National Roads Authority

Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes

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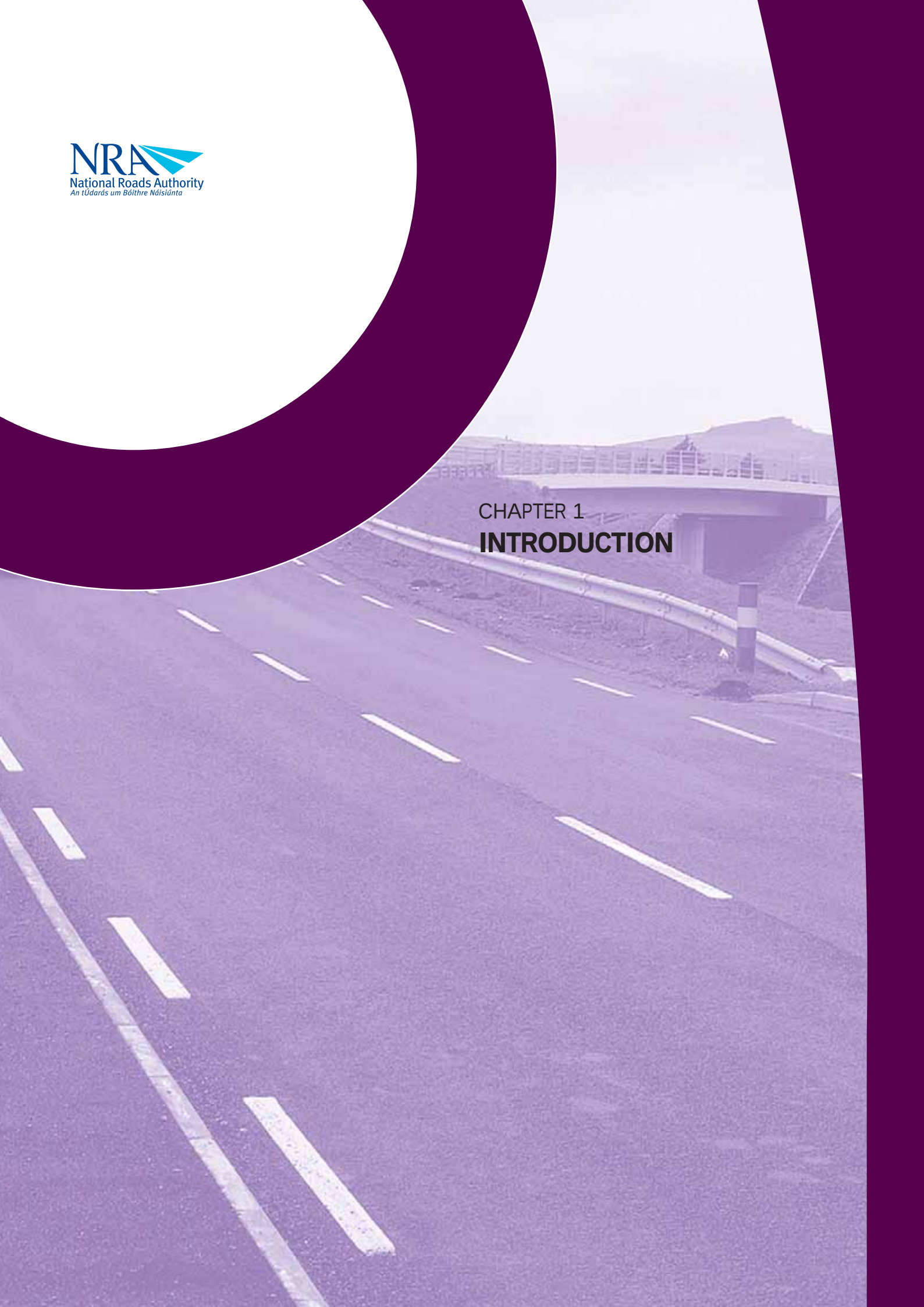

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

1.1 Background and Legislative Context

The purpose of this document is to provide guidance for the treatment of bats during the planning and design of national road schemes. These guidelines are not mandatory but are recommended to ensure appropriate protection for bats and consistency of approach during the different stages (i.e. Constraints Study, Route Corridor Selection and Environmental Impact Statement) of road scheme planning undertaken in accordance with the National Roads Project Management Guidelines (NRPMG).

This document contains information on how to undertake bat surveys as referred to in the publication *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (National Roads Authority, 2004). This is a complementary publication that builds on the principles identified in the ecology guidelines to be followed during road scheme developments, with the ultimate objective of preventing, or reducing, negative impacts on bat populations. Therefore, this document must be read in conjunction with the ecology guidelines.

The treatment of bats prior to and during the construction stage of a road is the subject of a separate guideline document, *Guidelines for the Treatment of Bats during the Construction of National Road Schemes* (National Roads Authority, 2005).

Legislation

All bat species in Ireland are protected under both national legislation – (Wildlife Act, 1976, as amended in 2000) and European legislation – (Habitats Directive (92/43/EEC)). There is additional protection for lesser horseshoe bats because of their inclusion in Annex II of the Habitats Directive. The Habitats Directive is transposed into Irish law in the European Communities (Natural Habitats) Regulations (S.I. 94 of 1997). The Irish Government is also a signatory to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 1979)) and the Bern Convention, 1982 (The Convention on the Conservation of European Wildlife and Natural Habitats) and has a commitment to the "Eurobats" Agreement (Agreement on the Conservation of Bats in Europe, 1991).

The Habitats Directive provides protection for the habitats and roosts of all bat species as well as the bats themselves. Under Annex II of the Habitats Directive the Irish Government is obliged to designate Special Areas of Conservation (SACs) for the lesser horseshoe bat. The National Parks and Wildlife Service (NPWS) of the Department of the Environment, Heritage and Local Government is responsible for the selection and designation of these sites.

Bat roosts are protected, irrespective of whether or not they fall within the boundaries of an SAC. The NPWS must be informed of all issues relating to bats during the planning and construction of national road schemes. This includes all roosts identified, timetable of activities that affect these roosts, measures proposed in dealing with roosts and outcome of all actions. This necessitates that all procedures and actions be reported, including accidental breaches of the scheduled removal of roosts.

1.2 National Roads Project Management Guidelines

The procedures followed by the National Roads Authority and local authorities in the planning, design and implementation of road schemes are specified in the Roads Act, 1993 and the National Roads Project Management Guidelines (NRPMG) (National Roads Authority, 2000).

The Roads Act requires the preparation of an Environmental Impact Statement (EIS) for certain types of road schemes and submission of the EIS to An Bord Pleanála for consideration. As a matter of practice, public consultation is catered for at a number of stages in the planning process while submissions on the EIS may be made to An Bord Pleanála as part of the decision process relative to the road scheme proposal (*Environmental Impact Assessment for National Road Schemes – A Practical Guide* (National Roads Authority, 2005).

The NRPMG were prepared to allow a phased approach to developing a major road scheme. The aim of this document is to provide advice on actions relating to bats during each of three phases of the guidelines: the Constraints Study (Stage 2), Route Corridor Selection (Stage 3) and the Environmental Impact Statement (Stage 4).

In order to avoid any significant impacts on bat populations, the treatment of bats should be considered during all three stages. The findings arising out of each stage should set the foundation for the next stage of planning and collectively should assist in the final design of the road scheme. The focus of attention during the constraints and route selection stages should be on impact avoidance while the EIS should describe any further steps necessary to avoid impacts and, where avoidance is not possible, any necessary mitigation measures.

1.3 Requirements of a Bat Specialist

It is essential that individuals involved in surveying bats are competent in identifying bats and their respective habitat, e.g., roosts, areas with potential for feeding. A bat specialist should be capable of capturing and handling bats and must be licensed to do so by the NPWS. In addition, they must consider their own health and safety, this may extend to tetanus and rabies vaccinations for full protection. The capture and handling of bats may be essential to confirm identification of certain species that are difficult to distinguish from each other in flight (e.g. Whiskered, Brandt's, Natterer's or Daubenton's bats).

Any individual undertaking bat survey work should have a thorough understanding of the life cycle of bats, the various species likely to occur in Ireland, and their ecological requirements. Based on this expertise, the potential and likely consequences of alterations to the landscape brought about by road construction should be identified. It is imperative that there is consultation between the bat specialist and the road project design team to ensure that any proposed mitigation measures are feasible and relevant to the scheme under investigation.

At the construction stage, it is essential that a bat specialist is present to advise on the appropriate schedule for tree-felling, building demolition or other activities that pose a risk to bat welfare or survival. Further information in this regard is contained in *Guidelines for the Treatment of Bats during the Construction of National Road Schemes* (National Roads Authority, 2005).

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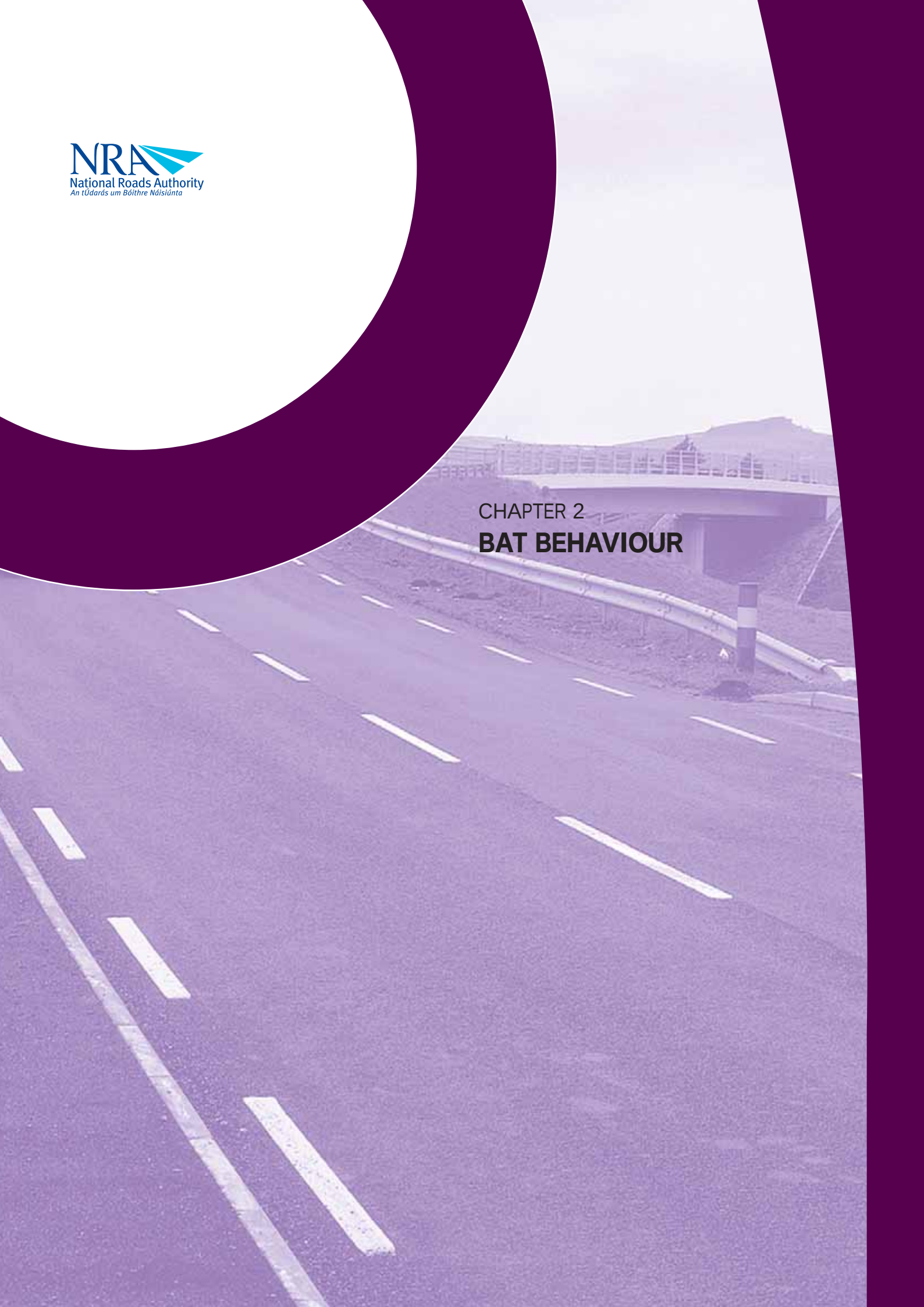

CHAPTER 2

BAT BEHAVIOUR

2.0 BAT BEHAVIOUR

2.1 Irish Bat Species

Information on the occurrence and distribution of bats in Ireland continues to increase as more field studies are undertaken (Table 1). Within the past ten years the identified number of species has increased from seven to ten and currently some debate exists relating to the possible presence of two additional species.

Table 1: Bat species recorded in Ireland

Bat species	Confirmed in Ireland
Common pipistrelle *(Pipistrellus pipistrellus)*	Yes
Soprano pipistrelle *(Pipistrellus pygmaeus)*	Yes
Nathusius' pipistrelle *(Pipistrellus nathusii)*	Yes
Brown long-eared bat *(Plecotus auritus)*	Yes
Leisler's bat *(Nyctalus leisleri)*	Yes
Whiskered bat *(Myotis mystacinus)*	Yes
Brandt's bat *(Myotis brandtii)*	Yes
Daubenton's bat *(Myotis daubentoni)*	Yes
Natterer's bat *(Myotis nattereri)*	Yes
Lesser horseshoe bat** *(Rhinolophus hipposideros)*	Yes
Barbastelle** *(Barbastella barbastellus)*	No
Noctule *(Nyctalus noctula)*	No

2.2 Bat Ecology

Bats tend to orient themselves in the landscape with the aid of tall vegetation cover. That is why they often fly along linearly-placed landscape elements, including roads and canals planted with trees.

Many of the bat species in Ireland have become inextricably linked with human habitations. This exposes them to the risk of dramatic population declines if roosting, breeding or feeding sites are damaged or destroyed. Recovery from a single localised event that causes numbers to decline (e.g. the demolition of a building while bats are in residence) may take many years.

The presence of bats in trees, buildings etc, can often be difficult to detect without the evidence of external signs of bat occupancy, special efforts to confirm their presence may be required. Bats are highly social species and often occur in large numbers. They gather in different places throughout the year depending on whether they are occupying breeding or roosting sites. Weather, food availability and disturbance to roosts all affect the sites used at any one time by a group of bats. When assessing the potential impacts of a road development on bats, it is recommended, where feasible, that comprehensive surveys are undertaken to determine the extent of all significant roosts and breeding sites in the locality (see Appendix I for criteria on bat roosts of national or international importance).

The following is a summary of the various types of roost routes and feeding areas likely to be found in areas with good potential for bats.
(see glossary of terms for additional explanation of these terms)

Location of Bat Roosts

Bats rarely roost in open spaces and are most commonly present in tight spaces within woodwork (e.g. mortise joints), stonework, rock crevices, between slate and felt, in damaged tree limbs, etc. Even those species that hang freely by their hind feet may be present within cavities that are initially unnoticed (e.g. lesser horseshoe bats may occupy chimneys or shallow attics without detection).

Types of Roosts

Maternity Roosts

Maternity roosts are the most significant roosts and they are predominantly all-female aggregations that are formed from late May onwards and remain as a relatively cohesive unit until mid to late August. Not all female bats give birth annually. These females that do bear young in a given year avail of a suitable building, tree and sometimes cave (or equivalent). The young are flightless for several weeks and hence are vulnerable to dangers such as tree felling and restoration, reinforcement or demolition of structures such as buildings and bridges.

Mating Roosts

Most bat species mate in autumn but pregnancy does not occur until the following spring. During this time males will take possession of a cavity in a building, tree, bridge, cave or mine and attract females to these sites to establish a harem. Male bats call both from a perch and in flight in much the same manner that male birds sing. Bat song can be identified to species level using time expansion bat detectors and this is useful in providing information on the species of bat breeding within a particular area (Russ, 1999, Fenton, 1985).

Hibernation Roosts

Bats have a high metabolic rate and in temperate countries, such as Ireland, flying insects are not available in sufficient numbers during winter to sustain bats. Therefore, bats hibernate during winter. In hibernation sites, bats are often completely inactive for several days and are extremely vulnerable to disturbance by human activities due to the time taken for them to become sufficiently active to allow escape. Hibernation may extend from November to the end of March, during which time bat activity will take place sporadically. The unpredictability of this activity renders winter feeding surveys of bats practically impossible. Winter studies can sometimes provide information on hibernation sites, but it is only during favourable weather conditions that winter feeding sites and commuting routes may be identified.

Bats may become inactive even on a daily basis during other periods of the year, and thus may be more susceptible to injury or death from human activities. Daily torpor is similar to the suppressed activity that is typical of winter hibernating bats, but the bat is synchronised to arouse from torpor at or around sunset and sunrise.

Commuting Routes and Feeding Areas

Bats feed on invertebrates (principally flying insects) (Figure 1) and most species seek out their

prey in areas that have good vegetation cover, including mature trees (woodland or forestry), hedgerow and scrub. They also frequently feed close to water as wetlands tend to support large insect communities. Bats fly along hedgerows and woodland edges as well as small lanes, minor roads and waterways, both to find and catch food and to commute between feeding areas and roosts and between alternative roosts. Good vegetative cover for bats is important and essential for much of their ecological requirements. Woodland is a highly beneficial habitat for bats and the colony sizes of species such as the lesser horseshoe bat is positively correlated with surrounding woodland size (Reiter, 2002). Hedgerows along roads may serve as an extension of woodland edge.

Figure 1: Hunting behaviour of three bat species

2.3 Bats and Roads

Bats interact with road developments in many ways:

- Bats avail of minor roads and country lanes as feeding sites and as commuting routes between roosts and feeding areas (such as woodlands or waterways). Such roads typically are flanked by well-developed hedgerows. Roads with hedgerows on either side that form a closed canopy are particularly favoured. The absence of lighting on such roads allows light intolerant bats to feed there. All species of Irish bat have been noted to feed along minor roads and lanes.

- The construction of a road sometimes destroys vegetation cover that previously was used by bats as they moved between roosts and feeding areas. Since the new road acts as a barrier preventing movement across a road, a bat population may be prevented from accessing a formerly used habitat potentially resulting in population decline. Also, vehicles may kill bats when they commute along the new road to move from one roosting or feeding area to another.

- Roosts lying within the land-take are generally removed to allow access for construction equipment and to construct the road itself. Trees immediately adjacent to roads are often removed as a safety measure. In some circumstances, there may be scope to retain trees or other structures if they are known to have good bat roost potential, provided they do not interfere with the construction or operation of the road.

- The necessity to remove substantial lengths of hedgerow and treeline and the loss of mature trees, draining of wet areas and rendering of some areas as unsuitable for feeding (e.g. due to light and noise pollution) all affect the availability of invertebrate prey and feeding sites for bats. Noise from traffic may render some sites unsuitable for bats, such as the brown long-eared bat that depends more on passive hearing (i.e. listening to sounds produced by prey) than on echolocation to capture prey.

As bats orient their flight using vertical landscape elements, their movements are reasonably simple to steer and it is relatively easy to find solutions for bottlenecks threatening their flight paths. The consideration of bat flight paths, feeding areas and roosts during the planning phase, followed by the incorporation of appropriate mitigation measures into the scheme design, will reduce the severity of significant impacts on bat populations.

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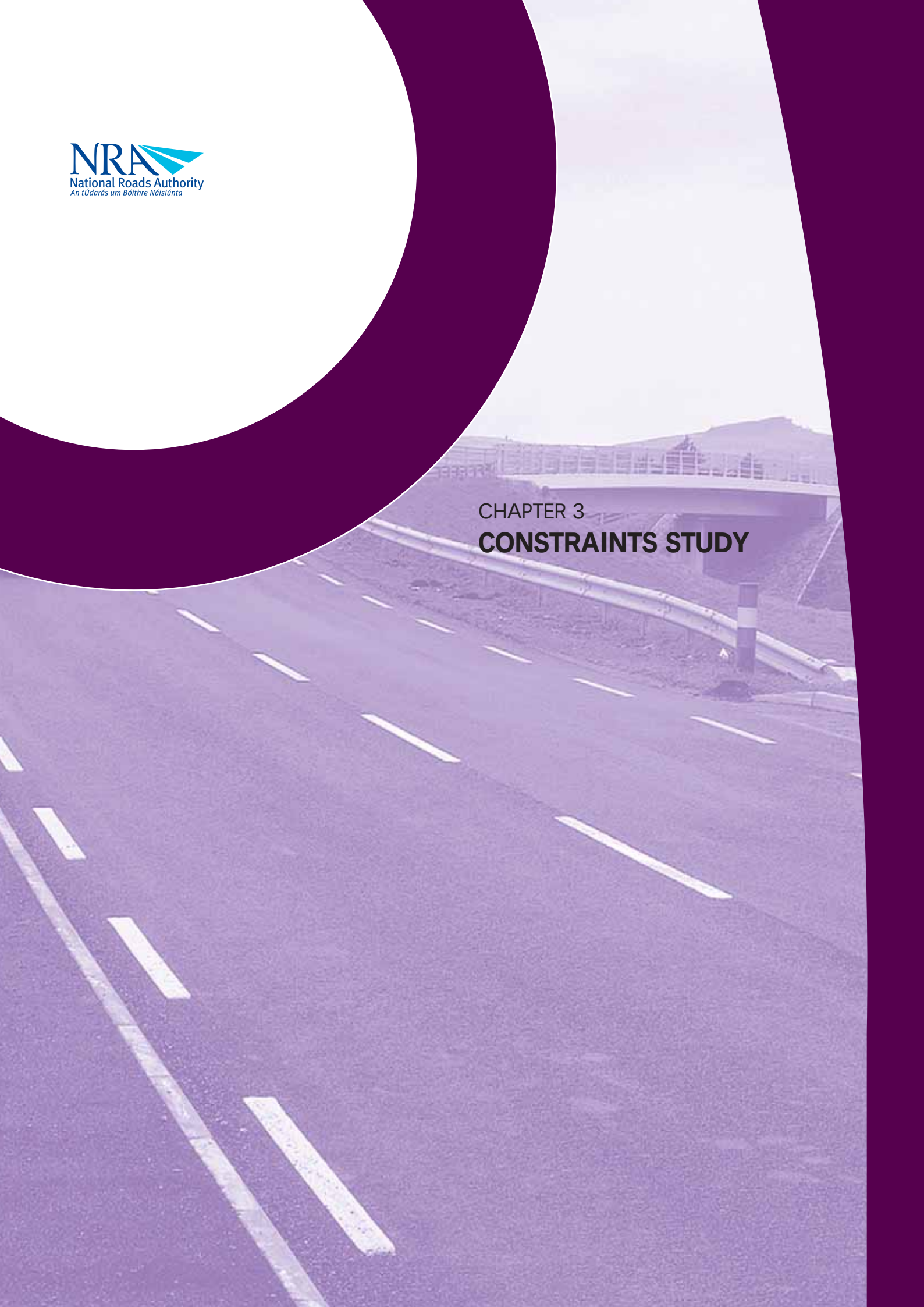

CHAPTER 3

CONSTRAINTS STUDY

3.0 CONSTRAINTS STUDY

The NRPMG state that the purpose of the Constraints Study is to gather *"as much information regarding the project as possible"*. This data collection should be focused on determining what constraints (physical, procedural, legal, environmental, etc.) exist that could affect the route choice and design of the scheme, delay progress, and influence costs. Large-scale maps (Ordnance Survey Discovery Series Maps, or equivalent) of the corridor should be prepared to determine the extent of the study area and all known physical constraints within the area should be identified and recorded. The first part of this data collection should be based on deskbound research studies.

For the initial evaluation of the potential impacts of a road within a given region, special attention should be given to designated conservation areas and sites proposed for designation within the study area. See NRA publication *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (National Roads Authority, 2004).

Initial information on bats should be sourced from the NPWS. The NPWS holds a database of known lesser horseshoe bat roosts together with records of Natural Heritage Areas (NHAs), SACs and Nature Reserves. Local wildlife conservation rangers may also be aware of local information such as feeding and commuting areas known to be important for bats. Published sources and datasets such as those held by Bat Conservation Ireland and the NPWS, including any records held by local bat groups, should also be consulted. Bats should be included in the overall assessment of the effects of a proposed road scheme on the ecology of the area. Bat roosts may act as important ecological constraints, especially in areas where an Annex II species, i.e. the lesser horseshoe bat, is known to exist.

There are limitations in the current state of knowledge in relation to bats and bat roosts. In circumstances where there is a high probability that roosts of Annex II species may be present in the proposed corridor, it may be appropriate to undertake some preliminary field assessments to establish the presence of such species during the constraints stage. In such cases, the principal ecologist (or a bat specialist) must consider whether a survey is appropriate at this stage of planning.

Consultation at this stage with all statutory bodies, Non-Governmental Organisations (NGOs) (see Appendix II for contact addresses) and relevant individuals with local knowledge or species-specific information may mean that highly valuable areas can be identified at this stage of planning with a view to such habitats being avoided as scheme planning evolves.

The data collected on bats during this stage of the planning phase should be incorporated into the constraints study report as outlined in section 3.3 of the *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (National Roads Authority, 2004).

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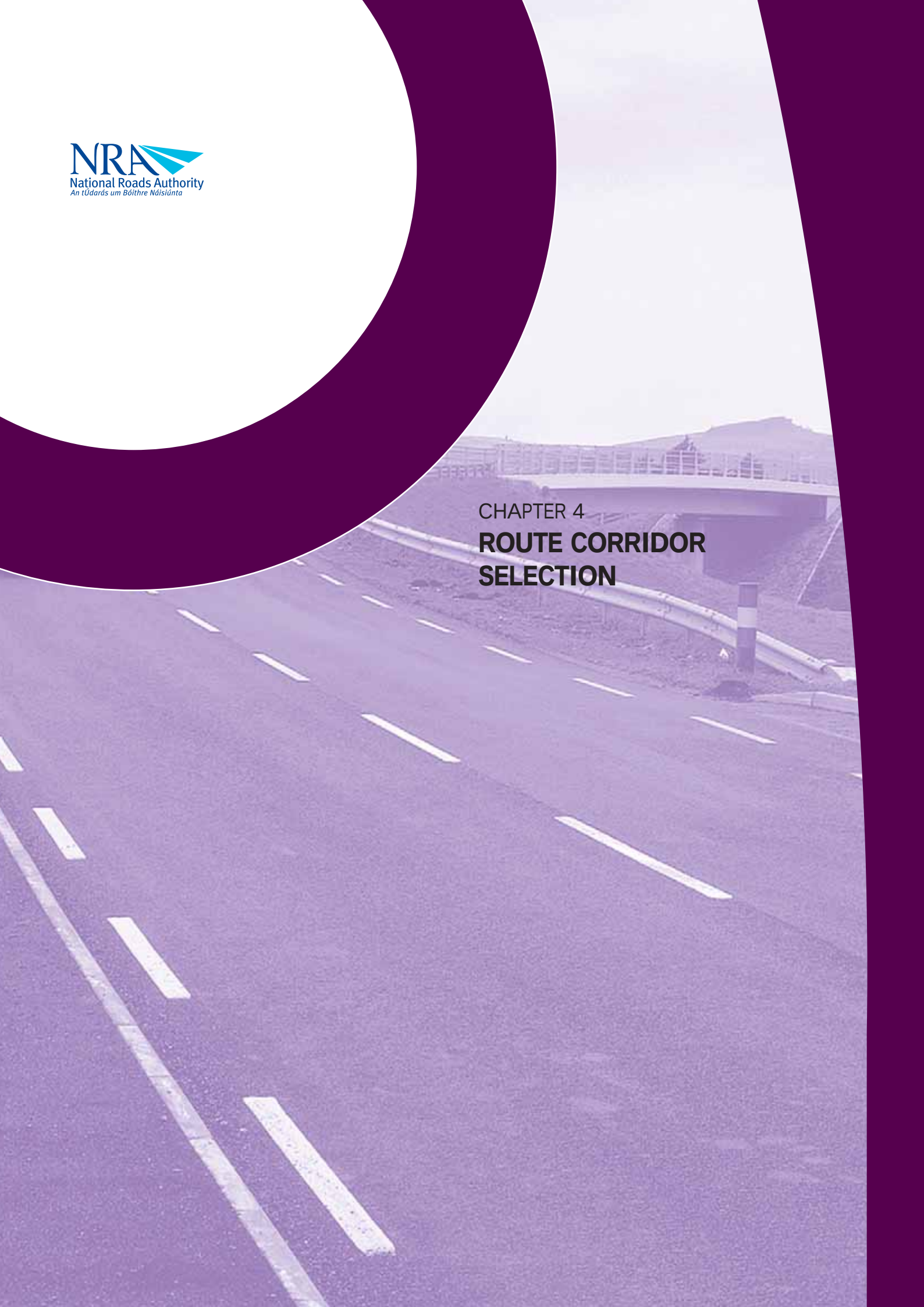

CHAPTER 4

ROUTE CORRIDOR SELECTION

4.0 ROUTE CORRIDOR SELECTION

The work undertaken as part of the Constraints Study is used by the Road Project Design Team to refine the broad study area into a number of route corridor options. The NRPMG state that the purpose of Route Corridor Selection is to "*carry out a detailed technical evaluation of the scheme corridor. The route selection process involves…. [the] identification and investigation of Route Options, assessment of environmental impacts for each option…*". This evaluation in turn leads to the production of a Route Corridor Selection Report.

At the route selection stage it is important that there is adequate information (i.e. building upon data gathered and collated during the Constraints Study Stage) on the bat fauna within the environs of the various route corridor options to allow an appropriate assessment of the likely significant impacts, if any, upon bats. Clearly, if there are few or no records of common bat species, it is likely that bats do not exist within the areas under investigation or there has been little survey work undertaken in the area. The importance of the area in close proximity to the route corridor is dependent upon the nature of the surrounding habitats and the habitats traversed by a proposed route corridor. These are most appropriately evaluated on an individual basis by a consultant bat specialist.

Since several route corridor options are under consideration at this stage of planning, it would be impractical and time consuming to undertake complete seasonal field surveys of all the individual routes. Therefore, the individual routes should be assessed in detail using comprehensive desk studies that should be supported by preliminary field studies, where appropriate, of the broad corridor. During the constraints stage the most sensitive known bat locations will have been identified and every effort at route selection should be made to avoid these sensitive locations. The elements of assessment for route selection should comprise of desk study and fieldwork, where appropriate.

4.1 Desk study

Building on the data already collated during the constraints stage from existing records, a desk study of locations with significant potential for bats should be undertaken using up to date aerial photographs in order to identify further potentially suitable bat habitats. Significant features for consideration in this phase of assessment include:

- Presence of mature woodland
- Presence of well-developed hedgerows and small fields
- High proportion of agricultural pasture in the area
- Presence of watercourse or wetland, including river, canal, lake, pond, reservoir, marsh or fen
- Presence of old farm buildings, estate houses, castles, with a combination of the above features
- Presence of souterrains, caves, mines, tunnels, bridges, wells and similar structures.

At this stage, it is recommended that consultations occur between relevant specialists, e.g., the agricultural and architectural specialists would provide information on the location of old farm buildings, estate houses and castles, that may have the potential to house sensitive bat roosts. In addition, information may be gathered from local contacts such as the Irish Wildlife Trust, BirdWatch Ireland or other environmental groups, or by advertising for information in local newspapers or parish bulletins, posters in newsagents, etc.

In general, most of the sensitive locations for the lesser horseshoe bat have been identified in Ireland and the most important known hibernation and maternity roosts of the species have been (or are in the process of being) designated as SACs. However, there is the potential that additional roosts of this species may exist if the study corridor is located in Mayo, Galway, Clare, Limerick, Cork and Kerry. Recently, the lesser horseshoe bat was recorded for the first time in Co. Roscommon and therefore, it is possible that further discoveries of this species will be made in other counties in the future.

While the roosts of the lesser horseshoe bat are important, it must be emphasised that all bat species are afforded full protection under national and EU legislation and that the absence of Annex II species from an area does not remove the necessity to evaluate the impacts of road construction upon the remaining species.

The most significant impacts upon bats are most likely to occur if the road impinges on a roost, or it is in close proximity to a roost site. In addition, there will also be a negative impact, in the absence of appropriate mitigation, if there is a severance of roost structures from good feeding areas.

In conducting desk studies during the route corridor selection stage, consideration should be given to all roosts within 1km of a route as these are seen to be the most vulnerable sites. However, where there is a roost of bats of national or international importance (Appendix 1), the desk study area should be extended to within 3km of a route. The extent of all the required study area should be considered during the evaluation of the impacts of each potential route option.

4.2 Fieldwork

Following the desktop studies of the individual route options, some preliminary night surveys should be undertaken in potential bat sensitive areas along designated sensitive routes and within the broad corridor in order to ascertain the presence or absence of bats, the likely species present and their activity. These surveys should be undertaken particularly in broadleaved woodland, mixed or coniferous woodland close to waterways (rivers, lakes, canals), river corridors, wetlands, limestone areas with exposed surfaces likely to possess crevices accessible to bats, or areas within which mines or tunnels are known.

In summary, fieldwork will be required if there is a known roost of national or international importance, if the area is within the range of the lesser horseshoe bat or if the routes traverse habitats likely to be of importance to bats (see Appendix I).

The data collated from the desktop and preliminary field studies for the various routes should be assessed using the approach specified in the *Guidelines for Assessment of Ecological Impacts of National Road Schemes,* (National Roads Authority, 2004) for the assessment of likely impacts (Section 4.3.3). In addition, regard should be given to criteria for the identification of bat roosts of national and international importance outlined in Appendix I of this document.

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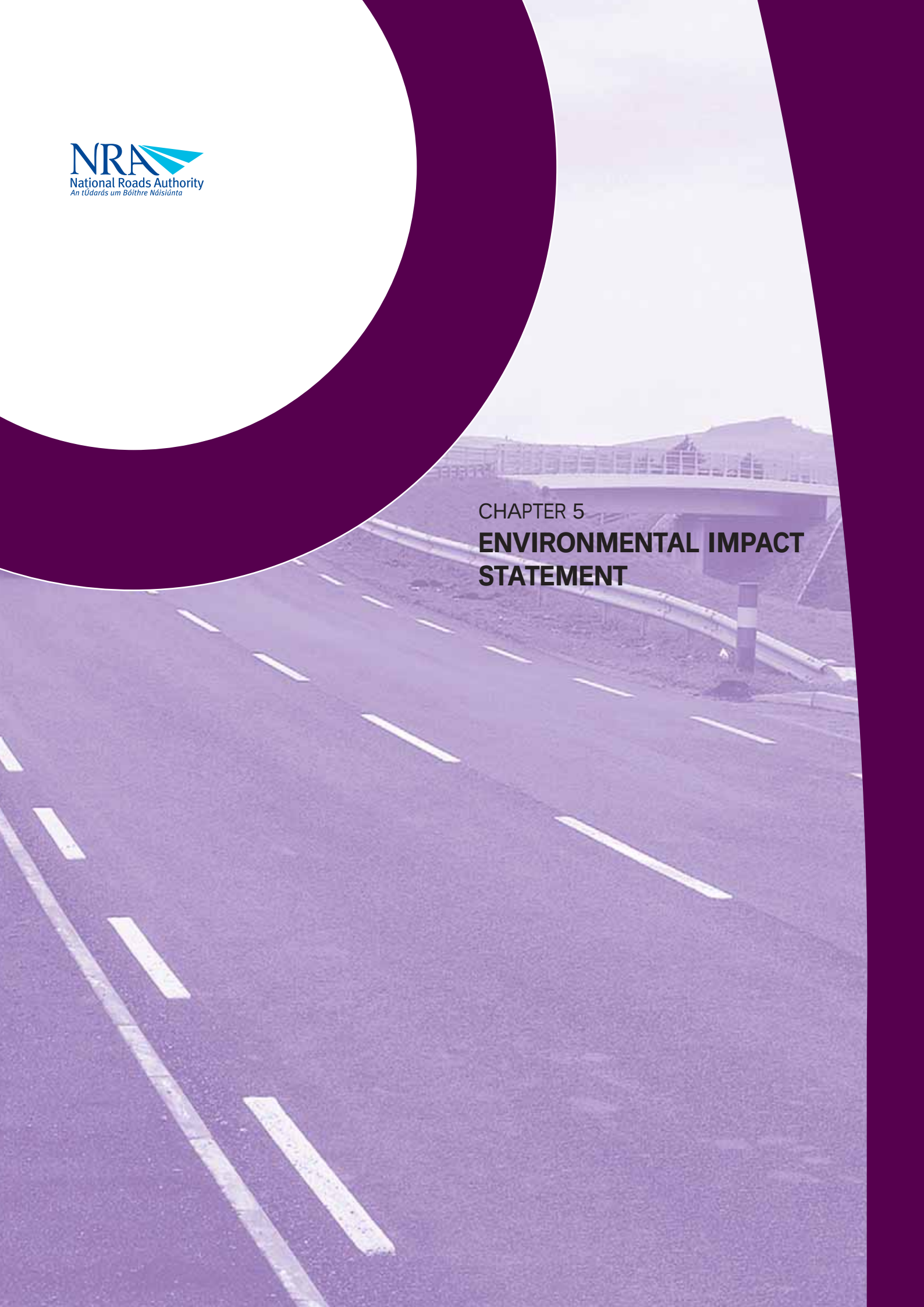

CHAPTER 5

ENVIRONMENTAL IMPACT STATEMENT

5.0 ENVIRONMENTAL IMPACT STATEMENT

5.1 Overview

The objective of the Environmental Impact Statement (EIS) is to undertake sufficient assessment to identify and quantify any significant impacts on bat populations likely to arise from the development of the preferred route. The baseline ecological (or biodiversity) conditions in the area of the proposed road project are described, based on information provided by consultees, background sources of information and the results of surveys carried out for the EIS. Those preparing the bat section for the Ecology Chapter of the EIS must follow the fundamental principles set down in the *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (National Roads Authority 2004). Reference should also be made to the *Guidelines on the Information to be Contained in Environmental Impact Statements* (EPA 2002) and the National Roads Authority's *Environmental Impact Assessment for National Road Schemes – A Practical Guide* (National Roads Authority 22005).

It is important that a detailed and comprehensive evaluation of the preferred route is undertaken for all bat populations and that mitigation measures are drawn up to ensure that any identified significant impacts are mitigated. The direct and indirect impacts of road construction upon bats must be identified in accordance with the EIA Directive (EU Directive 85/337/EC, amended by Directive 97/11/EC). This necessitates the examination of a corridor of land, including the land-take of the road, as well as the adjoining lands and roosts within buildings, trees, caves etc., that may be to either side of the proposed route.

Sufficient time must be allowed to conduct relevant surveys to obtain information on the various roost and hibernation sites, as well as feeding areas. This will minimise the possibility of areas of importance to bats or their roosts being discovered at a later stage of road development. It is important that adequate account is taken of the seasonal use by bats of roosting and foraging areas traversed by the proposed route of the road. Maternity and hibernation roosts are key elements to be examined in the EIS (see Appendix III for the most appropriate timing of surveys). It is also important to note that sex segregation does occur within habitats of various species. Therefore, the occupation of habitats by males/females should also be established. This is important because a woodland occupied by females would be more significant than one used by males. This could impact on the selection of trees for felling.

Bats may hibernate in a building or cave to the west of a proposed road alignment but have their summer roost to the east of that route. Thus, summer studies may indicate that bats do not come into contact with the road at any stage during feeding and commuting. However, a late autumn or winter survey may reveal that roosts are closer to the road and that the proposed road would affect feeding or commuting areas. Additionally, bat activity at any one site may be higher during certain periods than at others due to variations in the availability of insect prey, the recruitment of juvenile bats or even the availability of suitable roost sites at different times of the year. Summer roost sites may be unsuitable in autumn or winter and, hence, if checked outside the breeding season, a false impression of the importance of the area may be obtained.

A guide to the most appropriate timing of each bat survey is included in Appendix III and sufficient time should be allocated in the preparation of the EIS to allow these surveys to be undertaken.

In general, the approach to a bat survey should fulfil the following requirements:

(a) Visual assessment for bat roosts should be undertaken up to 1km either side of the proposed route in habitats with good potential for bats (roosts or feeding). These include,

- Broadleaved woodland
- Mixed woodland or mature coniferous plantations close to water
- River corridors
- Wetlands (lakes, canals, a series of ponds, marshes)
- Limestone areas with exposed limestone rock, caves
- Areas with mines, caves or tunnels

(b) Areas with bat NHAs (various species, including Natterer's bat and lesser horseshoe bat) or where SACs (lesser horseshoe bats) exist, the study area should be extended up to 3km.

(c) Bat detector assessments to provide information on feeding and commuting activity along the proposed route

(d) Identifying appropriate mitigation measures, it is important to identify any points at which the proposed road is crossed by a bat commuting route to or from the identified roosts.

Building on the data already collated during the Constraints and Route Corridor Selection phases, in preparing the EIS, the following should be undertaken to assess the importance of an area in close proximity to a proposed route that is identified as having potential for bats:

1. Examination of buildings and other built structures
2. Examination of natural structures and trees
3. A bat detector survey of the proposed route corridor
4. Mist netting and radio-telemetry

Steps 1 to 3 above should be considered a standard approach while Step 4 need only be undertaken where detailed information on particular species is required.

5.2 Examination of buildings and other built structures

Maternity roosts are typically found in attics or at roof level. Winter roosts are often in basements or underground cellars. Special care is required where a survey of old or disused buildings is proposed as the structure may be unsafe (due to decay, dangerous wiring, wasp nests or beehives, etc.).

It is important that surveys be undertaken by appropriately trained and experienced bat specialists to prevent roost abandonment and accidental injury or death to bats. Much information can be gained from a thorough examination of the eaves, windows and ledges without entry into a building.

Bridges, barns, sheds and walls are all potential roost sites and should be examined properly for evidence of the presence of bats (either current or historical). Inaccessible buildings can be surveyed by emergence surveys at the appropriate time of year. In general, several surveys are recommended to confirm the absence of bat summer roosts in inaccessible buildings. Recent best practice for internally surveying inaccessible buildings recommends a minimum of three emergence surveys between May and September, one of which should be in June or July.

Even where buildings are accessible, there are occasions when some sections of a building remain unchecked either due to the intrusive nature of a search within a dwelling or the inaccessibility of certain areas (e.g. an attic with no trap door or where sections are unsafe). Such buildings should be re-examined once access is possible (in the case of houses within the land take of a road) or the absence of bats should be confirmed prior to demolition (see section on the demolition of buildings in *Guidelines for the Treatment of Bats during the Construction of National Road Schemes* (National Roads Authority, 2005).

5.3 Examination of natural structures and trees

Caves and mature trees in close proximity to a proposed route have the potential for various types of bat roosts, including maternity roosts, transitional roosts, mating roosts and hibernacula. The exploration of caves should be carried out with extreme caution.

The use of trees as roost sites may also be established by means of a bat detector survey or alternatively by examination of all suitable crevices and cavities. The trees most likely to serve as bat roosts should be identified by a bat specialist from a walk-through of the route, from aerial photography or from a tree survey report.

Points on general surveying and features of trees that are most often used by bats include the following:

- In autumn, bats may establish mating roosts in trees, comprising a male bat and several females. These roosts may not be recorded during summer survey work, when maternity roosts are most easily identified.

- A maternity roost generally comprises adult females. These roosts also generally

comprise species that give birth to a single young on an annual basis. Maternity roosts are the largest aggregations of bats to occur in trees and may number in excess of 40 bats.

- Bat detector assessments in the winter period are not appropriate as bats may not become active during the period of examination but may be present within a given tree.

- Cavities: hollows created by fungal decay provide a large space within which bats may aggregate. Such cavities often provide a stable environment that may be used over a protracted period. Cavities are often well hidden and may be difficult to see unless the tree is examined carefully. Fungal fruiting bodies are one indication of the likelihood of internal cavities. Some tree species are especially prone to the formation of cavities, e.g. oak, beech, and horse chestnut, and where these species occur in areas with a high potential for bats, they should be inspected carefully for the presence of bats. With regard to health and safety considerations, cavities in trees should be approached carefully for inspection as they may contain bee or wasp colonies that may not be immediately apparent. Specialist equipment (e.g. rope access and fibre-optics) may be required in certain circumstances.

- Crevices: crevices may be formed where two limbs grow together over a period, where the tree has sustained damage historically and has resealed most of the damage, where limbs have fallen and left a stump, or due to human activities.

- Limb fractures: a split in a branch may provide adequate shelter from rain for one or more bats.

- Loose bark: bats may roost behind loose bark where alternative roosts are not available. However, only individuals or very low numbers of bats typically occur in such situations.

- Ivy: ivy provides good shelter for bats where there is easy access to and from it for flying bats. Bats may also land and crawl into ivy.

- Adjoining habitats: where mature trees are located adjacent to suitable habitat for feeding such as a watercourse, wet grassland, etc., the likelihood of a bat roost being present is increased.

- Bird and bat boxes: where no, or few, natural roost sites occur, the provision of bird and bat boxes may provide suitable sites.

5.4 A bat detector survey of the proposed route corridor

A bat detector survey is the principal field method used to evaluate bats in an area. Bat detectors are ultrasonic receivers that allow trained personnel to interpret the sonic emissions of bats within range of the equipment. This can provide identification to species level for most individuals encountered in flight and even allow interpretation of the activity at which the bat is employed (e.g. feeding, attracting mates in the case of males, commuting).

Caves and trees may be assessed for bat presence by a close inspection and also by the use of bat detectors and remote sensing equipment (e.g. remotely activated infrared beams, time expansion bat detectors and recording equipment).

Fieldwork must address bat activity during important times of the night so as to provide a proper overview of the utilisation of the sites by bats including the identification of key crossing points. Clearly, the most critical areas of conflict for bats and roadways is along the actual road itself and bat crossing points.

While bats are active at intervals throughout the night, peak activity occurs at dusk and before dawn, and much of the additional data obtained by surveying throughout the night will concern small numbers of foraging bats (the presence of which are unlikely to radically alter the subsequent impact assessment). However, there are exceptions, for example where a survey aims to identify mating roosts through song flights of particular species or swarming behaviour. In general, it is recommended that targeted all-night surveys are only carried out where it is considered that the results may affect the overall assessment of the scheme, rather than as a matter of course on all survey visits.

The recommended timescale for surveys is given in Appendix III. The most effective detector survey period is June, July and August. This will provide information on maternity roosts. Earlier studies (April and May) and later studies (September) will provide some information on alternative roosts and mating roosts.

5.5 Mist netting, harp-trapping and radio-telemetry

Mist netting entails the erection of a number of nets along likely feeding corridors to intercept and allow identification of species feeding and commuting through the site that may or may not be positively identified using a bat detector. Netting for bats can only be carried out under licence from the NPWS.

Harp-trapping is another technique which can be used to confirm the presence of species using commuting corridors. They are generally only effective if deployed in enclosed areas, such as under bridges or ‘tunnels’ of vegetation, or can be used to capture bats for radio-tracking studies.

In certain circumstances, the attachment of a radio-transmitter to track the movements of the individual bat may be required. This activity must also be conducted under licence from the NPWS. Radio-tracking can cause considerable disturbance to bats, particularly the smaller species. Therefore, this approach should only be considered when there is a very good reason why other methods, such as bat detector work, will not be effective. For the majority of schemes, radio-tracking will not be necessary for the preparation of the EIS. For further details on these techniques see Barlow (1999) or Barclay and Bell in Kunz (1988).

The content of the bat report, which should be incorporated in the overall ecology assessment section of the EIS, should follow the format outlined in section 5.4 of the *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (National Roads Authority, 2004).

National Roads Authority
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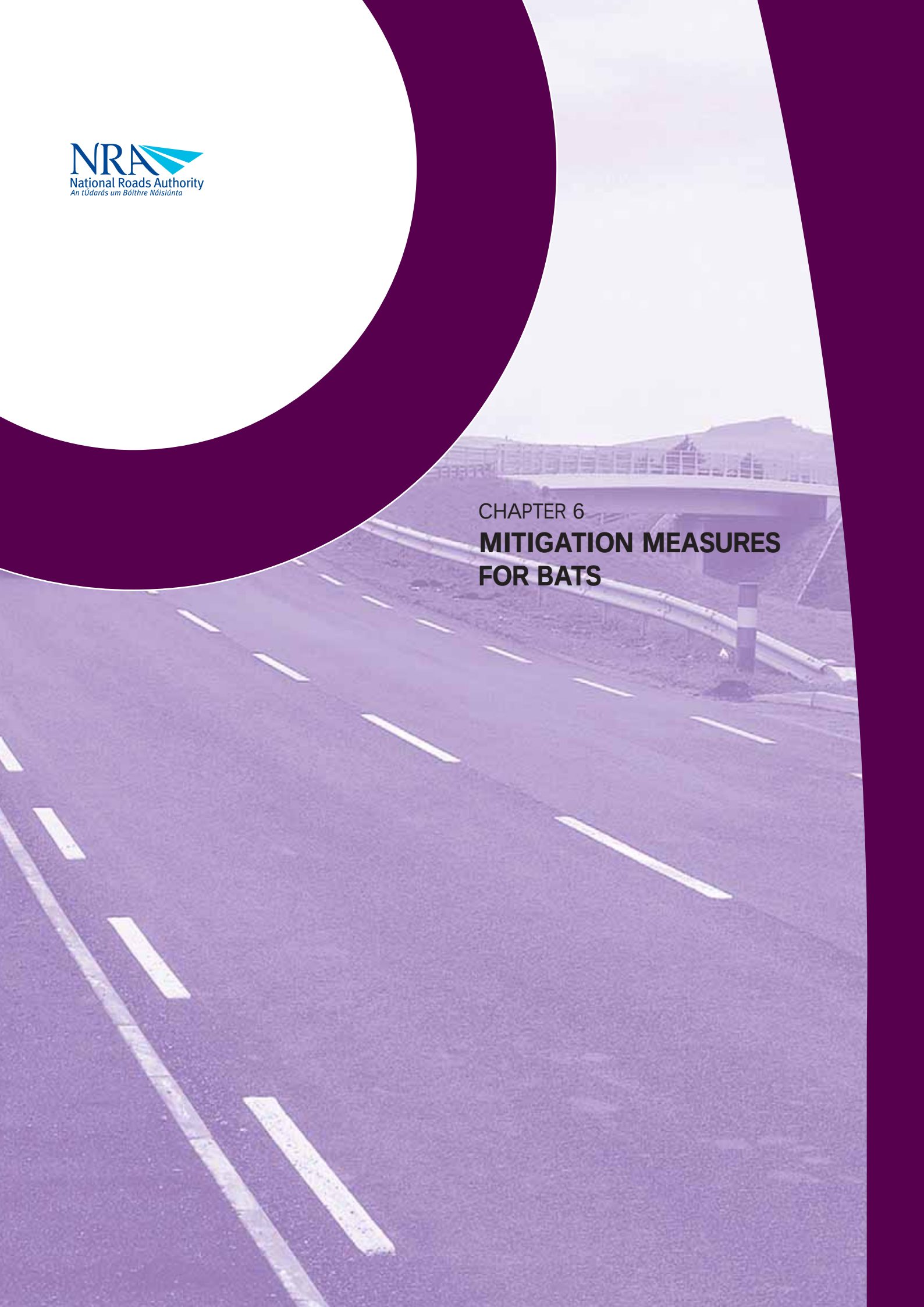

CHAPTER 6

MITIGATION MEASURES FOR BATS

6.0 MITIGATION MEASURES FOR BATS

The mitigation measures that are currently available to reduce the negative impacts of roads on bats are summarised in Table 2.

Table 2: Mitigation measures to reduce the negative impacts of roads on bats

Mitigation Purpose	Mitigation Measure
Protection of the existing environment	(a) Avoidance of an area, structure or local site (e.g. building, cave, mine, tree, or copse) (b) Lighting restrictions
Provision of access over and under the road	(c) Provision of a 'green bridge' or underpass with associated planting.
Providing alternative feeding sites, commuting routes and roosting areas	(d) Provision of a purpose-built structure as an alternative roost(s) (e) Adaptations to bridges to cater for bats (f) Provision of bat boxes (g) Provision of alternative feeding sites (lakes, ponds, woodland, wet grassland) (h) Provision of hedgerows/linear features (i) Use of lighting to inhibit bat entry onto roads specific sites (j) Use of close planting of tall vegetation to encourage a higher flight line
Roost protection during construction: *see Guidelines for the Treatment of Bats during the Construction of National Road Schemes* (National Roads Authority, 2005)	(k) Timing of demolition and tree-felling (l) Examination of buildings prior to demolition (m) Examination of trees prior to felling

When planning mitigation measures for bats, the underlying objective is to protect, where possible, landscape features that are needed by bats throughout the year during different phases of their life cycle. Hence, it is always preferable that bat roosts, feeding areas and commuting routes are preserved. Where this is not feasible in the context of route selection and overall route scheme planning, and where any of these roosting, feeding or commuting areas will be disturbed, similar features must be incorporated into the route at the design stage so that the bat population will not suffer a decline. It is also important to ensure that the recommended mitigation measures provided will satisfy the requirements of the particular bat species being impacted, e.g. use of bat boxes would not be an effective approach for mitigation with respect to lesser horseshoe bats

(a) Avoidance of an area

Avoidance of an area, structure or local site (e.g. building, cave, mine, tree, or copse) with a significant bat presence is seen as the best mitigation measure for the protection of bats. In some circumstances this may not be possible because of the range of other environmental, social and

economic factors that must also be considered when planning and developing an acceptable road route.

The significance of the roost under consideration will determine the likely mitigation measures adopted for a specific scheme. Where feasible, priority must be given to the protection of nationally and internationally important roosts. These roosts may include designated sites such as SACs (for lesser horseshoe bats), NHAs (for various bat species) or those that qualify for this designation based on the number of bats present.

Avoidance of a structure or local site may require alterations to the alignment of the road to provide a larger distance between the road and site structure or simply a modification in the land-take where the structure is not directly along the route.

(b) Lighting Restrictions

Lights have an effect on the ability of some species to feed and commute. For example, species such as the lesser horseshoe bat, whiskered bat, Natterer's bat and Daubenton's bat all avoid illumination. Intolerance of light is most marked at the roost. Bats may abandon a roost that is illuminated or, where they remain, their time of emergence may be delayed considerably. This has repercussions for the amount of time spent feeding and may thus affect body weight, reproduction and ability to survive hibernation. Areas that are well lit will prevent the movement of the above species and may prevent access to roosts as well as feeding areas.

(c) Provision of a 'green bridge' or underpass with associated planting

The provision of a 'green bridge' (Figure 2) or underpass has been used at a number of internationally important sites in Europe. A green bridge with specific modifications crossing over the new road may allow bats to continue to cross close to well-established commuting points. Such bridges have been tried in a small number of sites in Europe and range from a pedestrian bridge with one side adapted to provide a grass verge, up to substantial bridges with mature trees and grassland.

The most critical element to encourage use of a green bridge by bats is the absence of lighting both from the bridge itself and from the traffic below. Bridge walls must be solid to prevent light penetration. The provision of green bridges may offer a solution in some circumstances and allow bat movement from a nearby roost to feeding areas and alternative roosts.

Figure 2: A 'green bridge' planted with trees has proven useful in guiding bats over roads

The incorporation of a carefully designed underpass will also allow bats to gain access to either side of the road. This may range in size from a 1.5m concrete pipe or box culvert up to a 4m wide structure. In some situations, bats routes can be redirected to allow them to pass under certain watercourse crossings (Figure 3). The value of the smaller pipes has yet to be proven but larger culverts have been recorded as being widely used by most bat species.

Figure 3: A spacious spanning of a watercourse with a bridge offers bats good possibilities to cross the road safely. Original hedgerows or tree lines can be rerouted to such a point

A 3m diameter underpass provides adequate access for bats and reduces the possibility that the underpass will become blocked with vegetation or will become a site where predation by other mammals is a risk (e.g. Pine marten, fox, and cat).

The planting regime to encourage bats to avail of any structure installed for their use must direct bats towards the bridge or underpass. This may be best achieved by the provision of two rows of hedgerow. To ensure that a corridor is maintained between these two lines of hedgerow, it may be useful to use a plant-suppressing plastic layer and a layer of rough gravel or dry filling.

Planting of hedgerows leading to the underpass should encourage bats to discover it. If the underpass is at a distance from the roost and from an established crossing point, it may be necessary to direct bats along a double hedgerow corridor up to the entrance. Planting of linear corridors should take place early in the construction phase and, where possible, use should be made of relatively mature planting, both to ensure these are established quickly and, ideally, so that bats learn to use the corridors before completion of the scheme and opening to traffic.

(d) Provision of a purpose-built structure as an alternative roost(s)

It should be noted that the destruction of the breeding or resting place of any bat species requires a special derogation under the EU Habitats Directive. Such a derogation (which must be given by the Minister for the Environment, Heritage and Local Government) can only be sanctioned where there is no satisfactory alternative and where it will not be detrimental to the favourable conservation status of the species concerned. Where there is the loss of a maternity roost that holds a sizeable bat population or a number of bat species, it may be considered necessary to provide a purpose-built structure (known as a 'bat house') for bats. This structure should incorporate several facets of benefit to bats and allow colonisation by numerous species.

General principles for such a structure would be the availability of crevices between timber and stone, between slate and felt and within stonework. Summer breeding sites typically attain temperatures of 30° C or higher. The same building may also provide hibernation conditions if properly planned and even transitional and mating roosts, e.g., Bat Roost at Knockanean, County Clare (see figure 4) (See *Bat Mitigation Guidelines* (English Nature, 2004)).

Figure 4: Example of a Bat Roost at Knockanean, County Clare

While a number of designs exist for bat houses, a building with an external structure in keeping with the surrounding architecture may be appropriate. The structure should be endorsed by the NPWS and by specialists with experience in the construction of buildings for bats to ensure that it has the right conditions to satisfy the requirements of the impacted species.

(e) Adaptations to bridges for bats

New bridges have the advantage of allowing the incorporation of access points for bats into sites that are not created by the deterioration of the original structure (as is true of old bridges). There is scope for the engineering contractors to devise roosting sites on a bridge during the design phase.

(f) Provision of bat boxes

Bat boxes (examples displayed in Figure 5) may provide short-term roosting opportunities for bats and should be used to complement any mitigation measures to protect roosts. A bat box scheme as part of the mitigation measures for road schemes helps to reduce the impacts of such developments on local bat populations. The use of bat boxes provides alternative safe roosting sites for groups of bats where natural sites become unavailable. While a bat box will never provide the full potential of natural roosting sites, correct siting of bat boxes will improve their use by bats. A bat box scheme should be initiated prior to commencement of the development.

The number and type of bat boxes required depends on the species recorded within the development site and the number of bats or roosts that are affected by the development. A bat box scheme should include suitable bat boxes to cover the general requirements of different bat

species present all year around. Unfortunately, bat boxes are not suitable for lesser horseshoe bats.

Materials used for the construction of bat boxes range from traditional timber boxes to 'Woodcrete' boxes. Timber boxes are made from untreated (free from chemical treatment) rough softwood. 'Woodcrete' boxes are made from a mixture of concrete, sawdust and clay molded into a specified shape (Figure 5). 'Woodcrete' boxes have the advantage of allowing natural respiration, stable temperature and greater durability while black colouring attracts sunlight.

Figure 5: Example of bat boxes - Schwegler Woodcrete bat boxes - SE and SW aspect

Siting Bat Boxes

To ensure that bats use the boxes, it is important that they are appropriately sited. The boxes should be located in areas where bats are known to forage or adjacent to suitable foraging areas and they should be sheltered from the prevailing winds.

Boxes should be erected:

- on straight limb trees with no crowding branches or other obstructions for at least 3m above and below the position of the bat box,
- on trees with a diameter wide and strong enough to hold the required number of boxes,
- at a height of 3-5m to reduce the potential of vandalism and predation of resident bats,
- in groups of three bat boxes per tree arranged at the same height facing North, South-East and South-West. This ensures a range of temperatures are available to residing bats.

Inspection and monitoring

It is essential to monitor boxes for their acceptance of use by bats and those boxes that remain unused two years after the date of erection should be relocated. Seasonal inspection of bat boxes should be undertaken (excluding mid-June to mid-August, the lactation period of females, where any disturbance at this time can be detrimental to survival of young) to monitor bat usage and in wintertime for general wear and tear and to remove droppings following use the previous summer. This should be undertaken by a licensed bat-handler. See Box 1 for a case study on the use of a bat box scheme at Mount Falcon Estate.

Box 1. Case Study on the use of a Bat Box Scheme at Mount Falcon Estate, Co. Mayo.

The N26 Road Improvement Scheme passed through a woodland belt situated south and north of the main entrance to Mount Falcon Estate, Ballina, Co. Mayo. A Bat Box Scheme of eighteen Schwegler Woodcrete bat boxes was erected in November 2002.

The boxes were inspected in September 2004 and of the eighteen boxes erected, sixteen had bat droppings. Birds inhabited the remaining two boxes. On one occasion, seven soprano pipistrelles *(Pipistrellus pygmaeus)* and three Leisler's bats *(Nyctalus leisleri)* were residing within four boxes.

(g) Provision of alternative feeding sites (lakes, ponds, woodland)

There may be a requirement to manage the surrounding habitat to provide mitigation for losses in feeding areas. All plants used in this measure should be of local stock and native species should be employed wherever possible. Reference should be made in this regard to the NRA's *Guidelines on Landscape Treatments for National Road Schemes* (National Roads Authority, 2005). Lakes and ponds must be surrounded by vegetation to increase their benefit to bats.

(h) Provision of hedgerows/linear features

Hedgerow loss can be a feature in the clearance phase of roads. Replanting of salvaged plants or of cuttings, saplings and seedlings from the existing hedgerow assists in the maintenance of the local stock and limits introduction of plant genotypes not associated with the area. Other linear features such as treelines and walls may also be used by bats.

(i) Use of lighting to inhibit bat entry on to roads in specific sites

Light intolerance may be put to good use in dissuading bats, that avoid light, from using established commuting routes that would bring them into contact with traffic.

Light bollards placed along a roadside close to an identified crossing point have been shown to deter bats from crossing if placed at 10m intervals (Catherine Bickmore Associates, 2003). Vegetation must not obscure the lighting. An alternative crossing point must be provided in such circumstances.

(j) Use of close planting of tall vegetation to encourage a higher flight line

It may be possible at narrow points along a road to encourage bats to take a higher flight path and hence fly over the road. This may work in conjunction with a structure that spans the road width thus bringing bats over to the opposite side of the road. When a flight path is used by species that can fly through dense vegetation, e.g., lesser horseshoe, long-eared bats, and Natterer's bats, they should be forced to cross the road at a safe height. This can be achieved by placing a screen of wood or wire mesh at a height of 4 to 5m and by lighting the road at the location of the hop-over. The light should shine mainly on the road and not the surroundings.

For broader crossings, for instance a motorway with 2 x 2 or 2 x 3 lanes, there is the potential that bats will not be able to bridge the entire distance at the desired height. In this situation, tall vegetation can be strategically placed in the central reservation to provide two hop-overs, which will have the effect of keeping the bats higher in the air (Figure 6). Artificial net structures that close over the road can also be created, above which the bats then fly.

Figure 6: Shrubs or trees between the lanes make crossing a broader road more feasible

(k) Timing of demolition and tree-felling

(l) Examination of buildings prior to demolition

(m) Examination of trees prior to felling

Refer to the National Roads Authority *Guidelines for the Treatment of Bats during the Construction of* (National Road Schemes 2005) for appropriate practice in relation to the examination of buildings prior to demolition, trees prior to felling, and the timing of structure demolition and tree felling.

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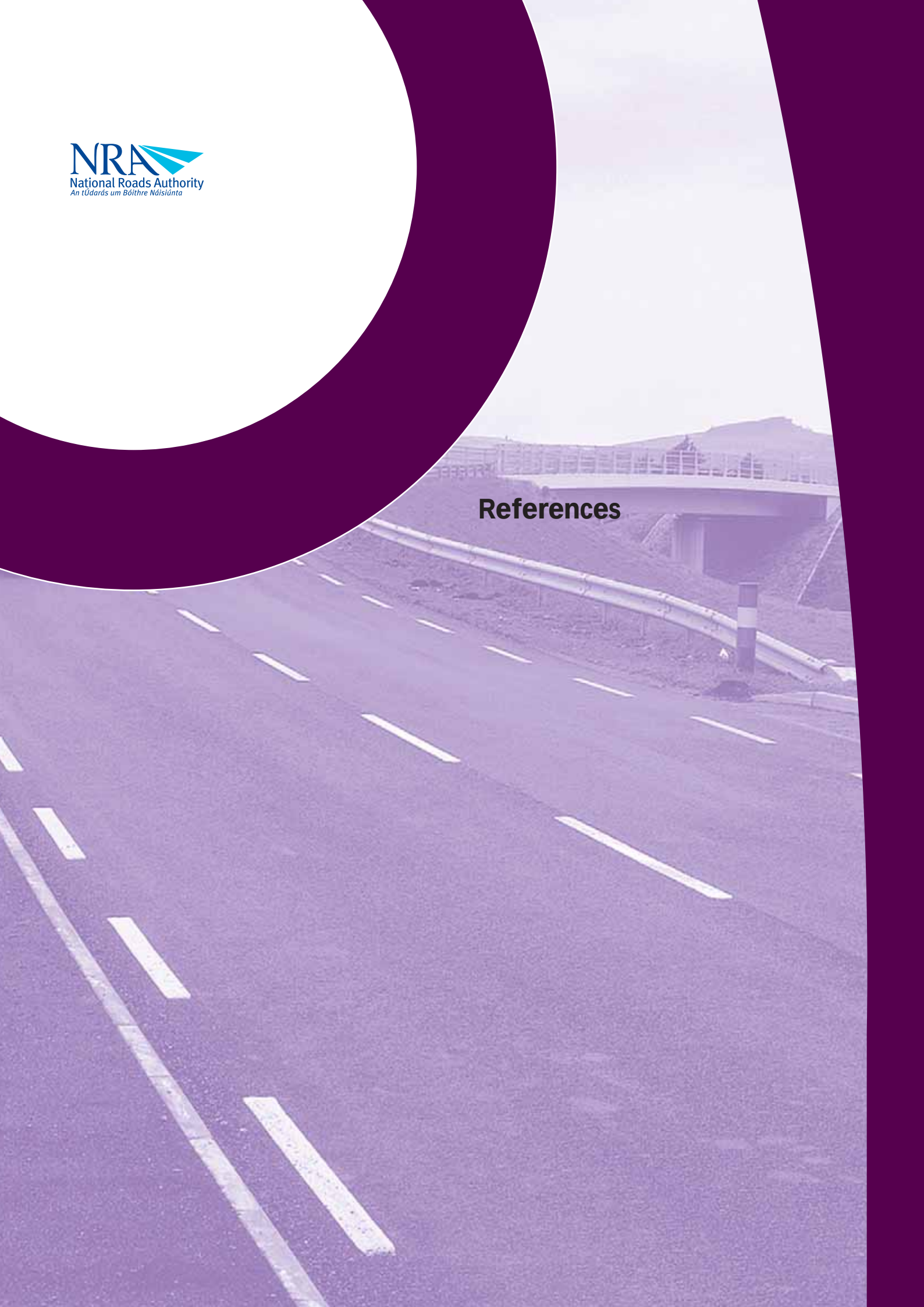

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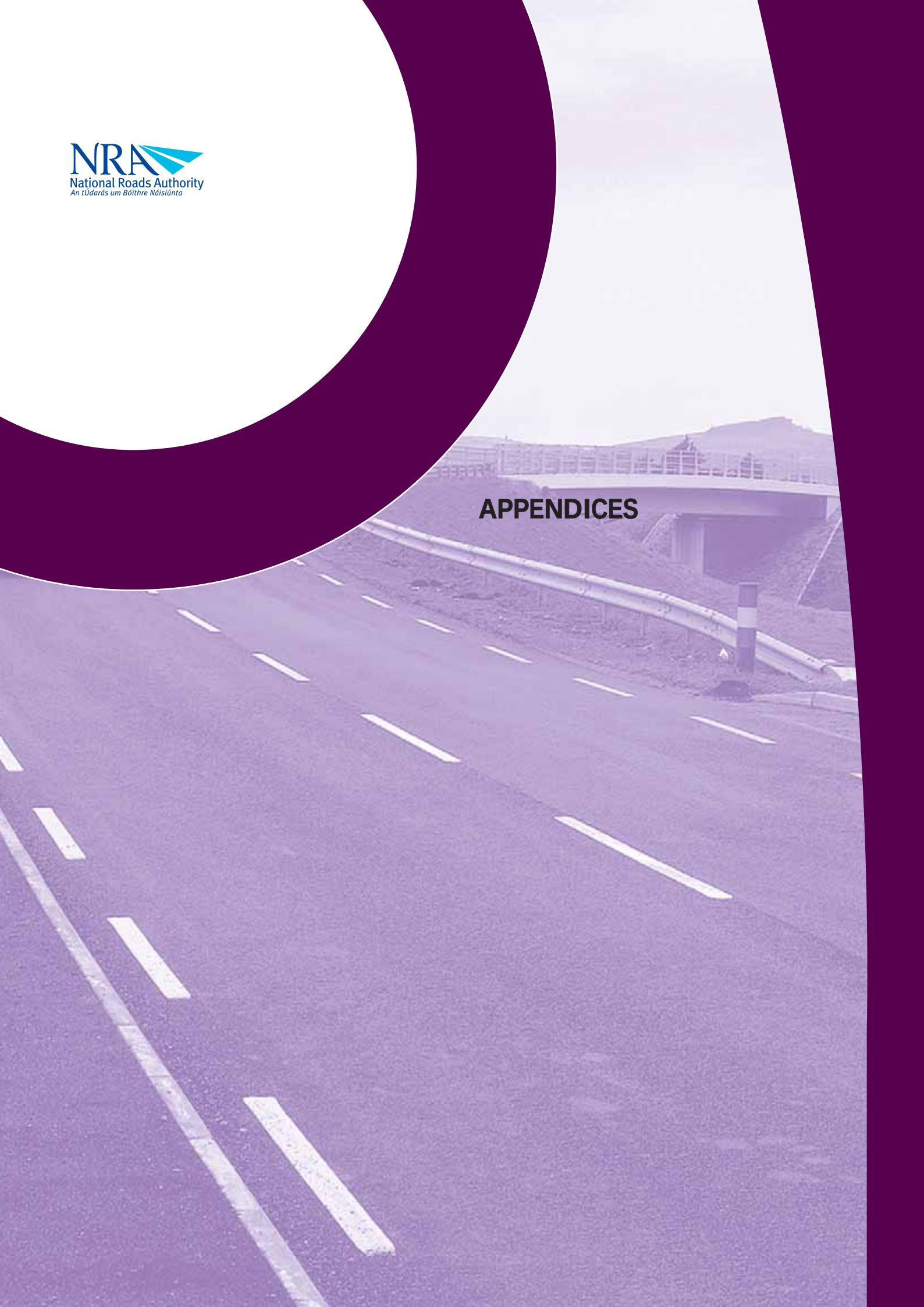
APPENDICES



Appendix 1 Criteria for Bat Roosts of National or International Importance

Lesser Horseshoe bats

In Ireland, the following bat population figures have been used as criteria for the designation of Special Areas of Conservation for the protection of lesser horseshoe bats.

(a) Maternity roost (summer): 100 individuals (approximately 1% of the Irish population)

(b) Hibernacula (winter): 50 individuals (approx. 0.5 % of the Irish population)

Internationally important roosts

There are no clear guidelines as to the nature of a bat roost of international importance. All of the largest roosts of lesser horseshoe bats in Ireland would be of international importance and it is anticipated that all large Leisler's bat roosts (in excess of 100) would also have international significance.

The following are working guidelines developed by the Bat Expert Panel of the Heritage Council in 2003 to provide a basis for comparing the importance of different building roosts nationally and internationally.

Species	Indicator	Significance
Lesser Horseshoe Bat	SAC	Very significant
	If present	Significant
Whiskered	>10	Very significant
	If present	Significant
Natterer's	>10	Very significant
	If present	Significant
Daubenton's	Maternity roost	Very significant
Leisler's	Maternity roost	Very significant
Common Pipistrelle	Maternity roost	Significant
Soprano Pipistrelle	Maternity roost	Significant
Brown Long-eared	Maternity roost	Significant

Appendix 2 Contact Details

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Irish Wildlife Trust
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Phone: 01 8602839
Fax: 01 8308914,
Email: enquiries@iwt.ie, http://www.iwt.ie/index.php.

Vincent Wildlife Trust,
Donaghpatrick, Headford, Co Galway,
Phone: 093 35304,
Email: katemcaney@vwt.org.uk, http://www.irishanimals.com/wildlife/8.html

Bat Conservation Trust,
15 Cloisters House, 8 Batters Park Road, London SW8 4BG, England
Phone: 0044 2076272629,
Email:enquiries@bats.org.uk, http://www.bats.org.uk/

Wildlife Officer, Heritage Council,
Rothe House, Kilkenny,
Phone: 056 70777,
Fax 056 70788,
Web: http://www.heritagecouncil.ie/

Appendix 3 Appropriate Survey Timetable for bats affected by a road scheme

Habitat → / Species ↓	Woodland and Parkland			Scrub		Individual trees	Recently felled woodland	Grassland	Tall herb and fern Bracken		Heath	Mire
	Broadleaved	Coniferous	Mixed	Dense/continuous	Scattered				Continuous	Scattered		
Common pipistrelle	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 All year	2 Mar (June-Aug) Sept		2 Mar (June-Aug) Sept			2 Mar (June-Aug) Sept
Soprano pipistrelle	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 All year	2 Mar (June-Aug) Sept		2 Mar (June-Aug) Sept			2 Mar (June-Aug) Sept
Nathusius' pipistrelle	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	2 All year	2 Mar (June-Aug) Sept		2 Mar (June-Aug) Sept			2 Mar (June-Aug) Sept
Brown long-eared	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	4 All year		2 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept		
Leisler's	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	4 All year	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept			1 Mar (June-Aug) Sept	
Daubenton's	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	4 All year						
Natterer's	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	4 All year		2 Mar (June-Aug) Sept				
Whiskered	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	4 All year						
Brandt's	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	4 All year						
Lesser horseshoe	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept				4 Mar (June-Aug) Sept			
Method →	Detector/harp/netting/lures/radio-telemetry			Detector/trapping/lures/telemetry		Fibrescope/binoculars		Detector	Detector/trapping		Detector	Detector

continued on pages 39 & 40

Annex II species

All season survey to locate/determine roost use

Spring/Summer/Autumn survey to confirm mating/ lekking sites and foraging areas

Summer/Winter survey to locate maternity, transitional and hibernation roosting sites

Winter survey to locate/assess hibernation sites

4 — Number of survey rounds per season required to confirm species presence and activity

Mar (Apr-Sept) Oct — Survey season with optimum months in brackets

Swamp	Wetland	Open water		Coastland				Exposed rock and bare ground					Cultivated land
								Natural		Artificial			
		Standing water	Running water	Intertidal	Saltmarsh	Sand dune	Cliff and slope	Cliff	Cave	Quarry	Mine	Refuse-tip	
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	—	4 Oct (Jan-Feb) Mar	2 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	—	—
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	—	4 Oct (Jan-Feb) Mar	2 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	—	—
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	—	4 Oct (Jan-Feb) Mar	2 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	—	—
—	—	—	—	—	—	—	—	—	4 Oct (Jan-Feb) Mar	—	—	—	—
—	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	—	2 Mar (June-Aug) Sept	—	—	—	—	—	—	—	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept
—	4 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	—	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	—	—
—	—	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	—	—	—	—	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	—	—
—	—	—	—	—	—	—	—	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	—	—
—	—	—	—	—	—	—	—	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	—	—
—	—	—	—	—	—	—	—	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	—	—
Detector	Detector	Detector		Detector				Detector	Torch	Detector	Torch	Detector	Detector

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Key:
- Annex II species
- Summer/Winter survey to locate maternity, transitional and hibernation roosting sites
- All season survey to locate/determine roost use
- Winter survey to locate/assess hibernation sites
- Mar (Apr-Sept) Oct — Survey season with optimum months in brackets
- Spring/Summer/Autumn survey to confirm mating/lekking sites and foraging areas
- 4 — Number of survey rounds per season required to confirm species presence and activity

Boundary			Structures								Bat & bird boxes	← Habitat / ↓ Species	Notes
			Overground							Underground			
Treeline/ Hedgerow/fence	Wall	Ditch	Barn/ House	Grotto	Folly	Aquaduct	Culvert	Bridge	Castle	Various			
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		4 All year (Apr-Sept)		4 All year	4 All year (Apr-Sept)			4 All year	4 Within light zone (Apr-Sept)	2 All year (Feb & Aug)	Common pipistrelle	**Mating activity apparent in Aug-Sept Lure (Apr-Sept)**
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		4 All year (Apr-Sept)		4 All year	4 All year (Apr-Sept)			4 All year	4 Within light zone (Apr-Sept)	2 All year (Feb & Aug)	Soprano pipistrelle	**Mating activity apparent in Aug-Sept Lure (Apr-Sept)**
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		4 All year (Apr-Sept)		4 All year	4 All year (Apr-Sept)			4 All year		2 All year (Feb & Aug)	Nathusius' pipistrelle	**Mating activity apparent in Aug-Sept Lure (Apr-Sept)**
4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 All year (Apr-Sept)	4 All year	4 All year	4 All year (Apr-Sept)	4 All year	4 All year	4 All year	4 Oct (Jan-Feb) Mar	2 All year (Feb & Aug)	Brown long-eared	**Mating activity apparent in April as well as Aug-Sept**
			4 All year (Apr-Sept)		4 All year	4 All year (Apr-Sept)			4 All year		2 All year (Feb & Aug)	Leisler's	**Lekking behaviour in Aug-Sept**
4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept		4 All year (Apr-Sept)	4 All year	4 All year	4 All year (Apr-Sept)	4 All year	4 All year	4 All year	4 Oct (Jan-Feb) Mar		Daubenton's	**Mating activity apparent in Aug-Sept**
4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept		4 All year (Apr-Sept)	4 All year	4 All year	4 All year (Apr-Sept)	4 All year	4 All year	4 All year	4 Oct (Jan-Feb) Mar	2 All year (Feb & Aug)	Natterer's	**Mating activity apparent in Aug-Sept Swarming (Sept-Nov)**
4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept		4 All year (Apr-Sept)	4 All year	4 All year	4 All year (Apr-Sept)	4 All year	4 All year	4 All year	4 Oct (Jan-Feb) Mar	2 All year (Feb & Aug)	Whiskered	**Mating activity apparent in July-Aug**
4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept		4 All year (Apr-Sept)	4 All year	4 All year	4 All year (Apr-Sept)	4 All year	4 All year	4 All year	4 Oct (Jan-Feb) Mar	2 All year (Feb & Aug)	Brandt's	**Mating activity apparent in July-Aug**
4 Mar (June-Aug) Sept		4 Mar (June-Aug) Sept	4 All year (Apr-Sept)	4 All year (Apr-Sept)	4 All year (Apr-Sept)		4 All year	4 All year	4 All year	4 Apr (May-Sept) Oct Nov (Jan-Feb) Mar		Lesser horseshoe	**Mating activity apparent in April as well as Aug-Oct**
Detector/Torch/Fibrescope/Trapping			Detector/Torch/Fibrescope/Trapping							Visual	Visual	**← Method**	

Annex II species

All season survey to locate/determine roost use

Spring/Summer/Autumn survey to confirm mating/ lekking sites and foraging areas

Summer/Winter survey to locate maternity, transitional and hibernation roosting sites

Winter survey to locate/assess hibernation sites

4
Number of survey rounds per season required to confirm species presence and activity

Mar (Apr-Sept) Oct
Survey season with optimum months in brackets

Glossary of Terms

Colony: The term colony is used to identify a genetically related or socially interactive population of bats within an area that may associate within a number of roost sites during the annual cycle.

Harem: The mating and association of several adult females with one male.

Population: A population is the number of individuals of a given species occupying a certain area of land over a certain period of time.

Roost: This term has a dual application and is used to describe the structure (house, shed, bridge, tree, cave, etc.) within or on which a number of bats take shelter. Secondly, the bats within or on such a structure are also referred to as a roost of bats. 'Roost' does not infer a genetic or social association between the bats within a structure

Maternity roost: A maternity roost is the structure within which pregnant females aggregate in summer (typically from late May onwards) to give birth to the annual single young. The young are born within the period June to July. The bats may utilise the maternity roost up until the early part of September, by which time the young are independent.

Maternity roosts may be evacuated periodically throughout the summer as bats avail of a number of roosts during the summer (there is rarely only one roost used for the entire summer for most species of bat),

Night roost: A night roost is a resting place availed of by a single or number of bats during the period of darkness and following emergence from a daytime roost. Night roosts play an important function as a resting place between feeding forays, refuges from predators and bad weather, sites to consume large prey that require manipulation and allow social interaction and information transfer between individuals of the same species (Kunz, 1982).

Hibernation roost : A hibernation roost or hibernaculum is the site within which bats spend the period of the year (winter) when food supply is at its lowest. To prevent high energy losses attempting to retain a constantly high metabolic rate, bats undergo a drop in body temperature, heart beat, breathing rate and thus energy consumption. Coupled with a huge increase in body fat levels in autumn, this allows bats to withstand the absence of adequate available insect numbers. Hibernation may be unbroken in some bats, but in Ireland it is much more intermittent, i.e. bats awaken from hibernation occasionally to feed, drink, change position within a site or go to an alternative site if necessary.

Mating roost : A mating roost is the site established by a reproductively fertile male to which females are attracted for mating. While there are a number of variations on reproductive strategy in bats, a widespread system in Irish bats is the formation of a 'lek'. Male bats defend a roost and airspace surrounding this roost within foraging and commuting areas of female bats. The male may also engage in 'song flight', flying repeatedly back and forth within a defined area while emitting a species-specific song. Mating roosts may be established in trees, walls, buildings or bridges.

Transitional roost: A transitional roost is a roost that is used by bats to seek daytime shelter for purposes other than those listed above. It also includes roosts such as the gathering roost within which females may aggregate prior to breeding but always leave prior to breeding. It may also be used to describe a roost of male bats as the stability of the social group is low and liable to fragment overnight.

The term transitional is commonly used for roosts formed in the spring and autumn period, prior to and subsequent to breeding (and equally prior to and subsequent to hibernation).