleviation	Extensive habitat creation in advance of works.
WSP Environmental Ltd	>50% (no voles recorded)	Business Park development and Quarry etc	Extensive habitat creation
Yorkshire Water Services	<50%	Conduit reconstruction	Amendment to plans to avoid habitat

The positive response questionnaires are held by English Nature at Head Office, and can be accessed by contacting Dr. Tony Mitchell-Jones, although these responses have been received in confidence and the information is not designed to be made easily available.

Negative responses

For completeness we have listed those returns where there has been a negative response – i.e. that no water vole mitigation work was being carried out, had not been carried out and was not planned for the foreseeable future. This is an extensive list of responses and has therefore been appended (Appendix 2).

3.1 Analysis of positive results

All positive projects were contacted by telephone to discuss the project progress and outcome. Only a small number of sites were visited as many had either not gone ahead or had yet to

begin, or were not relevant to this present study . In most cases, photographs and drawings were sufficient to show the scope of the study.

In addition to the above, Ecologists from British Waterways were visited in Gloucester and interviewed.

The projects listed in Table 1 show six main mitigation themes: alterations to plans (PL), changes to land management (L), , habitat enhancement (HE), habitat creation (HC), exclusion (E) and relocation of water vole population (R). They show the following occurrences (some are employed in more than one project):

PL - 15 projects;
L - 6 projects;
HE - 10 projects;
HC - 15 projects;
E - 10 projects;
R - 2 projects

Each of these mitigation types are discussed in the following chapters below. In addition, **Disturbance** is classed as a type of impact, and is discussed in terms of mitigation. Briefly, they can be defined as follows:

- Making **alterations to plans** to avoid or minimise impacts is a preferred option that can also avoid increased costs associated with providing mitigation.
- Changing the way in which one **manages land** can be used to either discourage water voles from using an area in advance of an impact, or can enhance a habitat to replace or extend water vole habitat.
- **Habitat creation** is a method to provide water voles with alternative habitat to move to in advance of exclusion. Equally, **habitat enhancement** is often used for the same purpose, achieved by changes in management and introduction of water vole friendly features and conditions.
- **Exclusion** is a method of removing the ideal habitat conditions that water voles require. This is achieved by removing the vegetation cover, thereby persuading water voles to voluntarily leave a site and move to another area.
- **Disturbance** is an indirect impact which can have significant negative effects on water vole populations and their habitat. Different mitigation methods have been applied to counter different levels of disturbance.
- **Relocation** of a population is an extreme option for mitigation. Water vole populations are trapped and removed from a habitat, to be relocated elsewhere or held in captivity to be returned after habitat restoration. Little is known about the effectiveness of this type of mitigation, and it is not a preferred option.

4. Definition of Impacts

Water vole mitigation is complicated by the range of different conditions particular to each site, the type and extent of impact and the fragility of each water vole population under threat. It is therefore more helpful to place types of impacts into distinct categories, and thus wherever possible provide methods for mitigation for each category. To make the picture less complex, mitigation can be analysed using the flow chart in Figure 1. The chart shows that impacts can be viewed initially as either direct or indirect, and much of the text in the following sections refer directly to this chart.

Each category is described below. Within these categories, it is evident that there are three fundamental methods of approach, each dependent on the local circumstances. These are, a) accommodate the water voles in situ and maintain conditions that support them, b) persuade voles to move of their own accord, or c) physically move the voles by relocating (or translocating) them to a suitable site.

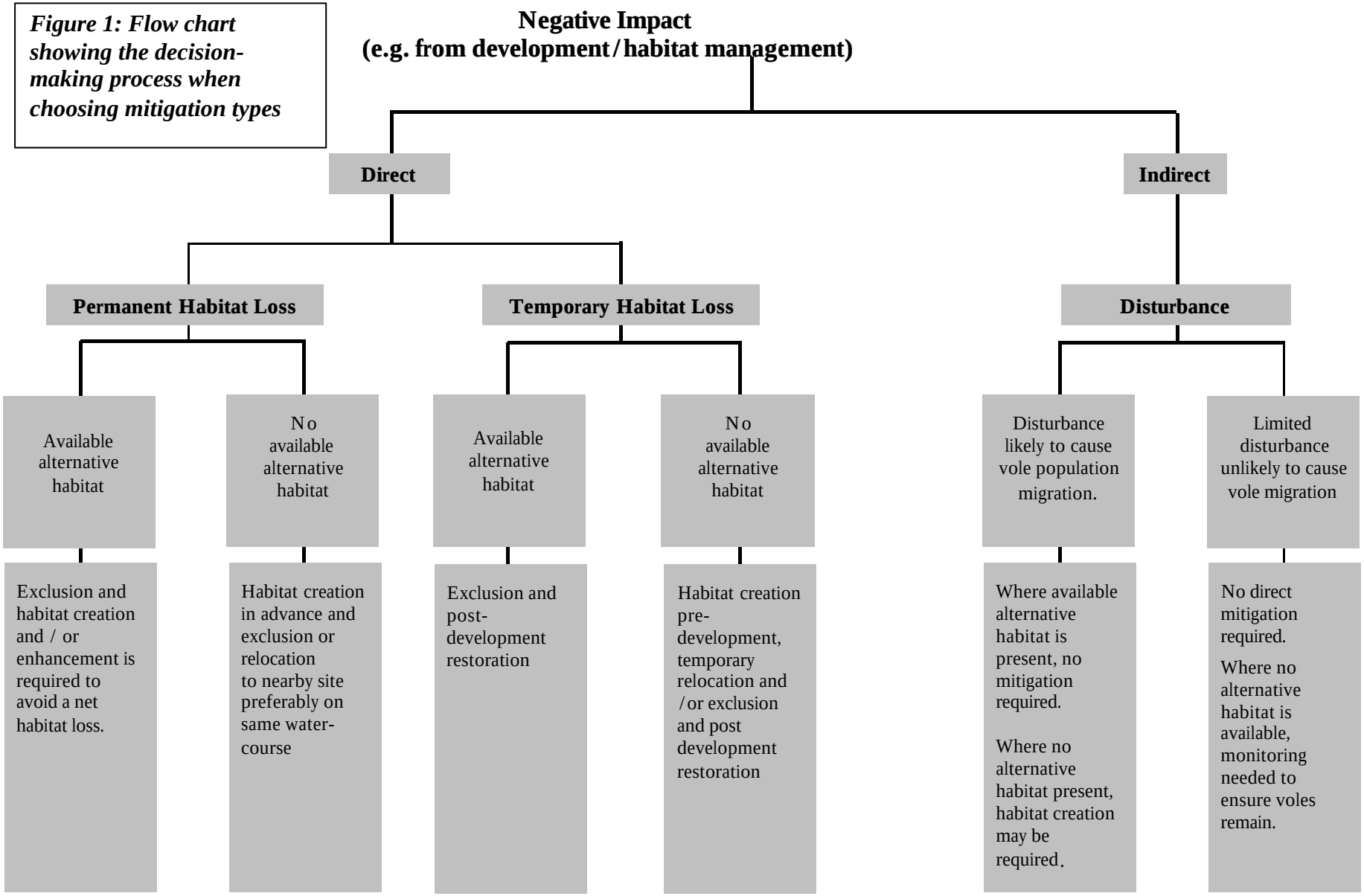
4.1 Direct impacts

Direct impacts are sub-divided into permanent or temporary habitat loss, each in turn being addressed by the availability of alternative habitat. Availability is important to assess during an initial survey stage prior to any mitigation project. It is defined by the availability of habitat that is not only suitable, i.e. with the right conditions, but is also accessible and unoccupied.

Accessibility: For those projects where voles can be persuaded to move of their own accord, it is important that there is no barrier between the existing water vole population and the alternative habitat, e.g. that a physical barrier such as a weir, road, mill etc. is not between the two sites; that there is no significant stretch of unsuitable habitat (approx. >250m), no significant stretch of habitat (approx. >250m) occupied by predators or competitors (e.g. brown rat (*Rattus norvegicus*). There is no evidence that brown rat would inhibit the movement of a water vole population through its territory: indeed water voles are very aggressive, and there have been studies showing that both brown rat and water voles will occupy the same burrow system temporarily when severely disturbed (Arnott and Dean 1998). However it is known that water voles may fall prey to brown rats and in a number of instances water vole colonies have been completely taken over by colonising rats (R. Strachan *pers obs*)]

Unoccupied: For those projects where voles will be persuaded to move of their own accord, that within 250m of the impact, alternative suitable habitat is vacant and not already occupied by water voles or brown rats.

Figure 1: Flow chart showing the decision-making process when choosing mitigation types



Habitat Suitability: Conditions for suitable habitat are:

- At least the same extent of new habitat should be available as that which is to be removed/impacted.
- Mature ground vegetation should be present which provides shading and food source
- Water must present all year
- Bank system with suitable substrate that water voles can burrow into
- No known mink presence
- Stretches of no cattle poaching
- No significant use of bankside habitat by wildfowl (e.g. roosting)
- No excessive shading
- Disturbance factor significantly less than the site of impact
- No known plans for impacts to this new site in the foreseeable future, or for the period of the proposed impact and 6 months following.

4.2 Indirect impacts

These impacts represent introduced disturbance, where there is no damage or significant alteration to the water vole's habitat. There are however still associated impacts. These impacts naturally depend on the level of disturbance and the length of time the disturbance is carried out. In some cases, for example percussion bore-holing, the disturbance will only last for a few hours and the voles are known to have remained *in situ* during the period of disturbance (see 5.5.3 below).

Water voles are known to be very resilient and quite adaptable. They are found in good numbers along many urban river and canal stretches and adjacent to busy trunk roads and motorways. However, where introduced disturbance is too great, water voles will leave their habitat and move to an alternative area (see 5.5.1), normally on the same watercourse. More often this will be a temporary move, with animals recolonising almost immediately. There is little understanding about what water voles do when a disturbance causes animals to leave a site permanently, especially where there is no habitat available for them to occupy.

Disturbance has to be assessed in advance to gauge the effect that it will have on the population. There is no 'scale' to which disturbance can be compared. We have however represented types of disturbance during this research project where voles have been forced to leave the site and where they have remained to tolerate the disturbance. This is discussed in more detail under section 5.5.

5. Methods of mitigation

Based on the initial summary of the types of mitigation that have been recorded by this study, it is possible to give examples of the works carried out in different cases, to highlight the effectiveness of different methods adopted, and thereby provide guidelines on how to go about mitigation in future projects.

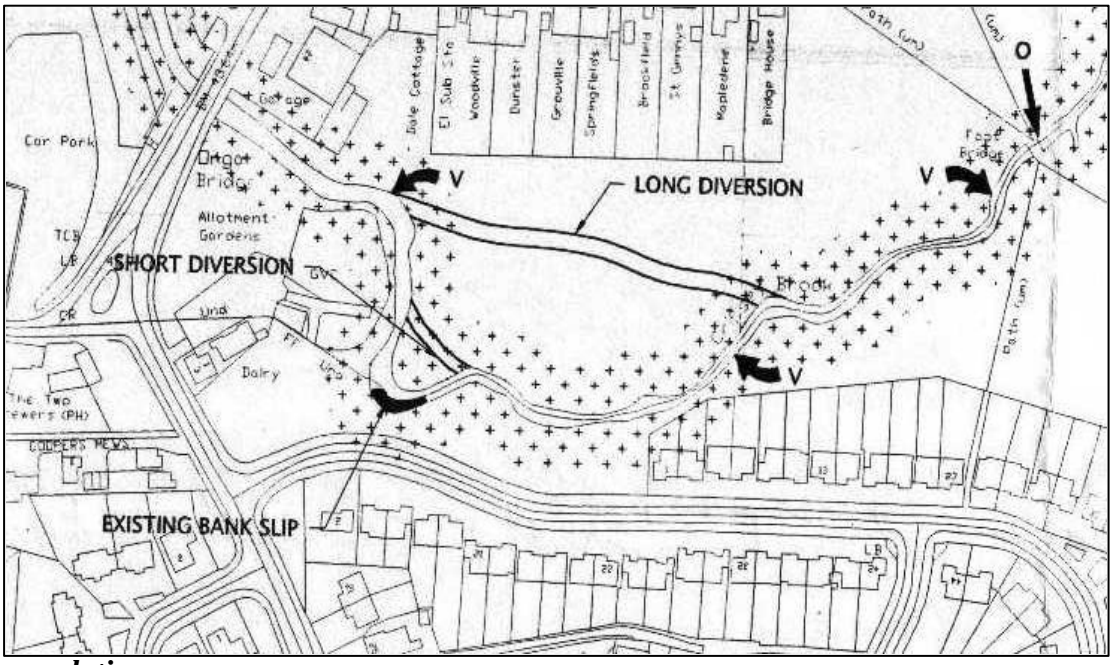
5.1 Alteration to plans

A total of 15 projects were submitted that had altered plans in different ways to avoid or reduce impacts to water vole populations. Of these, 9 projects re-designed their working methods and development design to completely avoid any impact, and examples are provided below. In 2 instances, applications for development were not approved, based in part to the presence of water voles. There are clear benefits for water voles using this type of mitigation, and altering plans (not necessarily refusing an application) has to be the first consideration for any project.

5.1.1 Avoiding impacts

In some cases, alteration of existing plans can even have other benefits, such as financial ones. For example, Epping Forest District Council were faced with emergency repairs to a water course resulting from bank slippage. The first option considered a long diversion, but the identification of water vole populations gave the Council reasons to re-consider their diversion route, and a shorter route was subsequently chosen, avoiding water vole populations (see fig. 2 below), and the need for detailed mitigation.

Figure 2: Epping Forest District – alteration to plans to avoid water vole populations



(V=water vole presence, O= otter sighting, and ++ = survey area.)

5.1.2 Introducing sensitive work methods

Another way to mitigate is to adapt the method of working. This is usually appropriate to temporary, small-scale projects such as brickwork repairs or bank revetment and stabilisation for short stretches. There are general guidelines which can be introduced:

- Detailed water vole surveys will identify the extent of use by water voles, allowing burrows to be avoided by works.
- Careful planning of a proposed development at the point of impact can often avoid burrows, and with a temporary loss of habitat and careful restoration, the impact to water vole populations will be minimal.
- A minimum 3 metre zone (preferably 6m) from the bank face inland should be marked out and contractors not allowed entry, including storage of materials and heavy plant machinery.
- The use of revetments that seal a bank face should be avoided. Therefore wherever possible sheet steel or concrete piling should be replaced with coir rolls, faggots and more natural features such as willow spiling (see section 5.3 for more information).
- The time of year can often have a bearing on any predicted impact. This has been discussed throughout this report for the different techniques presented in later sections.

i) A good example of sensitive working procedures as mitigation was carried out in Yorkshire. Yorkshire Water Services were faced with water conduit brickwork repairs during February. The brickwork lay below an area of banks used by water voles. Due to the time of year, exclusion from the banks (see 5.4 below) was not considered to be the right option, as temporary loss of habitat through strimming would present a greater impact than sensitive and careful repairs to the brickworks. Therefore, the following method was employed:

   - Brickworks repairs carried out by hand;
   - Works carried out in one constant direction, towards known alternative suitable habitat on the same watercourse;
   - Water vole habitat not touched or directly disturbed since burrows were above the brickwork and so works did not directly affect the habitat.

ii) In Derbyshire, the Wildlife Trust reported one pipeline construction project that avoided impacts to water vole populations completely, simply by reducing the size of the working footprint. Similarly, in Nottinghamshire, Severn Trent Water went to considerable lengths to identify breaks in a population's extent, and with some minor adjustments to the direction of a pipeline, fitted the development easement between known stretches of burrows.

   A pipeline working footprint, or easement, can be reduced to as little as 10 metres, and as such it will be possible to avoid water vole burrows in many instances.

iii) In the Pennines in Northumberland, a local charitable foundation discovered water voles present on the River East Allen, planned for bank revetment and

vegetation management. To account for water voles, the following changes were made to plans:

- Wherever walling was required, works were carried out by hand, and spaces were left for voles to gain access to the banks behind.
- Drainage pipes were introduced to maintain vole access to the bank soil behind the walling. (It is not currently known whether this is effective as water voles do appear to avoid using pipes elsewhere – see 5.3.3 iv).
- Large gauge mesh (minimum 8-10cm), similar to that used in rock gabions, was used for bank stabilisation along many small lengths (Figure 3), with walling reduced to a minimum. These were secured by pinning them to the banks and therefore through the mesh allowed water voles full access to the banks.
- Fencing was erected to restrict grazing, poaching and human disturbance
- A number of small ponds are planned to allow water voles areas of refuge as the river was prone to spate flooding.
- Additionally, willows were placed carefully to provide areas for voles to sit during these flood times. Ongoing monitoring has shown that water voles favour overhanging branches to sit on.

Figure 3: Gabion mesh used to make small repairs

5.2 Land management

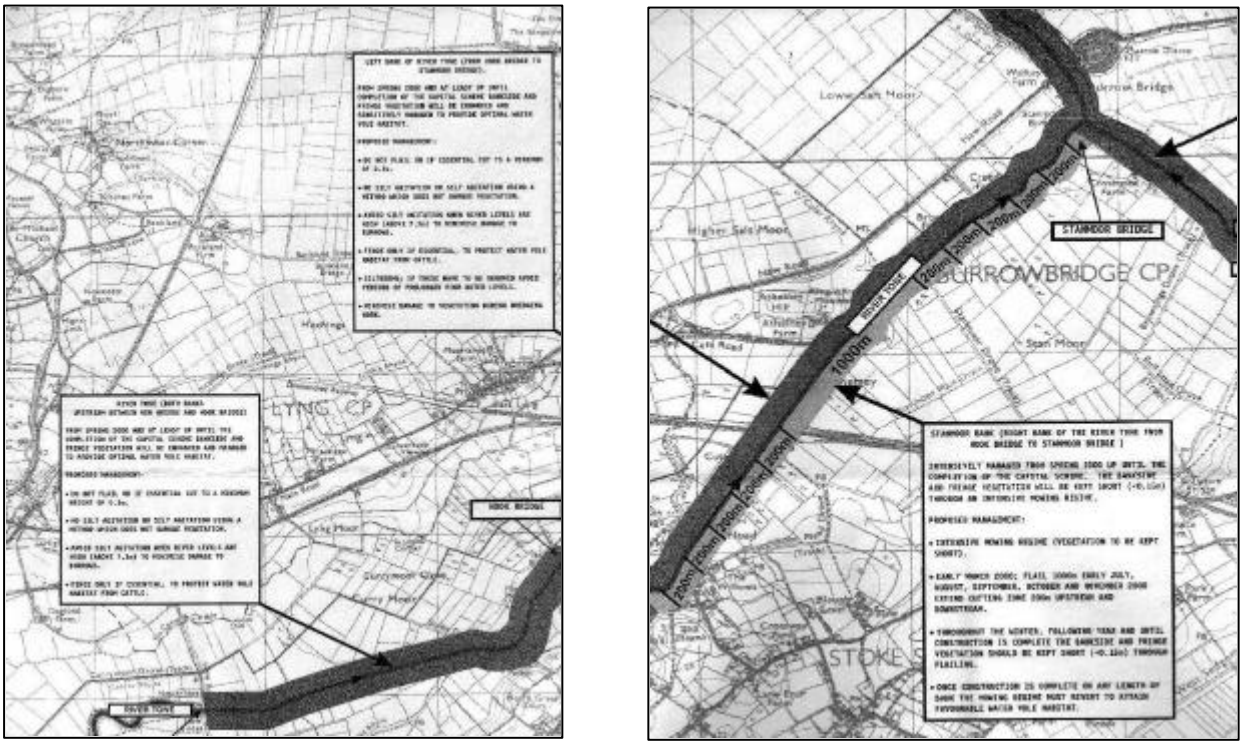
A number of land management activities have to be carried out annually, most often by either the land drainage authority, the Environment Agency or British Waterways. The most common of these are:

Mowing towpath and pathside vegetation
Dredging drains and canals and vegetation maintenance
Mowing urban river corridors for flood defence control

In most cases, these activities are traditional, and water vole populations are generally resilient to low disturbance activities, such as pathside mowing. However, different mitigation methods have been put in place to reduce the impact of management activities, as discussed below.

5.2.1 Changes in management to exclude water voles
(see 5.4 for Exclusion methods)

The Environment Agency in Somerset had to strengthen and raise banks of the River Tone for flood defence reasons. An extensive population of water voles were present, and therefore mitigation was designed to reduce and wherever possible remove the impact associated with the proposed works. Exclusion was introduced to discourage voles from using the banks to be affected, in advance of works. The opposite banks were enhanced at the same time, and a management regime was adopted to reflect this. The drawings shown below show the extent and presentation of management.



Habitat managed and enhanced for water voles

Habitat managed intensively in advance of proposed works

Figure 4: Example of management recommendations (text detail below)

Mitigation measures adopted to exclude voles from using the banks to be affected were:

i) Intensively managed from Spring until the completion of the capital works;
ii) Bankside and fringe vegetation kept short (<0.15m) through intensive mowing;
iii) Mowing staged as follows: initial 1000m cut in March in the centre of the bank stretch, mowed area then expanded by 200m each month from early July through to November, thus gradually increasing the loss of habitat on the works side, while allowing the enhancement of the habitat on the opposite side.
iv) Bankside vegetation then kept short throughout the winter and until the works are complete.
v) Following completion of works, vegetation management reverts to encourage the re-development of water vole habitat.

Mitigation measures adopted to encourage voles to use the opposite banks were:

i) From the Spring prior to the works and until the completion of the capital works, the aim was to enhance and sensitively manage fringe and bankside vegetation to provide optimal water vole habitat;
ii) Only flail vegetation if necessary, and then not to flail below 0.3m;
iii) No silt agitation, or if necessary employ a method which does not damage vegetation;
iv) Avoid silt agitation when river levels are high (above 7.3m) to minimise damage to burrows;
v) Fence only if essential, to protect habitat from cattle poaching;
vi) If silt berms have to be removed, avoid period of prolonged high water levels;
vii) Within zone of works, minimise damage to vegetation during dredging.

These water vole habitat enhancement measures were also extended to affect both banks of the River Tone for 2 km upstream from the proposed works, and where the proposed works met the River Parrett on both banks 1 km up and downstream. Neighbouring drains were also enhanced. This therefore extended ideal habitat for water voles to compensate for the loss of habitat during the mitigation and works.

This method of exclusion through vegetation removal, together with positive management of adjoining and neighbouring areas, often on the same watercourse, is a common method which has been applied throughout many projects. There are no reports of water vole mortality, and only a few sightings of water voles returning to a site while the vegetation is low. Monitoring of the above site has shown that evidence of water voles has increased significantly along the banks managed positively for water voles, while little evidence of water voles has been found on the intensively managed banks.

5.2.2 Timing of maintenance tasks

Many organisations have been advised to carry out maintenance tasks in winter months to reduce the impact on water vole populations. For low disturbance, this would be appropriate. However, where extensive clearance of vegetation is to be carried out, which would otherwise provide cover for water voles, it is advisable to

carry this out in Spring. Since the vegetation will not substantially re-grow in the winter, removal of this protection for the local population
is likely to expose the population to increased predation over an extended period of time (e.g Howes 1979 and Singleton 1984).

5.2.3 Towpath and pathside mowing

Both British Waterways and local authority access and recreation staff will regularly mow paths, often for safety reasons. The Environment Agency promote the following advice:

- Leave a fringe of vegetation along the top of the bank
- Do not mow bank faces
- Use a noisy mower (to scare water voles into their burrows!)
- Reduce the frequency of mowing to a minimum
- Wherever possible, phase mowing to reduce the overall impact.

i) Mowing urban corridors for flood defence
Many Environment Agency regional offices are now modifying their approach from total cutting to the river edge, by leaving a strip of vegetation along the river bank. Preferably this would be as wide as 3 metres, but clearly this will be determined by the particular water course in question.

ii) Width of a protective swathe
In nearly all cases, monitoring has yet to realise tangible results (or has even not been carried out), and therefore measuring an optimal width for a strip of vegetation to be left along the top of a bank is not possible. Generally, it would be desirable to leave as much as 3 metres wherever possible when the impact is from mowing, although voles occupy banks along canals with as little as 0.5 metres of bank top vegetation (see also 5.5 Disturbance). What is also desirable is to leave the bank face vegetation intact.

iii) Winter mowing
It is important not to mow extensively after September as this removes cover and food plants with little chance of recovery before winter (see 5.2.2 above). Late cuts should leave higher vegetation and should be phased along a bank course.

5.2.4 Drain channel maintenance work

There is detailed advice to be found in the Water Vole Conservation Handbook (Strachan 1998) which should be followed when dredging and maintaining drainage channels. The following guidelines have proved to be beneficial to organisations in this study:

Drainage Channel Maintenance Advice

- Heavy machinery is not driven onto banks
- Dredged materials are not dumped onto the banks but placed 2-3 metres inland from the bank top
- Operations take place from one bank only
- Refuge zones are left as often as practicable, up to 20 metres in width, constituting about one third of the ditch untouched
- Where slubbed vegetation and silt material is to be placed onto banks, known water vole sites are avoided and alternate banks are used at 50 metre intervals (but avoid using both banks for operations).
- Vegetation is not removed or cut back, but if this has to be carried out then the bank face vegetation, a continuous strip of marginal vegetation and as much of the bank top vegetation should remain.
- Dredging should take place during the winter months, especially where it is a frequent maintenance operation, but care is taken to avoid loss of vegetation voles use for defence against predation.
- The use of herbicides should be avoided.
- Sensitive dredging is carried out regardless of vole presence, thus potentially extending water vole habitat.

5.3 Habitat enhancement and creation

The majority of projects employed some form of enhancement/creation, with a total of 25 of the 50 responses reporting this form of mitigation.

There are two occasions when habitat enhancement and/or creation have been employed as mitigation for water voles. The first is where there is no (or little) available habitat on the same water course/system for water voles to move to in advance of a development. Habitat up- and/or down-stream is enhanced or created, thus creating available alternative habitat to which the water voles are then persuaded to move through a method of exclusion (see above). The second is part of the habitat restoration period, post-development.

Some examples of this type of work are as follows:

i) In Cheshire, the Wildlife Trust advised on the creation of ponds and ditch systems to mitigate for temporary habitat disturbance from a proposed Business Park development, and extend the amount of habitat available to water voles during construction. The newly-created habitat was being used by water voles within 2 months of their construction.

ii) In Swansea, Environment Agency staff propose to create buffer strips through the use of fencing and rehydrate adjacent ditches to extend suitable habitat for water voles in advance of ditch clearance and future management.

iii) In the Peak District, the Park Authority, in advance of ditch clearance, have created bunds in side drains in adjacent areas to impound water and permanently improve and extend water vole habitat.

iv) In Staffordshire, a mitigation pond and ditch system was designed and installed upstream and in advance of a proposed by-pass development which would remove a fishing pond currently occupied by water voles. Water voles will be encouraged to leave the site in advance of development.

v) An Environmental Assessment in Abingdon ensured that a buffer strip of ideal habitat was created in advance of a proposed development to protect water voles from habitat loss and disturbance.

vi) In Reading, a bank stabilisation project identified water voles in the surrounding area, but not on the stretch to be affected. Stabilisation was therefore carried out using woven willow instead of pilings, thus extending the available habitat for water voles to occupy in future years.

5.3.1 Habitat enhancement guidelines

The Water Conservation Handbook (Strachan 1998) provides extensive details about different types of habitat enhancements, and all projects submitted to this study have followed these guidelines. This list is a useful summary of what other organisations have used:

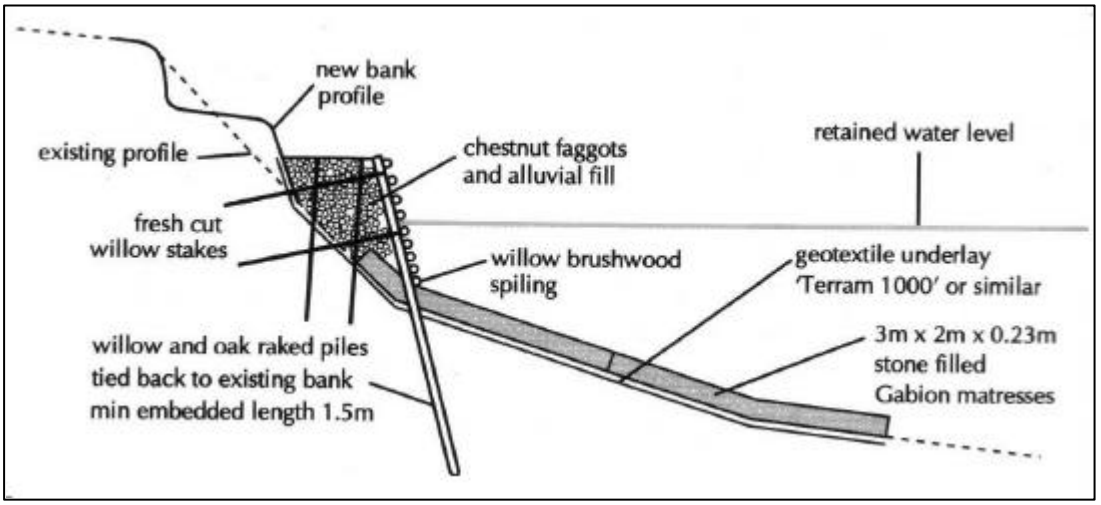
Enhancement features

- Remove some overhanging branches to reduce shading
- Selectively remove an occasional shrub to provide un-shaded gaps (in liaison with the local wildlife trust and landowner– it would be desirable to keep trees and mature shrubs in most instances)
- Erect fencing to reduce or remove cattle poaching
- Create and/or profile banks for water voles to burrow into (see 5.3.2)
- Introduce vegetation that will provide cover and food for water voles (a comprehensive list is provided in Strachan 1998 – pp 7)
- Create ditches and pools or ponds connected to the river, ditch or pond that is under impact, and profile these for burrowing, with ample vegetation.
- Dry ditches/drains may be re-hydrated by introducing sluices or low bunds (may need EA consent)
- Change the current management regime (e.g. mowing) to be less intensive and/or to leave a wide swathe of vegetation along the river bank, encompassing the bank top and bank face (see 5.2)
- Address any vermin control that may be practiced – e.g. rat poisoning and trapping – there are water vole sympathetic methods of rat control (e.g. Strachan 1998 – pp 44)
- Reduce litter and sources of anthropogenic foods which may attract brown rats (e.g. fishing bait, snack remains, wrappers etc.)
- Adapt the course of a fast-flowing river in places to form slower, pools of water next to bank areas that would be more attractive to water voles. On-line and off-line ponds will act as refuge areas for water voles during flooding. Meanderings are ideal not only for different flow rates, but the shelvings and berms they can create are ideal for water voles.

5.3.2. Water vole bank creation

The principle behind creating good water vole banks is to provide a stepped bank face, with good vegetation cover and using a substrate that voles can easily dig into. Again, there are ample details provided in the Water Vole Conservation Handbook (Strachan 1998).

Figure 5: Water vole bank design from the Water Vole Conservation Handbook (Strachan 1998)



Some key requirements for ideal water vole banks are:

- Watercourse has water at all times of the year
- Bank face is stable, vegetated with tall grasses and herbs
- Bank face is stepped (see above) to provide refuge areas during increased water level rise
- There is some depth to the water immediately in front of the bank to allow water voles to quickly escape, and enter burrows unseen
- Bank soils ideally should be friable and loam-rich. Water voles are unlikely to use the site if the substrate is too stony.

i) Bank substrate

Bank edges faced with 'rip-rap' (a substrate comprising large stones and some sub-soil), may inhibit occupation by water voles even if they support a thick margin of vegetation. This can be seen on one refurbished section of the Kennet and Avon Canal where rip-rap was used to anchor replanted reeds; subsequently this was found to be unnecessary. In Shrewsbury, the Environment Agency have reported the use of rip-rap for canal bank stabilisation, and to date surveys have revealed no re-colonisation by water voles. The ideal is to avoid large stones, using top soils wherever possible. Gravelly substrates, which may make burrows less stable should also be avoided.

ii) Bank stability

New bank faces will require some form of stabilising agent, to avoid erosion problems until vegetation can establish. One project in Derbyshire made the mistake of covering the entire new river channel, from bank to bank, with rabbit netting to stop erosion. Consequently, water voles could not dig into the face and what is otherwise ideal habitat remains un-colonised. A project in Northumberland successfully stabilised new banks using large-gauge mesh from gabions (see 5.1.3 iii). These were secured by pinning them to the banks and therefore allow water voles full access to the banks through the mesh. Water voles have been recorded in good numbers along this stretch of bank.

5.3.3 Water vole friendly bank protection measures

i) Sheet pilings

One of the key obstacles to water vole colonisation along a bank after works have been carried out is where pilings are used to create bank and edge stability. Steel piling has been extensively used to address erosion and leakage in canal (& other) banks but in doing so effectively remove water vole habitat totally, often for significant stretches. Ironically, in some cases existing water vole burrowing has caused much of the original damage, compounding erosion and causing a need for bank protection measures. Alternatives to piling to address erosion are easier to find than where leakage is the problem, however deep piles set away from the water's edge can be used in places where there is impermeable geology below the embankment.

In Oxfordshire, along Drinkwater's Embankment, Oxford Canal, British Waterways successfully buried sheet piling under the outer edge of the towpath instead of the bank edge. The end result was a protected canal bank with ample opportunity for water voles to return. They have now been recorded along the canal bank at this point in good numbers, representing a successful mitigation project.

Figure 6: Restored towpath with sheet piling under the towpath

Supplied by Cengiz Philcox

Line of steel piling set under towpath, leaving ample room for water voles to continue to use canal banks

ii) Assessing different bank protection types

Where repairs to river and canal banks do not require heavy construction methods, mitigation can involve the use of sensitive methods and natural materials, such as coir rolls, faggots and spilings. While these types of measures have been described in some detail in the Water Vole Conservation Handbook (Strachan 1998), other instances recorded by this study are mentioned below.

The Oxford Canal required extensive alteration to one bank which was restored using 4 different bank face protection types (see Figure 9 below). This was a useful study carried out by the Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust (BBOWT) Water Vole Project on the Oxford Canal, together with British Waterways, to examine the relative success of using different bank protection measures.

Type 1: Coir Rolls alone as protection

Where natural earth bank was present, coir rolls were tied to willow stakes. Where the development disturbance was minimal, water vole burrows were found at 14.9 burrows/100m. Where disturbance was very high during the development, no burrows were subsequently found one year after the development. Throughout this area, there was a high latrine count, averaging 59.7 latrines/100m. Feeding signs were also frequent.

Type 2: Concrete piling with coir rolls below (fig. 7)

Where still intact, the old concrete canal piling was left untouched in some stretches and coir rolls were attached at water level. While some latrines were found (11.3/100m), and some feeding stations (17.0/100m), no burrows were located.

Supplied by Cengiz Philcox

Figure 7: Coir rolls pinned with willow poles, with no other bank revetment

Type 3: Steel piling in front of concrete piling with gaps(fig. 8)

Stretches of bank were repaired using steel piling, where significant repairs were required to stop canal leakage. The deteriorating concrete piling was left in place, and steel piling was driven in to water level approx. 150 mm in front of the original piling. The 150 mm trench was back-filled to encourage colonisation by emergent vegetation and the original concrete was broken at intervals to provide 'bays' of damp earth. Some evidence of burrowing (2.0/100m), latrines (11.0/100m) and feeding (7.0/100m) was recorded.

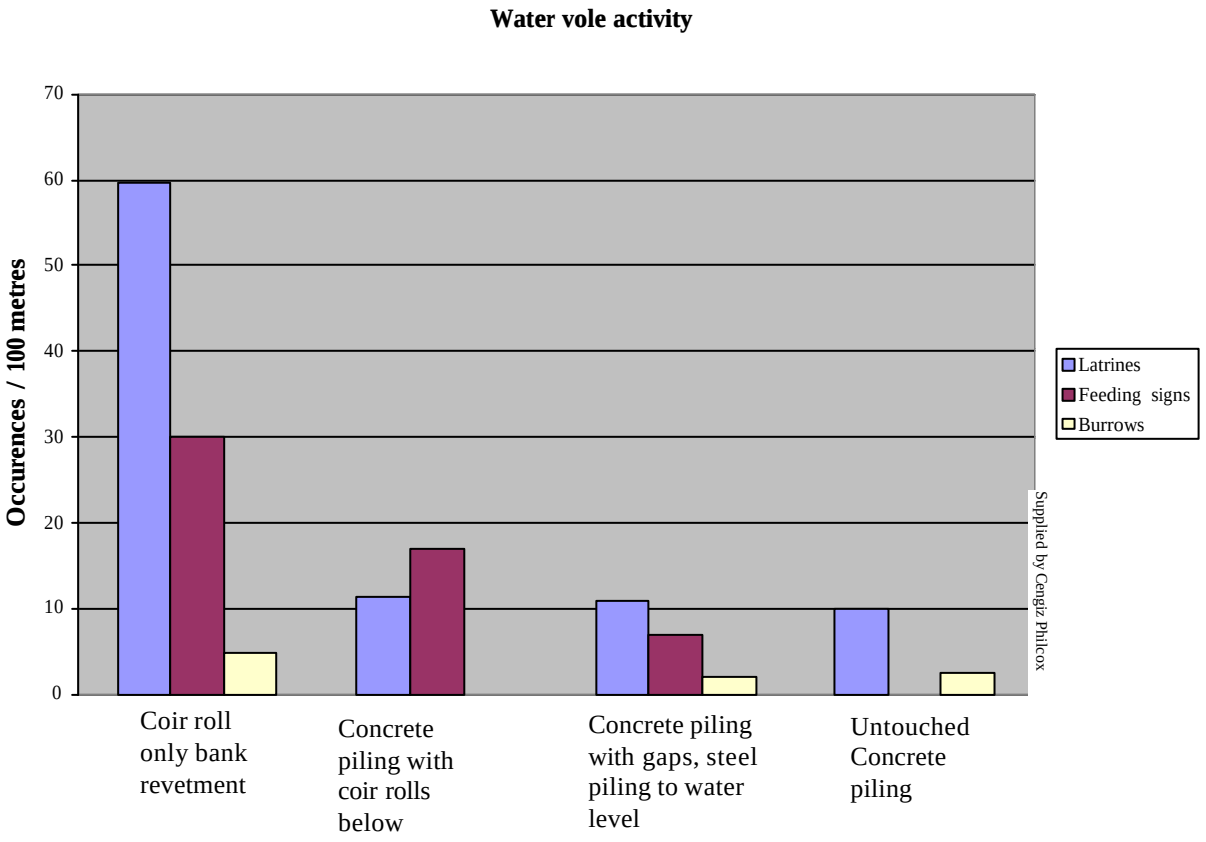
Type 4: Original concrete piling left undisturbed

In this case, where the concrete piling needed no repairs, some evidence of burrowing above the piling (2.5/100m) and latrines (10.0/100m) were found, existing from pre-development times.

Supplied by Cengiz Philcox

Figure 8: Concrete piling with gaps to provide 'bays' of damp earth, steel piling to water level

Figure 9: Frequency of water vole activity following different protection types

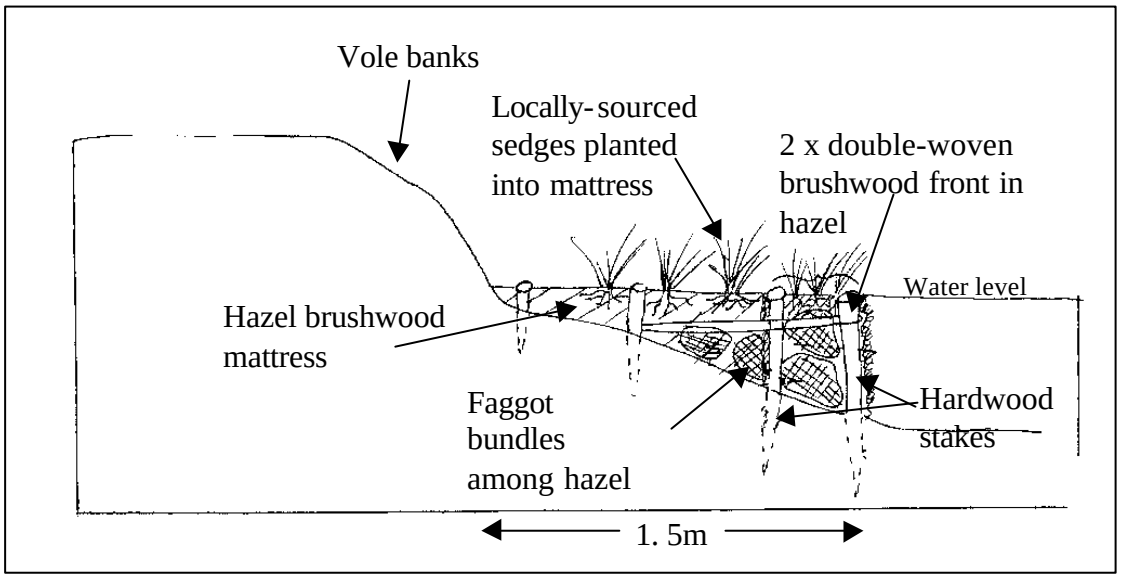


The graph in Figure 9 above confirms the benefits to water vole populations of using natural bank protection material, with little disturbance. The use of piling to water level, in front of existing damaged pilings is also of some value, as shown by this chart. There is, however, likely to be significant habitat destruction and disturbance during these works, and water voles may have to be excluded in advance of works.

iii) Hazel revetment

River management consultants in Wiltshire designed a bank protection scheme using woven hazel wattle retaining walls and faggot bundles (Figure 10). Water voles quickly occupied the banks following revetment works and graze the locally-sourced sedges. In some cases the faggot bundles were back-filled, with dredgings over the faggot bundles. Water voles are known to have used banks with or without backfilling, following restoration.

Figure 10: Hazel revetment in Wiltshire



Produced with kind permission from The Cain Consultancy

iv) *Using pipes and boarding*

Many design projects have attempted to overcome the problems of water vole access to banks by leaving holes in wooden boarding, or by including pipes, or leaving gaps through brickwork. There is little evidence that these are successful. One Environment Agency project in Wales used wooden boarding to stabilise a bank face, and left a series of holes for water voles to gain access to the bank behind the boarding. The water voles did not use the holes, and were recorded climbing over the boarding instead.

Other projects have left gaps between brick or stonework. These have been used by water voles in some cases. Water voles have also been recorded occupying bank faces through holes in derelict brickwork that has started to crumble.

The use of pipes has yet to be recorded as successful. One project used degradable pipes, so that the water vole burrow became natural. Another used ribbed lining in the tube, to make plastic pipes easy to climb into. However, no monitoring results are available. Leaving holes for water voles, and using pipes, is therefore not a proven solution for mitigation, but may offer some limited opportunity where no alternative is available. Further monitoring is required by those projects which have employed this type of mitigation and information such as pipe diameter, texture, angle and height above water is still required.

v) Vole habs

British Waterways has used a commercially available product designed to allow burrowing where bank protection measures would have otherwise removed access to the bank face. They are wooden box-like inserts built to fit the size of an area of erosion/bank protection. Used where steel piling was unavoidable, these structures were placed with the base at water level, fitted between steel pilings, allowing access to the bank behind. In some situations, a shelf can be created in front to support plants; nearby good habitat is a likely prerequisite for success.

For most situations better solutions, such as coir rolls, are available. However, where highly engineered solutions are required which will preclude such softer measures, these may be a option for consideration. Water voles have not yet been recorded using these structures, but voles are known to occupy banks between gaps in brickwork. More information can be obtained from British Waterways.

5.4 Exclusion

This type of mitigation was planned or carried out in 10 projects reported to this study. It is encouraging that many organisations are employing a method of exclusion. What is not always clear are the detailed methods of exclusion being practised. For example, in some cases, trapping is being advocated alongside exclusion, often without justification. The methodology for exclusion in this report will provide a reference for future projects.

Exclusion is a method of mitigation which persuades water voles to leave a stretch of water course to allow development or land management to go ahead. It is carried out by removing the vegetation. There are certain conditions under which this method will not work or will not be appropriate, and the method must be carried out in a certain way otherwise it will not be successful.

5.4.1 Trialing exclusion

Perhaps the most significant exclusion project is that carried out in Lincolnshire, at Keadby Power Station. This project trialed an exclusion method to assess whether voles would leave a site as a result of vegetation removal, and whether they could re-establish their population (Arnott and Dean 1999).

The project aimed to build an access road to the power station, from the A18, across a number of drainage ditches which surrounded agricultural fields. Discrete populations of water voles were present on a number of the ditches, and occupied the location planned for bridge foundations. Water vole populations were therefore under direct threat from this development, and mitigation was required.

The initial survey identified ample available alternative habitat on the same stretch of drain, and elsewhere on neighbouring drains. The development was scheduled for late September 1998. Following the survey, and in close liaison with the Environment Agency local office, it was agreed to attempt the removal of vegetation. This was carried out using a strimmer and supervised by an ecologist. Importantly, it was discovered during this project that a metal-bladed strimmer is the best tool to use, and grass cuttings must be raked off, exposing as much earth as possible. Burrow entrances were marked and checked to ensure they were unblocked.

Fencing was erected 3 days after strimming to prove the theory that voles would leave of their own accord (Figure 11 below). As burrowing animals, it would be difficult to be absolutely sure that any or all of the population had left. The fencing ensured that during a later trapping phase, water voles would not return, and that any animals caught in traps would be from burrows in the affected area. Traps were employed and extended for five days after fencing.

Results

Following the strimming, a heavily trampled pathway was discovered leading along the ditch to a newly burrowed area about 100 metres from the fenced site, and passing through existing water vole territory. The new burrowing was evident from the spillage of new spoil from >15 new burrow entrances (Figure 12 below).

Over the next three days, vole runs were found running into the adjacent corn field and piles of seed husks were found around the new habitat; evidence of new food stores being collected. Water voles are rarely known to feed on seeds from arable fields like this, avoiding competition from other small mammals: this is a more typical feeding sign of brown rat at this time of year (September). However, no signs of brown rat were found, and it is more likely that in this case, water voles collected seeds in an urgent attempt to build up food stores.

The trapping resulted in no water voles caught, and it was therefore clear that the strimming had been successful. Following development, the water vole population is present in good numbers along the ditch.

Figure 11: Fencing of strimmed area

Supplied by Andrew Arnott

New burrow system 100 metres from original site.

Figure 12: Newly created burrow system

5.4.2 Exclusion to mitigate for a short-term temporary loss of habitat

The majority of projects submitted to this study detailed temporary loss of habitat, often just for a few days, to allow a watercourse crossing for developments such as a pipeline or road-crossing, or for small projects such as the installation of a sewage outfall next to a new housing development. In these cases, exclusion through intensive strimming of vegetation has proved to be a cost-effective, successful way of encouraging water voles to move from a site for a few days.

Where impacts cannot be avoided, this method of mitigation appears to be the most beneficial to water vole population conservation and welfare. It can be applied as a single technique, or can be part of a larger mitigation project. Wherever active mitigation is required, this is by far the most preferable of methods to be used and should be the first option to consider.

i) Principle

The principle of the method is to change conditions locally so that the population of water voles make a decision themselves to leave a particular bank or area, and to carry this out at the right time of year where there is available alternative habitat. It may be that the habitat the water voles currently occupy is to be permanently removed or temporarily disturbed/removed. Whatever the event, where alternative suitable habitat is available and accessible (see chapter 4), this method should be applied.

One method of habitat change might be to remove the water that the water voles are dependent on. However, this is nearly always impossible and/or very expensive, and in some cases water voles show such a site fidelity that they may remain in place after the water has been removed (pers. comm. Rob Strachan). An alternative approach is to remove the vegetation that they use for shelter. From the trials in Lincolnshire (see 5.4.1 above), this is known to be effective.

ii) Vegetation removal

With only one exception in instances where this has been applied (see 5.4.5 below), the population has vacated within three days and will only return when the vegetation returns. However, the vegetation removal must be total, without using heavy machinery or digging, since both these activities may cause underground burrows to collapse. Prior to vegetation removal, a survey should identify all burrows and their entrances should be clearly marked, so that they can be checked following vegetation removal to ensure they are not blocked.

An ideal way to achieve this is with a metal-bladed strimmer, removing the vegetation and then skimming the surface to leave as much bare earth as possible. One project employed this method with a plastic cord strimmer and left a few centimetres of grass. This encouraged the voles to maintain latrines throughout the site and may even have given the voles reason to continue to occupy the burrows, since the short grass is good food for grazing (although the voles themselves may have suffer a higher predation risk).

The vegetation should be removed from water level, up the face of the bank and up to a minimum of 1.5m/maximum of 3m inland from the top of the bank. Also, emergent vegetation should be removed from the water's edge, but limited to the edge to ensure that no significant damage is done to other dependent water species (where developments intend to cross a water course, or completely 'destroy' it, it may be beneficial to consider complete removal of emergent vegetation). The site should then be left for a minimum of three full days and nights to allow voles to abandon their burrows. At the end of the three days, the site should be checked to ensure that latrines are not being maintained in burrow entrances. If they are, then the site should be left for a further three days, with constant attention to maintaining the bare-earth effect.

The extent of strimming should include the total zone within which the developer intends to work, and a further 10 metres either side of this zone to act as a buffer from disturbance (see Figure 13 below). The area should be clearly marked out so that contractors do not store materials or park heavy machinery with the area, thus potentially causing underground chambers to collapse. An ecologist should be present to oversee the strimming and check burrow entrances for blockages after the strimming.

Supplied by Andrew Arnott

Figure 13: Banks of the River Leen following strimming, in advance of an open cut pipeline crossing

iii) Mitigation timing

Ideal timing

The ideal time of year for exclusion is April, after the water voles have emerged from winter activities and prior to voles having young. Alternatively, late – August/September is a good time of year, since the population is at an all-time high for the year, and when any mortality in young still in burrows, that are abandoned by females, will not contribute to a local population fall. It is, however, more likely that a female will carry her young to an alternative site.

Winter works

If the project is planned for winter months, it is possible to carry out this method at the times mentioned above and then maintain an unsuitable habitat until the time of development. It is important to ensure that in changing the habitat, appropriate measures are put in place to stop bank erosion and protect the river corridor.

Water voles are also known to have a higher fidelity to a site in winter (pers. comm. Rob Stachan 2001), when there is a greater dependency to underground foodstores and a greater risk from predation. Should the development need to be carried out in winter, but with no prior notice to allow summer working (e.g. emergency works such as bank

stabilisation or flood alleviation), then the water voles will have to be excluded as above, but vole-proof fencing may have to be introduced 3 days later, with traps set to remove voles, since their fidelity to a site may mean they will not voluntarily move as easily as in Summer. Trapping will be, however, more difficult due to reduced above ground activity and may even risk vole fatalities due to animals losing heat over night if temperatures fall too much. Water voles will still move through their home range during the winter months, especially during warmer periods, and latrines can even be found. Where there is available habitat, the voles can then be released outside the fencing. Where there is no available habitat, exclusion should not be carried out, and the voles will have to be trapped and relocated.

It is imperative that winter mitigation measures are not carried out during periods of intense cold (especially over-night) or high rainfall/floods. In addition ample sources of food, such as carrots, apples and grain, and bedding such as hay or straw, should be left conspicuously in and around the alternative habitat that the voles will occupy, allowing them to quickly build up their winter stores. It is possible to identify the water voles' new habitat by surveying the banks for new burrows (identified easily by the new piles of spoil outside burrow entrances), and scattering food and bedding around this area.

Summer breeding period
It is recommended that work is avoided over the period of prime breeding for water voles, such as May – August, deferring action until September. If unavoidable and work has to commence in the summer then the period of vegetation removal should be extended and maintained for at least 2 weeks prior to the development, thus giving young water voles time to become mobile. It is, however, more likely that a female will carry her young to an alternative site.

iv) Extent of mitigation
As discussed above, the exclusion technique is dependent on there being available alternative habitat that vacating water voles can move into. This is nearly always the case, since it is rare that this method will be applicable to excessively long stretches of bank. More often, this method will be applicable to those developments that do not exceed 100 metres of constant impact. Some examples of the types of developments that will require small scale exclusion are:

- Installation of / repairs to sewage outfall – often required with new housing / holiday developments
- Pipeline crossings (open cut)
- Road crossings
- Bridge developments/modifications/repairs
- Bank repairs/modifications
- Installation of gauging stations

Where the impact is considered to be significantly greater, then more substantial mitigation measures will be required, which will take longer to plan and implement, such as habitat creation in advance of development (see 5.3).

v) Knowing when exclusion has worked
As burrowing animals, water vole movements are difficult to monitor, and short of using radio tracking techniques (which are expensive and not always available), it will

not always be possible to be absolutely sure that all animals have left an area of exclusion. A method employed or proposed by two studies was to fence off the area of exclusion 3 days after strimming vegetation (e.g. see 5.4.1). Traps are then employed for a further five days. In both cases no animals were subsequently caught. It is therefore not clear whether this latter stage of fencing is required, but where the ecologist on site has evidence that water voles are still using the area of exclusion, it is recommended that fencing and trapping should be employed. Trapped animals should then be released into available alternative habitat, or in the absence of this, relocated to ideal habitat elsewhere. In the latter case, ideal habitat on the same watercourse would be the most preferred, and in some cases (e.g. 5.6.1), these animals may have to be fenced in to encourage site fidelity.

Only through future monitoring of a wide range of developments will it be possible to have confidence that the method of exclusion is as effective as it appears to be. Of the variety of exclusion projects submitted to this study, there have been no reports of water vole mortality and only one report of water voles having such high fidelity to a site that they chose to remain in the absence of vegetation.

vi) Signs to look for to assess whether voles are still using a site following strimming

- Actual sightings of water voles within the exclusion zone
- Fresh latrines, especially at burrow entrances
- Newly-worn track ways which water voles may create during emigration (see 5.5.4 & fig. 17)
- new digging in an undisturbed area up- or downstream from the area of exclusion (see 5.4.1)

It may be possible to employ other means of detection, such as placing vegetation over the entrance to burrows and regularly checking these. Alternatively, a full day's observation from a hide may also be employed to keep watch on the area, although even this may be difficult as the reduction in cover may encourage voles to only surface in the night.

vii) Water vole fencing

Very few projects have employed fencing which makes it difficult to prove the best type of water vole proof fencing to employ. However, the following are some parameters which must be met:

- The fencing should be high enough to stop water voles climbing over the top – the Keadby project employed ½" plywood c.270cm high (5.4.1), and the Papplewick project (5.6.1) used similar material c.180cm high.
- Fencing should be buried into the ground to deter voles from burrowing underneath (perhaps to the depth of the water level).
- Fencing should be checked every day and searches made for any signs of burrowing, both from the outside and inside;
- Fencing down a bankface should ensure that connecting burrows are cut off from the outside by the fencing being buried deep enough (fig. 14). At Keadby in Lincolnshire (see 5.4.1), a JCB was employed, with a spike-ripper, to tear a slot into the ground down to water level, into which fencing was buried. An ecologist was on-site to carefully observe operations, and the JCB was kept off the bank top to avoid causing any underground burrows to collapse

- When trapping voles, animals should be marked in some way (e.g. a small area of fur snipped off in a visible place) to prove that the animals being caught are not returning to the exclusion area, or are not escaping from a receptor site.
- The disturbance from fencing may in itself be the last straw and cause any tenacious voles to leave a site. Therefore it is important to leave one face of any fencing open for the first night, to allow voles to escape.
- It is important to ensure that in carry out fencing, the impact does not cause underground burrows to collapse.
- Simple ½ inch plywood has proved effective fencing material, and is relatively inexpensive.

Supplied by Andrew Arnott

Figure 14: Plywood dug into the banks to cut off inter-connecting burrows prior to trapping.

5.4.3 Excluding in advance to avoid a potential problem

In Gwynedd, a road and railway construction project identified ideal habitat which was to be lost to the development. Survey work concluded that no water voles were present, although they were known to be present in the surrounding area. Since the project was not due to start immediately, the banks to be affected were strimmed regularly in advance thus ensuring that water voles did not move onto the site prior to the start of works.

Another project in the East Midlands destroyed unoccupied banks on a water course known to have water voles present, in advance of a proposed development, as opposed to strimming them over a long period of time. While this did have the desired effect, it removed important habitat for other river species, and is not a preferred option.

5.4.4 Removing vegetation using light-proof barriers

One project employed the use of a light-proof barrier to remove vegetation and stop it returning. The barrier was constructed on a frame, and made out of material similar to carpet underlay. The vegetation did not die off to a significant extent, and water voles were not discouraged from the site. The project resorted to strimming and hand removal of vegetation, which proved successful. The voles left the site and the works commenced.

Exclusion: A ten-step summary

The following is a tried and accepted way to carry out the Exclusion Technique:

a) Carry out a survey looking for signs of voles, using methods documented in Strachan 1998. Extend the survey to encompass 500m of bank length where possible, with the point of development at the centre.
b) From plans provided by the developer, identify their working zone, and include at least 10 metres either side of the extent of this zone. This is the area where vegetation will be removed, and the 10 metres extension of vegetation removal either side constitutes a buffer zone.
c) Identify and mark the location of all burrows within that area.
d) Strim the vegetation with a metal bladed strimmer, removing vegetation so that only bare earth remains. During this procedure, an ecologist should be present and should ensure that burrow entrances do not remain blocked.
e) Maintain this bare earth effect until the development proceeds. Ideally, this should be carried out 3 days prior to the development commencing, but will vary according to the timing.
f) For Summer works, vegetation removal should be carried out for a 2 week period prior to development. Winter works should either carry out the mitigation in September and maintain unsuitable habitat until the works or in the event of an emergency trapping and vole-proof fencing may have to be employed. In this latter instance, advice from an expert is required.
g) Works to the banks following strimming should be done by hand wherever possible. Where this is not possible, then an ecologist should be present while the banks are being opened up.
h) At no time should any machinery, vehicles, materials or other heavy items such as porta-cabins be stored on or within 3 metres of the banks.
i) Restoration should be carried out as part of the overall scheme, to return the affected banks back to at least the habitat that was originally there, although there are always opportunities to improve the habitat as part of a restoration scheme.
j) To complete the mitigation package, some form of monitoring should be implemented. This should consist of at least one visit to the site once the vegetation from restoration has matured, and during the breeding season when signs can be found to tell whether the voles have returned to the site. An ideal monitoring scheme would include two visits for two breeding seasons, at the start and end of each season. The results of monitoring should be made available to the local Statutory Agency office, the Environment Agency or the local Wildlife Trust as part of the monitoring of local Biodiversity.

5.4.5 Where exclusion did not work

A development project in Leicestershire introduced exclusion through intensive strimming of canal banks, in advance of a marina development. Extensive new habitat was created and allowed to mature in advance of mitigation.

Water voles on this site did not leave voluntarily, regardless of the very intensive strimming. The turf was then removed completely to further intensify the disturbance and habitat removal. Voles were still recorded re-entering underwater burrows. It was then decided to begin piling along the banks, to further increase disturbance, and in the knowledge that ideal habitat on the same watercourse was immediately available. Still water voles persisted, and even during these works, were recorded "swimming around workmen", trying to re-enter old burrows. This is the **only** record of the exclusion method not working. It represents a very unusual case, and the reason for such high site fidelity is currently not known. **It does represent a need to carry out exclusion with caution, with an ecologist present at all stages and a need for monitoring throughout the project**.

5.4.6 Other potential problems with exclusion

i) *Predation*
Without the pressures of predation, the water vole may be capable of reproducing sufficiently to recover from temporary loss of habitat and/or disturbance, and surviving in such numbers that loss of habitat would have only a very localised, and often temporary, effect. However, studies carried out in the past have shown that habitat loss has resulted in an increased predation by native predators such as barn owl and fox (Howes 1979), but which in more recent times will undoubtedly now include mink. It is imperative that emigrating water voles have easy access to good cover when being persuaded to move through the method of exclusion.

ii) *Recolonisation*
A study in Lancashire showed that it took up to 18 months for the population to fully recover after dredging and bank re-profiling of a drainage ditch (Singleton 1984). Monitoring of projects will provide valuable information about the re-colonisation rates of different populations in different circumstances. There has been few long term studies recorded to date concerning mitigation work by exclusion and much of the monitoring being carried out has yet to yield results. Where monitoring has been carried out, site visits have confirmed that in all cases where water voles have been successfully excluded and the habitat has been restored to at least its former quality, water voles have returned the following year, although little evidence exists yet to determine the numbers in which they have returned, and if indeed these water voles are from the original population.

5.5 Disturbance.

Disturbance, for the purposes of this report, is an activity that does not directly affect water vole habitat: there is no habitat loss, nor any activity that physically changes the water vole habitat.

A number of studies showed that water voles are capable of tolerating quite high levels of disturbance, whereas in some cases it was evident that water voles preferred to move on to quieter grounds. There is no objective way of knowing what a particular population will decide to do in the event that disturbance is introduced and there is therefore no scale to which disturbance can be measured in respect of water vole tolerance. However, using examples of other project's experiences, we are able to provide useful reference points for future projects.

Disturbance is therefore assessed by examining four different categories, high and low disturbance factors, with alternative habitat either available or not (see Figure 1 above, and Chapter 4 for definitions).

5.5.1 Available alternative habitat/high disturbance factor

Should it be likely that the population will be forced to move as a result of the high level of disturbance, then the availability of alternative habitat must be assessed. Where there is available alternative habitat then no mitigation will be required, since migrating voles leaving the site have somewhere to move to and they are known to be able to re-establish in alternative habitat at their own volition. Even better is if the voles remain *in situ*, being able to tolerate the disturbance.

Supplied by Andrew Arnott

Figure 15: Development works in Oxfordshire, showing the 2-3 metre corridor left for water voles

A development project in Oxfordshire left the adjacent watercourse habitat protected from direct impact, with a buffer zone of 2 – 3 metres (fig. 15). The habitat was ideal for water voles and was occupied prior to development works commencing. Subsequent survey work in August, once the works were underway, found no water voles present. Clearly, as can be seen from the adjacent picture, the development caused significant disturbance for a prolonged period. However, the water voles did have alternative habitat to occupy up- and downstream and chose to move of their own accord.

In instances like this, where alternative habitat is available and accessible, and there is no expected direct impact on the water vole's habitat, then mitigation can be confined to assessing the availability of alternative habitat and fencing a good buffer zone from the proposed works.

An ideal minimum buffer zone would be 5 metres (pers. comm. Rob Strachan 2001), providing water voles with the choice of staying in their original habitat. An optimum buffer zone is 10 metres or more. However, this may not be possible (or 'reasonable' in a legal context) with some developments.

It may also be necessary that a Watching Brief be agreed upon, to ensure that contractors do not breach the protected habitat area, especially where the water voles decide to remain *in situ.*

5.5.2 No available alternative habitat/high disturbance factor

In the event that no alternative habitat is available, and the disturbance cannot be significantly reduced or avoided, there are two options top consider, in order of preference:

a) Create habitat by adapting current unsuitable habitat on the same water course or adjacent to the same water course in advance of a development (see 5.3 Habitat Creation) but ensuring that it is a suitable distance from the proposed works to avoid disturbance. Some points to incorporate are:

- The newly–created habitat should be at least the same size as that to be disturbed
- Where the newly-created habitat runs contiguously with the area to be disturbed, the water voles should not be excluded (e.g. by removing vegetation), but rather given the choice of moving or remaining.
- Where the area to be disturbed is not going to be directly affected, and the newly-created habitat does not run contiguously up- or downstream from here, a vegetated aquatic corridor between the two sites should be created (if necessary) and maintained. Water voles will not have to be excluded in this case, being given the choice of staying or moving of their own accord.
- Newly created habitat should be permanent wherever possible, providing an extension and overall gain to water vole habitat as a positive project outcome.

b) Where high grade habitat is not going to be directly affected – i.e. left untouched, and perhaps enhanced through positive management (see 5.2) - it may be possible to begin the proposed works with no mitigation, monitoring the population closely. The water voles may decide to attempt to leave the site, but with nowhere to move to, and a good quality habitat protected from direct impact, it is more likely that they will remain. This is a decision that must be reached with full agreement with the regional Statutory Agency office before works commence, and it is only in cases where creating habitat as in (i) above is not regarded as 'reasonable'. For this mitigation, then consideration should be given to the following before works commence:

- widening a buffer zone to a minimum of 5 metres, although preferably 10 metres where possible. The minimum 5 metre buffer zone should be a pre-requisite for this type of mitigation.

- Ensuring that the greatest disturbance times, e.g. earth moving, is carried out quickly and avoids late April to late August when water voles are likely to have young.

5.5.3 Available alternative habitat/low disturbance factor

Where the disturbance is not expected to cause water voles to leave their habitat, and where alternative habitat is available, then no mitigation will be required. It will be useful to monitor the site at the start of any disturbance, including the following morning, in order to record the effect of that type of disturbance, and disseminate this information so that other projects can benefit from the experiences gained.

One project in the East Midlands required percussion bore-holing within 10 metres of occupied banks, lasting for 5 hours (fig. 16). The population was monitored both visually and through photographic monitoring of the vegetation to record any significant changes in trampling (by voles migrating through the night). The disturbance was so great that the percussion bore-holing caused the opposite banks from the bore-holing to noticeably vibrate and no other form of bore-holing was feasible at this site.

Figure 16: Boreholing 10 metres from water vole population

Supplied by Andrew Arnott

No evidence of water voles leaving the site was recorded, and fresh latrines were found throughout the site. The water voles clearly remained *in situ*, and tolerated the disturbance. There is no information from this or other projects to assess whether water voles would move should the disturbance have lasted longer. Therefore, it is reasonable to require bore-holing to be staged when it is likely to last more than one day. Perhaps one or two day lapses would be suitable.

5.5.4 No available alternative habitat/low disturbance factor

Where the disturbance is not expected to cause water voles to leave their habitat, and where no alternative habitat is available, then the population should be closely monitored during the disturbance, and it should be stopped immediately on discovering that the voles are not tolerant to the disturbance. In nearly all known instances, water vole populations that evacuate their burrows as a result of indirect impacts have done so during the night. It is important to be able to monitor this, but difficult to achieve. One study used photographic monitoring, taking photographs of the vegetation before and after to look for excessive increases in trampling by the water voles, since they have been known to create conspicuous runs in the vegetation when migrating (see 5.4.1).

Supplied by Andrew Arnott

Figure 17: Trampled runs left by excluded water voles overnight

Where the impact is only deemed to last for a short period of time, water voles are likely to remain in situ. It may therefore be possible to reduce the length of time that a disturbance impact will last and extend periods between bouts of disturbance. However, if the impact is clearly displacing the population with no alternative habitat for them to occupy, then the advice given in 5.5.2 above should be followed.

5.5.5 Timing of disturbances

Many small-scale disturbances, such as bore-holing or small excavations near to a water course, have flexible timescales. Generally, it is the experience of this study that water voles will tolerate these small scale disturbances, conditional to no habitat loss or degradation. Water voles are also known to have a higher fidelity to a site in winter (pers. comm. Rob Strachan 2001), when there is a greater dependency to underground food stores and a greater risk from predation. Small scale disturbances are therefore likely to cause less vole migration during the non-breeding months.

Where water voles are likely to be displaced by disturbance, either to other available habitat or to created habitat, the ideal time of year would be March/ April or August/ September. This avoids winter months and, early in the year, avoids main breeding times when females will have young. August/September is the time of year when the population will be at its all time high, and overall any mortality, through for example increased predation, will have the least impact.

5.6 Relocation

Only two projects were reported to this study where voles had to be moved, of which only one actually went ahead in Nottinghamshire.

Should exclusion not be suitable to mitigate where direct habitat loss is unavoidable, e.g.. where there is no alternative available habitat for water voles to occupy, then water voles will have to be moved to a new receptor site. The impact to a water vole population will be quite significant, and it is likely that there will be considerable costs involved. This method of mitigation must be a last option, having considered and rejected all other options.

The relocation of a population is a serious undertaking, and research into the methods, effects and impacts associated with this form of mitigation is still being carried out. This study can only provide evidence from one project. Professional advice and expertise should be sought in advance of carrying this type of work out.

Relocation can be divided into two categories: relocating water voles along the same water course, and relocating, or translocating, water voles to a receptor site on a different water course or pond. Both of these mitigation techniques can be relevant to permanent or temporary habitat loss.

5.6.1 Relocation to areas on the same water course

There are certain conditions where exclusion will not be a suitable method to move water voles, thus creating a need to relocate voles by trapping and moving them. The most obvious reason to move a population is the absence of any alternative habitat for the voles to move to. This could be because a physical barrier inhibits the water vole's ability to reach alternative habitat, or it could be that all available habitat is already occupied, either by brown rat or by other established water vole populations. It is also possible that the population is currently occupying the only stretch of suitable habitat on the water course. Where that habitat is to be lost, then the only course of mitigation is to move the water voles out to a new habitat elsewhere.

Where water voles must be moved, then the best option is to keep the population on the same water course. It is likely to be less expensive to do this, and will maintain the local genetic resource. Water voles are also known to have a high site fidelity and will be more likely to re-occupy a restored habitat following works, thus potentially extending the local population along the same water course.

i) River-bed regrading, River Leen, Nottinghamshire

As a result of subsidence, the bed of the River Leen in Nottinghamshire had to be re-graded and the banks re-profiled over a 400 metre stretch to alleviate flooding of local residences. A healthy population of water voles was identified along the stretch of river to be worked, and no suitable alternative habitat was available upstream because culverting and a converted mill blocked any pathway upstream. Downstream all habitat was entirely unsuitable with no possibility of enhancement.

It was decided to construct a receptor site as close to the river as possible of sufficient size to accommodate all of the water vole present. The chosen area was an old dried up mill pond approximately 30 metres from the river at the bottom end of the impacted reach.

The design of the receptor site was critical if it was to function effectively. It needed to have a constant water supply and needed to be vegetated to provide the voles with cover and a food source. The site also needed to be fenced to prevent voles from returning to the river whilst the works were in progress.

The site was constructed by carefully digging a single ditch that zig-zagged back and forth to create the maximum length of watercourse possible in the available area. The ditch was cut using a long reach excavator to avoid damaging the vegetation on either side of the new channel. The vegetation along the line of the ditch itself was carefully stripped off as a series of turves and these were carefully placed along the finished channel so that they overhung the sides. The upstream end of the ditch was linked to the River Leen by a pipe to provide an inflow of water to the site and a piped outlet was installed at the bottom end. Water levels within the arms of the ditches were adjusted by placing spare turves in the channel to create mini dams.

Figure 18: Newly created water vole habitat, River Leen

Supplied by Steve Betts

Figure 19: Water vole fencing

Supplied by Steve Betts

The end result was a long flowing ditch with established vegetation on the bank tops and overhanging vegetation along the sides of the ditch. The site was completed in March when the vegetation was starting to grow vigorously with the result that the site matured rapidly following its completion. The finished receptor site took two days to complete and received its first water vole the following week. More than 20 water voles were moved to the receptor site over the next two weeks. However, an accurate

final estimate of the total number moved was not possible because of escapes during the first few days of the exercise.

Regular surveys of the receptor site revealed that water vole readily adapted to the new habitat by creating burrows and runs underneath the turves. Within two weeks of the translocation process being completed surveys also revealed many new signs of water vole activity including burrows, runs, droppings, latrines and feeding stations.

The bank re-profiling included the creation of a berm on both sides of the watercourse onto which the marginal vegetation was replaced. This had the effect of re-establishing vegetated banks straight away and within a couple of months of completion the engineering works were virtually undetectable.

Once the re-grading work had been completed the fencing around the water vole receptor site was removed to allow the animals to return to the river. Within a week of this happening fresh signs of water vole activity were observed on the section of river nearest to the receptor site.

Water vole surveys carried out during late summer 2000 showed that water vole were still present within the receptor site and had recolonised the regraded section of the river. The results of a trapping exercise carried out at the same time suggested that only juvenile animals remained within the receptor site, the only adults trapped being found along the river itself. Further survey and trapping work is planned for Spring 2001 to investigate animal distribution throughout the site.

Supplied by Steve Betts

Figure 20: Pipe inlet from the neighbouring river to provide a constant water supply

Some key lessons that can be learned from this project are:

i) A receptor site can be created and used effectively within a couple of weeks if the site chosen comprises mature grassland, the channels or ponds are constructed sensitively to avoid compaction, and if the work is carried out in the Spring.

ii) A regraded watercourse can provide useable water vole habitat within a couple of weeks of completing the work if vegetation is saved and transplanted. In this case the marginal sedge vegetation was saved and replanted on a marginal wet berm/shelf created as part of the regrading works. Water vole recolonisation was observed within two weeks of the work being completed. The channel was completely revegetated within a month.

iii) Riparian marshes provide important refuge areas for water vole, and possibly a breeding area. The sedge marsh at the downstream end of this site yielded far more voles than expected and not all may have been captured.

iv) Water voles have a very strong homing instinct and will try to burrow out of enclosed receptor sites. In this case burrows were found under the marine ply fencing and in one case through the fencing. In retrospect the translocated animals could have been marked in some way to detect escapees more readily.

5.6.2 Translocation to a habitat on a different watercourse

In extreme cases, a population's habitat will be completely destroyed with no opportunity for that population to be excluded or to be locally moved to a habitat on the same water course. There is considerable research being carried out by the Environment Agency into the effects of translocation and the ideal methods to employ and this report does not aim to pre-empt that work.

The works carried out to stabilise the Kennet and Avon Canal in Wiltshire is an example of this type of project, where the water vole habitat was to be removed totally, and the population was held in captivity and returned at the end of each phase of works. The project has been documented in the Water Vole Conservation Handbook (Strachan 1998).

6. Monitoring

Of the projects submitted to this study, greater than 95% did not have any results from monitoring, either because it had not started or the first year of monitoring was not complete. In addition, a small percentage of projects had not followed up original plans to monitor. In all cases, monitoring was part of the proposed mitigation.

6.1 Benefits of monitoring

6.1.1 Widening knowledge

Monitoring will provide important information about the methods of mitigation used and their success/failures. This information can then be widely disseminated, and future projects will be able to 'fine-tune' mitigation methodologies and work towards more efficient and water vole-friendly techniques.

6.1.2 Making changes

During a scheme, changes may be required to ensure water voles are not harmed. Ongoing monitoring will help to identify these changes at the earliest opportunity.

6.1.3 Assessing water vole distribution

Records of water vole populations collected during surveys, and through future monitoring, adds to our wider knowledge of water vole distribution.

6.2 Types of monitoring

6.2.1 Surveys

Water vole surveys can be carried out to assess the presence and absence of water voles on completion of the works. There is little knowledge about recolonisation rates and numbers, and therefore to assist in collecting that knowledge, the following schedule is recommended.

i) Where restoration is complete during breeding months, surveys should be conducted at 1 month intervals until water vole presence is detected. Where works are complete in winter months, a survey should be carried out in April, followed by one in each of the following two Septembers.

ii) On detection of water vole recolonisation, one survey should then be carried out in September, followed by one in the following April and the following September.

iii) All results from monitoring should be made available to a wider audience through for example published articles. The results should also be made available to the local Statutory Agency office, the Environment Agency or the local Wildlife Trust as part of the monitoring of local Biodiversity.

6.2.2 Photographic monitoring

It will be important to assess whether water voles have actually left a site as a result of exclusion methods. Water voles have been recorded moving in numbers over-night, making it even more difficult to assess presence and absence. The use of radio-tracking would be an ideal method for monitoring movements of voles, but this is very expensive.

One study in Nottinghamshire employed the use of photographic monitoring, to observe changes in trampling as a test to see if water voles would move as a result of heavy disturbance. The work carried out in Keadby (see 5.2.1) observed heavy trampling along new runs as a sign of excessive over-night water vole movement.

i) Method

Stakes were placed at regular intervals along the stretch of bank and photographs were taken at fixed points between each stake. These photographs were then repeated the following two days, and carefully examined for significant changes in vegetation cover.

ii) Results

In this case, no changes were observed, and it was determined that the water voles had not been displaced by the disturbance. Latrines found during the second and thirds photographic episodes supported this.

iii) Conclusion

This is a time consuming method, and the results are difficult to interpret. Heavily trampled runs can be seen without the use of photographic monitoring, and the method was therefore deemed to be of little benefit.

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Appendix 1. Questionnaire

National Water Vole Mitigation Research Project

EMEC Ecology, The Old Ragged School, Brook Street, Nottingham, NG1 1EA

If you have any queries, please contact **Matthew Bowell** on **0115 964 4828**.
We understand the issues of client confidentiality and if there are any questions you do not wish to answer we will be happy to receive partly filled questionnaires.

We would be grateful if this questionnaire could be completed by the March 15th 2000

A. General Details:

Organisation: **Contact name:**

Address: **Nature of work:**

Tel. no.:

B. Water Vole Work

1. Has your organisation ever surveyed for or instigated a survey for water voles? *YES* *NO*

2. What were the main reasons for your survey (e.g. planning conditions)?

3. Have any of these surveys been positive (e.g. voles present)? *YES* *NO*

4. Approximately how many positive sites have you had to mitigate for?

C. With Reference To Your Most Recent &/or Significant Water Vole Work:

Type of development/water vole survey

1. What was the broad nature of the development works (i.e. pipeline construction, ditch clearance)?

2. What was the reason that the vole survey was undertaken (e.g. planning conditions)?

3. What date did you undertake the water vole survey for this piece of work?

4. How many different water vole populations were affected by this work?

5. What is the estimated extent of each population in river bank lengths?

6. If possible, please provide on the attached sheet a sketch of the works vs. their presence prior to the development..

7. Did you find signs of any other riparian mammals?

OTTER *BROWN RAT* *MINK*

8. What proportion of the habitat was affected by these works?

ALL *>50%* *<50%* *MINIMAL*

9. If the works affected the banks or any other water vole habitat did this result in:

Permanent habitat loss *Temporary habitat disruption* *Indirect effects*

Mitigation works

10. If the habitat was disrupted was any provision in the form of mitigation made for voles? *YES* *NO*

11. Was the relevant statuary body consulted for mitigation advice? *YES* *NO*

12 If yes which office?

13. In summary, how was the mitigation carried out?

14. Did this include any habitat improvement works? *YES* *NO*

15. Was the site re-surveyed after the completion of the works? *YES* *NO*

16. Do you regard the mitigation as successful? YES NO

17. Would you use this mitigation method again? *YES* *NO*

18. Would you be prepared to provide further details of this or any other similar water vole projects to EMEC Ecology for the preparation of a water vole mitigation hand book? *YES* *NO*

19. Would you be prepared to fill in a second longer questionnaire on this subject? *YES* *NO*

20. Are there any further comments you wish to make regarding this or other mitigation works? (please continue on the attached sheet)

Thank you very much for your time.

Appendix II: Negative questionnaire responses

Adur District Council
Aquatic Environmental Consultants
Argus Ecological Services Ltd
Arun District Council
Arun District Council
Arun District Council
Arun District Council
Ashford Borough Council
Ashford Borough Council
Astra Zeneca
Aylesbury Vale District Council
Barnet London Borough Council
Basildon District Council
Bath Spa University College
Bedford Borough Council
Bedfordshire County Council
Bournemouth Borough Council
Breckland District Council
Brent London Borough Council
Brentwood Borough Council
Bridgnorth District Council
Brigend (County Borough) Council
Bristol (City) Unitary Authority
Buckinghamshire County Council
Buckinghamshire County Council
Bury Metropolitan District Council
Caerphilly (County Borough) Unitary Authority
Caerphilly (County Borough) Unitary Authority
Caerphilly (County Borough) Unitary Authority
Cambridge (City) District Council
Caradon District Council
Cardiff (County) Unitary Authority
Carrick District Council
Castle Point Borough Council
Castle Point Borough Council
Centre Environment, Fisheries & Aquaculture Science
Cheltenham & Gloucester College of Higher Education
Cheltenham Borough Council
Cherwell District Council
Chichester District Council
Chiltern District Council
Clerk to Rea IDB
Clerk to South Gloucestershire IDB
Conwy County Borough Council
Cornwall Wildlife Trust
Cotswold District Council
Countryside Council for Wales – West Area, Carmarthen
CRA
Cumbria Wildlife Trust
Dartford Borough Council
Dartmoor National Park Authority
Daventry District Council

David Hawker Ecological Consultancy
Dover District Council
Durham Wildlife Trust
East Hampshire District Council
Eastbourne Borough Council
Eastbourne Borough Council
Eastbourne Borough Council
Elmbrdge Borough Council
English Nature - Cumbria team
English Nature - N & E Yorks
Environment Agency - Cornwall area
Environment Agency - Devon
Environment Agency - IOW
Environmental Assessment Services Ltd
Fareham Borough Council
Farnborough College of Technology
Fenland District Council
Field Studies Council
Flinthshire County Council
Folkestone & Dover Water Services Ltd
Forest of Dean District Council
Forest of Dean District Council
Forestry Commission - Midlands Conservancy
Friends of the Earth
Gosport Borough Council
Great Yarmouth Borough Council
Green Balance
Greenwich London Borough Council
Hammersmith & Fulham London Borough Council
Harlow District Council
Harper Adams Agricultural College
Hart District Council
Hart District Council
Hastings Borough Council
Havant Borough Council
Havant Borough Council
Havering London Borough Council
Hertsmere Borough Council
Hill Environmental Consultants Ltd
Hounslow London Borough Council
Hunting Technical Services
IACR-Centre for Aquatic Plant Management
Ipswich Borough Council
Ipswich Borough Council
Kettering Borough Council
King's Lynn & West Norfolk Borough Council
Lake District National Park Authority
Lancashire Wildlife Trust
Leicestershire & Rutland Wildlife Trust
Lewes District Council
Lewes District Council
London Corporation (City of) London Borough Council
Luton (Borough) Unitary Authority
Malvern Hills District Council
Marcus Hodges Environment Ltd
Medway Council
Mendip District Council

Merthyr Tydfil (County Borough) Unitary Authority)
Merton London Borough Council
Mid Devon District Council
Mid Suffolk District Council
Mid Sussex District Council
Middlemarch Environmental
Monitor Environmental Consultants Ltd
Neath Port Talbot (County) Unitary Authority
Neath Port Talbot (County) Unitary Authority
Neath Port Talbot (County) Unitary Authority
Nene Valley Project
Newport (County Borough) Unitary Authority
Norfolk County Council
North Devon District Council
North Devon District Council
North Dorset District Council
North Dorset District Council
North Norfolk District Council
North Surrey Water Ltd
North York Moors National Park Authority
Northumbrian Water Limited
Northumbrian Water Services Ltd
Norwich City Council
Norwich District Council
Oakwood Environmental Ltd
Oswestry District Council
Oxfordshire County Council
Penwith District Council
Plymouth (City) Unitary Authority
Pond Action
Poole Unitary Authority
Portsmouth (City) Unitary Authority
Portsmouth (City) Unitary Authority
Purbeck District Council
Redbridge London Borough Council
Redbridge London Borough Council
Reigate & Banstead Borough Council
Response Environmental Services Ltd
Richmond upon Thames London Borough Council
Rivers Idle & Ryton IDB
Rochford District Council
Runnymede Borough Council
Scottish Natural Heritage - Elgin
Scottish Natural Heritage - Shetland
Scottish Natural Heritage - Strathclyde & Ayrshire
Sedgemoor District Council
Shrewsbury & Atcham District Council
Shropshire County Council
SNH - Orkney
SNH, Isle of Rum
Snowdonia National Park Authority
South Buckinghamshire District Council
South Buckinghamshire District Council
South Cambridgeshire District Council
South East Water
South Gloucestershire Council
South Norfolk District Council
South Northamptonshire District Council
South West Lakes Trust
St Edmundsbury Borough Council
St Edmundsbury Borough Council
Stevenage Borough Council
Stockton on Tees Unitary Authority
Stratford on Avon District Council
Surrey County Council
Surrey Heath Borough Council
Surrey Heath Borough Council
Swale Borough Council
Swindon (Borough) Unitary Authority
Taunton Deane Borough Council
Teignbridge District Council
Tendring District Council
Test Valley Borough Council
Tewkesbury Borough Council
Thanet District Council
The Broads Authority
The University of Bradford
The University of Hull
The Vincent Wildlife Trust
The Wildlife Trusts
Three Valleys Water Plc
Torfaen (County Borough) Unitary Authority)
ULG Consultants Ltd
Unicomarine Ltd
University College Worcester
University of Newcastle upon Tyne
University of Wales
Uttlesford District Council
Uttlesford District Council
Vale of Glamorgan (County) Unitary Authority
Vale of White Horse District Council
Waveney District Council
Wealden District Council
West Devon Borough Council
West Oxfordshire District Council
West Sussex County Council
West Wiltshire District Council
Winchester City Council
Windsor & Maidenhead (Royal Borough) Unitary Authority
Woking Borough Council
Worcestershire County Council
World Wildlife Fund UK
Worthing Borough Council
Writtle College
Wyre Forest District Council
Yorkshire Dales National Park Authority

Appendix III: Full list of Organisations that were contacted.

A

A & F Specialist Consulting Engineers
AB Consultancy Services
Abbott Ecology
Acacia Environment
ACWI Ltd
Adams Hendry
ADAS Environmental
Adrian Lisney & Partners
Adur District Council
AIG Consultants Holdings Ltd
AJT Environmental Consultants
Allen Pyke Associates Ltd
Allott Environmental
Amphibian Reptile & Mammal Conservation Ltd
Anglesey (County) Unitary Authority
Anglesey County Council
Anglia Polytechnic University
Anglian Water
APEM Ltd
Applied Ecology Research Group
Applied Environmental Management Unit
Applied Environmental Research Centre Ltd
Aquatic Environmental Consultants
Aquatic Environments
Argus Ecological Services Ltd
Argyle Energy
Arthur D Little Ltd
Arun District Council
Arup Environmental
ASH Consulting Group
Ashdown Environmental Ltd
Ashford Borough Council
Askham Bryan College
Aspen Burrow Crocker Ltd
Aspinwall & Company Ltd
Aston University
AstraZeneca
Avon Wildlife Trust
Aylesbury Vale District Council

B

Babergh District Council
Babtie Environmental
Barking & Dagenham London Borough Council
Barnet London Borough Council
Barnsley College
BASIC
Basildon District Council
Basingstoke & Deane Borough Council
Bath & North East Somerset Unitary Authority
Bath Spa University College
BCM Environmental Services Ltd
Bedford Borough Council
Bedford District Council
Bedfordshire County Council
Beds, Cambs, Northants & Peterborough Wildlife Trust
Bell College of Technology
Bell Fischer Landscape Architects
Berks, Bucks & Oxon Wildlife Trust
Bexley London Borough Council
BHWB
Binnie Black & Veatch
Birmingham & Black Country Urban Wildlife Trust
Birmingham (City) Metropolitan District Council
Blaenau Gwent (County) Unitary Authority
Bolton Institute of Higher Education
Bournemouth & West Hampshire Water Plc
Bournemouth Borough Council
Bournemouth Unitary Authority
Bournemouth University
Bracknell Forest (Borough) Unitary Authority
Braintree District Council
Branch Landscape Associates
Breckland District Council
Brecknock Wildlife Trust
Brent London Borough Council
Brentwood Borough Council
Bridgend (County Borough) Unitary Authority
Bridgnorth District Council
Brigend (County Borough) Council
Brighton & Hove Unitary Authority
Bristol (City) Unitary Authority
Bristol Water Plc
British Association of Nature Conservationists
British Dragonfly Society
British Ecological Society
British Herpetological Society
British Reed Growers' Association
British Trust for Conservation Volunteers
British Waterways
Brixham Environmental Laboratory
Broadland District Council
Broads Authority
Bromley London Borough Council
Bromsgrove District Council
Broxbourne Borough Council
Brunel University
Buckinghamshire Chilterns University College
Buckinghamshire County Council
Bury Metropolitan District Council

C

Caerphilly (County Borough) Unitary Authority
Calderdale Metropolitan Borough Council
Cambridge (City) District Council
Cambridge University
Cambridge Water Plc
Cambridgeshire County Council
Camden London Borough Council
Canterbury (City) District Council

Canterbury Christ Church College of Higher Education
Caradon District Council
Carbon Data Environmental Communications
Cardiff (County) Unitary Authority
Carmarthenshire (County Borough) Unitary Authority
Carrick District Council
Casella Ltd
Castle Point Borough Council
Centre Environment, Fisheries & Aquaculture Science
Centre for Env & Safety Management for Business
Centre for Environmental Research and Training
Centre for Research in Env. Appraisal & Management
Centre for Research into Environment and Health
Ceredigion (County) Unitary Authority
CES (Consultants in Environmental Sciences Ltd)
Chelmsford Borough Council
Cheltenham & Gloucester College of Higher Education
Cheltenham Borough Council
Chemex International Plc
Cherwell District Council
Cheshire County Council
Cheshire Wildlife Trust
Chichester District Council
Chichester Institute of Higher Education
Chiltern District Council
Cholderton & District Water Company
Chris Blandford Associates
Christchurch Borough Council
Christopher Betts Environmental Biology
CL Associates
Clerk to Adlingfleet & Whitgift IDB
Clerk to Althorpe IDB
Clerk to Armthorpe IDB
Clerk to Ashfields & Westmoor IDB
Clerk to Crowle IDB
Clerk to Everton IDB
Clerk to Fairham Brook IDB
Clerk to Finningley IDB
Clerk to Gainsborough IDB
Clerk to Garthorpe IDB
Clerk to Hatfield Chase IDB
Clerk to Kingston Brook IDB
Clerk to Lanetam IDB
Clerk to Longdon & Eldersfield IDB
Clerk to Melverley IDB
Clerk to Messingham IDB
Clerk to Newark Area IDB
Clerk to North Gloucestershire IDB
Clerk to Potteric Carr IDB
Clerk to Powysland IDB
Clerk to Rea IDB
Clerk to Rivers Idle & Ryton IDB
Clerk to Scunthorpe IDB
Clerk to South Axholme IDB
Clerk to South Gloucestershire IDB
Clerk to Sow and Penk IDB
Clerk to Stine IDB
Clerk to Tickhill IDB
Clerk to Tween Bridge IDB
Clerk to West Axholme IDB
Clerk to West Butterwick IDB
Clerk to West Gloucestershire IDB
Cleveland Wildlife Trust
Colchester Borough Council
Colchester Institute
Common Ground
Conestoga Rovers & Associates (UK) Ltd
Conwy (County) Unitary Authority
Conwy County Borough Council
Cooper Partnership Ltd
Corby Borough Council
Corby District Council
Cornwall College with Duchy College
Cornwall County Council
Cornwall Wildlife Trust
Cotswold District Council
Council for the Protection of Rural England
Country Landowners Association
Countryside Commission East Midlands & West Midlands
Countryside Commission Yorkshire & The Humber
Countryside Commission
Countryside Commission North East
Countryside Commission North West
Countryside Commission South East
Countryside Commission South West
Countryside Council for Wales
Countryside Council for Wales – Abergavenny
Countryside Council for Wales - Bangor
Countryside Council for Wales – East Area
Countryside Council for Wales – East Area
Countryside Council for Wales - Monmouthshire
Countryside Council for Wales – North East Area
Countryside Council for Wales – North East Area
Countryside Council for Wales – North West Area
Countryside Council for Wales – North West Area
Countryside Council for Wales – North West Area
Countryside Council for Wales – South Area
Countryside Council for Wales – South Area & Tir Cymen
Countryside Council for Wales – West Area

Countryside Council for Wales – West Area
Countryside Council for Wales – West Area
Countryside Council for Wales – West Area
Countryside Council for Wales – West Area, Carmarthen
Countryside Council for Wales - LIFE Project
Countryside Commission Eastern
Coveney Management Services
Coventry Metropolitan District Council
Coventry Metropolitan District Council
Coventry University
CPM
CRA
Crane Environmental Ltd
Cranfield University
Crawley Borough Council
Cresswell Associates
Croydon London Borough Council
Cumbria College of Art & Design
Cumbria Wildlife Trust
Cynefin Environmental Consultants

D

Dacorum Borough Council
Daedalus Consulting
Dames & Moore
Dartford Borough Council
Dartmoor National Park Authority
Daventry District Council
David Hawker Ecological Consultancy
David Jarvis Associates Ltd
De Montfort University
Dee Valley Water Plc
Delta-Simons
Denbighshire (County) Unitary Authority
Department of the Environment
Derbyshire Wildlife Trust
Devon County Council
Devon Wildlife Trust
DGS Associates
Doncaster College
Dorset County Council
Dorset Wildlife Trust
Dover District Council
Durham Wildlife Trust
Dwr Cymru

E

Ealing London Borough Council
Earthdome Ltd
Earthscience Ltd
East Cambridgeshire District Council
East Devon District Council
East Hampshire District Council
East Hertfordshire District Council
East Sussex County Council
Eastbourne Borough Council
Eastleigh Borough Council
Ecological Planning & Research
Ecological Survey Consultants
Econ-Ecological Consultancy
Ecoscope Applied Ecologists
Ecosurveys Ltd
ECUS
Edge Hill University College
Elgin Ross & Company Ltd
Elmbrdge Borough Council
EMSi Ltd
Emu Environmental Ltd
EnAct International
Enfield London Borough Council
English Nature HQ
English Nature - Cumbria team
English Nature - Devizes
English Nature - Grantham
English Nature - N & E Yorks
English Nature - Taunton
English Nature - Three Counties
English Nature - York
English Nature (Berkshire)
English Nature, Cornwall
English Nature, Devon
English Nature, Dorset
English Nature, East Midlands
English Nature, Kent
English Nature, Leyburn
English Nature, London
English Nature, Norfolk
English Nature, North West
English Nature, Suffolk
ENSIS Ltd
Entec UK Ltd
EnViable
Environ Conusulting Ltd
Environment Agency
Environment Agency - Cornwall area
Environment Agency - Devon
Environment Agency - Dorset
Environment Agency - Exeter
Environment Agency - Hampshire
Environment Agency - Head office
Environment Agency - IOW
Environment Agency - Lichfield
Environment Agency - Newcastle upon Tyne
Environment Agency - Shrewsbury
Environment Agency - South West Region
Environment Agency - Swansea
Environment Agency - Tewkesbury
Environment Agency - Wales
Environment Agency (Bangor)
Environment Agency, Central Area Office
Environment Agency, Dales Area Office
Environment Agency, Midlands Region
Environment Agency, North Area Office
Environment Agency, North East Area Office
Environment Agency, Regional Office
Environment Agency, South Area Office
Environment Agency, West Bridgford

Environmental Assessment Group Ltd (EAG ENVIRON)
Environmental Assessment Services Ltd
Environmental Auditors Ltd
Environmental Design Consultants
Environmental Management & Training
Environmental Resources Management Ltd
EPCAD Consultants
EPDM Consultancy
Epping Forest District Council
Epsom & Ewell Borough Council
Essex & Suffolk Water Plc
Essex County Council
Essex Wildlife Trust
Excel Partnership
Exeter (City) District Council
Exmoor National Park Authority

F

Fareham Borough Council
Farming & Rural Conservation Agency
Farming & Wildlife Advisory Group
Farnborough College of Technology
Fauna & Flora Preservation Society
Fawside Foundation
Fenland District Council
Ferguson & McIlveen
Fichtner Consulting Engineers Ltd
Field Studies Council
Flinthshire County Council
Flintshire (County) Unitary Authority
Folkestone & Dover Water Services Ltd
Forest Heath District Council
Forest of Dean District Council
Forestry Authority
Forestry Commission
Forestry Commission - Midlands Conservancy
Forestry Commission Central Office
Forestry Commission Research
Foster Wheeler Energy Ltd
Friends of the Earth
Froglife

G

GIBB Environmental
Glamorgan Centre for Art & Design Technology
Glamorgan Wildlife Trust
Glasgow Caledonian University
Glen Kemp
Gloucester (City) District Council
Gloucestershire County Council
Gloucestershire Wildlife Trust
Gosport Borough Council
Grantham Brundell & Farran
Gravesham Borough Council
Great Yarmouth Borough Council
Green Balance
Greenspace Ecological Consultancy
Greenwich London Borough Council
Groundwork Ashfield & Mansfield
Guildford Borough Council
Gwent Wildlife Trust
Gwynedd (County) Unitary Authority

H

Hackney London Borough Council
Halcrow
Halton College
Hammersmith & Fulham London Borough Council
Hampshire & Isle of Wight Wildlife Trust
Hampshire County Council
Haringey London Borough Council
Harlow District Council
Harper Adams Agricultural College
Harrow London Borough Council
Hart District Council
Hartlepool Water Plc
Hastings Borough Council
Havant Borough Council
Havering London Borough Council
Herefordshire Nature Trust
Herefordshire Unitary Authority
Herpetofauna Consultants International
Herpetological Conservation Trust
Hertfordshire & Middlesex Wildlife Trust
Hertfordshire Biological Records Centre
Hertfordshire County Council
Hertsmere Borough Council
High-Point Rendel
Hill Environmental Consultants Ltd
Hillingdon London Borough Council
Horsham District Council
Hounslow London Borough Council
Hunting Technical Services
Huntingdonshire District Council
Hyder Environmental

I

IACR-Centre for Aquatic Plant Management
Imperial College of Science, Technology & Medicine
Industry & Environment Associates
Institute of Hydrology
Institute of Terrestrial Ecology
Ipswich Borough Council
Isle of Wight Council
Isle of Wight Unitary Authority
Islington London Borough Council

J

Jaqueline Fisher Associates
Johnston Associates
Joint Nature Conservation Committee

K

Keele University
Kennedy & Donkin Ltd
Kennet District Council
Kensington & Chelsea London Borough Council
Kent County Council
Kent Wildlife Trust
Kerrier District Council
Kestrel Environmental Services

Kettering Borough Council
King Alfred's Winchester
King's College London
King's Lynn & West Norfolk Borough Council
Kingston University
Kingston upon Thames (Royal Borough)
Kingston upon Thames London Borough Council
KMM MARENCO
Knight Piesold Ltd
Komex Clarke Bond

L

L.A. B. Coastal
La Societe Guernesiaise
Lake District National Park Authority
Lambeth London Borough Council
Lancashire Wildlife Trust
Lancaster University
Land Research Associates
Land Use Consultants
Landscape Town & Country Ltd
Lee Donaldson Associates
Leeds College of Art & Design
Leeds Metropolitan University
Leicestershire & Rutland Wildlife Trust
Leisure Services Department
Leithgoe Services Ltd
Lewes District Council
Lewisham London Borough Council
Liverpool Community College
Liverpool Hope University College
Liverpool John Moores University
London Corporation (City of) London Borough Council
London Natural History Society
London School of Economics & Political Science
London Wildlife Trust
Lorraine Weeks Environmental Consultant
Losehill Hall Training
Loughborough University
LRZ Ltd
Luton (Borough) Unitary Authority

M

M.J Carter Associates
MacAlister Elliott and Partners Ltd
Maidstone Borough Council
Maldon District Council
Malvern Hills District Council
Mammal Society
Manx Nature Conservation Trust
Marcus Hodges Environment Ltd
Medway Council
Medway Towns Unitary Authority
Mendip District Council
Merthyr Tydfil (County Borough) Unitary Authority)
Merton London Borough Council
Michael Freeman
Mid Bedfordshire District Council
Mid Devon District Council
Mid Kent Water Plc
Mid Sussex District Council
Middle East Environmental
Middlemarch Environmental
Middlesex University
Mike Gordon Consultancy
Milton Keynes Unitary Authority
Ministry of Agriculture, Fisheries & Food
Mole Valley District Council
Monitor Environmental Consultants Ltd
Monmouthshire (County) Unitary Authority
Montgomery Watson
Montgomery Wildlife Trust
Mott MacDonald
Mouchel Consulting Ltd

N

N.A. Duncan & Associates
Naiad Aquatic Environmental Services Ltd
Neath Port Talbot (County) Unitary Authority
Nene – University College Northampton
Nene Valley Project
New Forest Committee
New Forest District Council
Newham London Borough Council
Newport (County Borough) Unitary Authority
Nicholas Oxley Associates
Norfolk County Council
Norfolk Wildlife Trust
North Cornwall District Council
North Devon District Council
North Devon District Council
North Dorset District Council
North Hertfordshire District Council
North Norfolk District Council
North Shropshire District Council
North Somerset Council
North Somerset Unitary Authority
North Surrey Water Ltd
North Tyneside Metropolitan District Council
North Wales Environmental Services Ltd
North Wales Wildlife Trust
North West Water
North West Water Ltd
North Wiltshire District Council
North York Moors National Park Authority
Northamptonshire County Council
Northumberland National Park Authority
Northumberland Wildlife Trust
Northumbrian Water Limited
Northumbrian Water Services Ltd
Norwich City Council
Norwich District Council
Nottinghamshire Biological Records Centre
Nottinghamshire Wildlife Trust

O

O'Neill Pollution Consultants
Oakwood Environmental Ltd
Oftec
Oscar Faber Group Ltd

Oswestry District Council
Otter Trust
Owen Williams Consulting Engineers
Oxford Brookes University
Oxford City Council
Oxford District Council
Oxfordshire County Council

P

Parsons Engineering Science
Paul Garrad Associates
Peak District National Park Authority
Pembrokeshire (County) Unitary Authority
Pembrokeshire Coast National Park Authority
Pennine Science & Environment
Penny Anderson Associates
Penwith District Council
People's Trust for Endangered Species
Peterborough (City) Unitary Authority
Plymouth (City) Unitary Authority
Pond Action
Poole Unitary Authority
Portsmouth (City) Unitary Authority
Portsmouth Water Plc
Posford Duvivier
Powys (County) Unitary Authority
Pryce Consultant Ecologists
Purbeck District Council

Q

Qualex Ltd
Queen Mary & Westfield College

R

RAC Environment
Radnorshire Wildlife Trust
Ramblers Association
Reading Unitary Authority
Redbridge London Borough Council
Reigate & Banstead Borough Council
Response Environmental Services Ltd
Restormel Borough Council
Rhondda Cynon Taff (County) Unitary Authority
Richatds Moorehead & Laing Ltd
Richmond Borough Council
Richmond upon Thames London Borough Council
Ridegway Environmental Management
Risk & Policy Analysts Ltd
Rivers Idle & Ryton IDB
RKL Arup
Robens Centre
Rochford District Council
Roehampton Institute London
Rother District Council
Royal Holloway, University of London
Royal Society for the Protection of Birds
RPS Group Plc
RSK Environment Ltd
Runnymede Borough Council
Rushmoor Borough Council

S

Salisbury District Council
SAUR Water Services Ltd
SBC & Associates
Scott Wilson Resource Consultants
Scottish Natural Heritage - Angus & Dundee
Scottish Natural Heritage - Elgin
Scottish Natural Heritage - Shetland
Scottish Natural Heritage - Strathclyde & Ayrshire
SECOR Environmental Ltd
Sedgemoor District Council
Sefton Metropolitan District Council
SEQM Ltd
Sevenoaks District Council
Severn Trent Water Ltd
SGS United Kingdom Ltd Environment Division
Sheffield College
Sheffield Hallam University
Sheffield Wildlife Trust
Shepway District Council
Shepway District Council
Shrewsbury & Atcham District Council
Shropshire County Council
Shropshire Wildlife Trust
Simon Davey Ecological Consultancy
Slate Ecology Company Ltd
Slough (Borough) Unitary Authority
Smith Grant Partnership
SNH - Aberdeen Office
SNH - Orkney
SNH, Isle of Rum
Snowdonia National Park Authority
Soil Survey & Land Research Centre
Somerset County Council
Somerset Wildlife Trust
South Bank University
South Bedfordshire District Council
South Buckinghamshire District Council
South Cambridgeshire District Council
South East Water
South Gloucestershire Council
South Gloucestershire Unitary Authority
South Hams District Council
South Norfolk District Council
South Northamptonshire District Council
South Oxfordshire District Council
South Shropshire District Council
South Somerset District Council
South Staffordshire Water Plc
South West Lakes Trust
South West Water Services Limited
Southampton (City) Unitary Authority
Southampton Institute
Southend on Sea Unitary Authority
Southern Water Services Limited
Southwark London Borough Council
Spelthorne Borough Council
SPMJ
St Albans District Council

St Edmundsbury Borough Council
St Helens College
St Mary's University College
Staffordshire University
Staffordshire Wildlife Trust
Stanger Science and Environment
Stevenage Borough Council
Stevenson and Wheeler
Stockport College of Further & Higher Education
Stockton on Tees Unitary Authority
Stratford on Avon District Council
Stroud District Council
Sue Sutherland Landscape Architects
Suffolk Coastal District Council
Suffolk County Council
Suffolk Wildlife Trust
Surrey County Council
Surrey Heath Borough Council
Surrey Wildlife Trust
Sussex Wildlife Trust
Sutton & East Surrey Water Plc
Sutton London Borough Council
Swale Borough Council
Swansea (County) Unitary Authority
Swansea Institute of Higher Education
Swindon (Borough) Unitary Authority
Symbio
Symonds Group

T

Tandridge District Council
Taunton Deane Borough Council
Teignbridge District Council
Temple Environmental Consultants Ltd
Tendring District Council
Tendring Hundred Water Services Ltd
Terence O'Rourke Plc
Test Valley Borough Council
Tewkesbury Borough Council
Thames Valley University
Thames Water Utilities Limited
Thanet District Council
The Broads Authority
The Conservation Foundation
The Environment Practice
The Lincolnshire Trust
The Manchester Metropolitan University
The National Trust
The Nature Conservation Bureau Ltd
The North East Wales Institute of Higher Education
The Nottingham Trent University
The Riverway Trust
The Robinson Penn Partnership
The University of Birmingham
The University of Bradford
The University of Durham
The University of Huddersfield
The University of Hull
The University of Kent at Canterbury
The University of Liverpool
The University of Manchester
The University of Manchester Institute of Science & Technology
The University of Nottingham
The University of Reading
The University of Salford
The University of Sheffield
The University of Wales
The University of Wales, Lampeter
The University of York
The Vincent Wildlife Trust
The Wildfowl & Wetlands Trust
The Wildlife Trusts
Three Rivers District Council
Three Valleys Water Plc
Thurrock Unitary Authority
Tonbridge & Malling District Council
Torbay (Borough) Unitary Authority
Torfaen (County Borough) Unitary Authority)
Torridge District Council
Tower Hamlets London Borough Council
Transport Research Laboratory
Trinity College Carmarthen
Tunbridge Wells Borough Council

U

UK Centre for Economic & Environmental Development
ULG Consultants Ltd
Ulster Wildlife Trust
Unicomarine Ltd
University College Chester
University College of Ripon & York St John
University College Scarborough
University College Worcester
University of Brighton
University of Bristol
University of Central England
University of Central Lancashire
University of Derby
University of East Anglia
University of East London
University of Exeter
University of Glamorgan
University of Greenwich
University of Hertfordshire
University of Hertfordshire
University of Leeds
University of Lincolnshire & Humberside
University of Luton
University of Newcastle upon Tyne
University of North London
University of Northumbria at Newcastle
University of Paisley
University of Plymouth
University of Portsmouth
University of Southampton
University of Sunderland
University of Sussex
University of Teeside

University of the West of England
University of Ulster
University of Wales
University of Wales
University of Wales College, Newport
University of Wales Institute
University of Westminster
University of Wolverhampton
Uttlesford District Council

V

Vale of Glamorgan (County) Unitary Authority
Vale of White Horse District Council
Venture Property Services Ltd

W

Waltham Forest London Borough Council
Wandsworth London Borough Council
Wardell Armstrong
Warwick District Council
Warwickshire Wildlife Trust
Watford Borough Council
Waveney District Council
Waverley Borough Council
Wealden District Council
Welwyn Hatfield District Council
Wessex Water Services Limited
West Berkshire Unitary Authority
West Devon Borough Council
West Dorset District Council
West Oxfordshire District Council
West Somerset District Council
West Sussex County Council
West Wales Wildlife Trust
West Wiltshire District Council
Westminster London Borough Council
Weymouth & Portland District Council
White Young Green Environmental Ltd
Wildlife Conservation Research Unit
Wiltshire County Council
Wiltshire Wildlife Trust
Winchester (City) District Council
Winchester City Council
Windrush Aquatic Environmental Consultancy
Windsor & Maidenhead (Royal Borough) Unitary Authority
Woking Borough Council
Wokingham Unitary Authority
Wolverhampton Metropolitan District Council
Worcester City Council
Worcester District Council
Worcestershire County Council
Worcestershire Wildlife Consultancy
Worcestershire Wildlife Trust
World Wildlife Fund UK
Worthing Borough Council
WRC PLC
Wrexham (County) Unitary Authority
Writtle College
WS Atkins
WSP Environmental Ltd
Wycombe District Council
Wye College, University of London
Wyre Forest District Council

Y

York Waterworks Plc
Yorkshire Dales National Park Authority
Yorkshire Water
Yorkshire Wildlife Trust
Young Associates