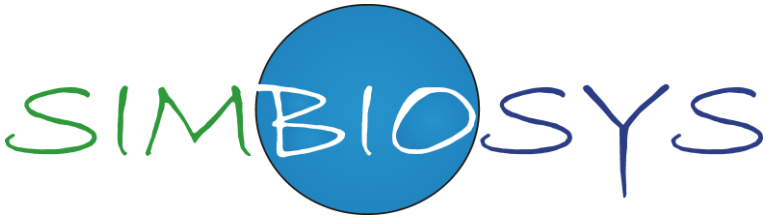

The Road to Improvement:
The Ecological Highways of the Future

Strategic Review prepared by Lisa M. J. Dolan[1,2], Jane Stout[3] and Padraig M. Whelan[1,2] as part of the SIMBIOSYS Project, an EPA funded project examining sectoral influences on biodiversity and ecosystem services.

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Executive Summary

Due to the recent economic down turn, the number of road projects currently under construction in the Irish landscape has decreased dramatically. This affords an opportunity to those involved in research and the design, construction and management of national road schemes to take a step back and examine the environmental performance of those road projects completed to date. This will allow a review of relevant best practice guidelines, standards and legislation and to improve on current practices for future road development projects.

In this regard, the purpose of this paper is to examine the various phases[1] (see Figure 1) of the national road development process in Ireland and the National Roads Authority (NRA) Environmental Assessment and Construction Guidelines (the "NRA EACG") and other road related guideline documents in order to identify key areas for improvement in relation to biodiversity conservation.

While the NRA EACG have adopted best practice in Europe and thus are considered to be in line with international best practice, a number of key areas during the planning, construction and implementation process have been identified which require attention in terms of building on national capacity, based on the experience gathered by the relevant consultees[2]. In addition there are a number of other relevant guideline documents which require updating in order to be brought into line with best practice.

Road schemes in Ireland are generally developed under three forms of contract i.e. traditional contract, Design and Build (D&B) contract and finally Public Private Partnership schemes (PPPs). While each of these forms of contracts has its own set of conditions, there are opportunities to improve on current best practice which are relevant to all three forms of contract.

This paper aims to examine both the perceived general and the contract-specific biodiversity issues and key areas which require revision or updating. In order to assemble these issues and key areas, a multidisciplinary consultative workshop was held in March 2010. Contributions were made by a wide range of consultees involved in road project development in Ireland.

This paper is a synthesis of the information that was assembled from various sources including the discussions held at the workshop, experience gathered to date by the authors and discussions with

[1] It should be noted that the major phases of the road development process changed in January 2010 (NRA, 2010). The Detailed Design and Construction stages are now entitled the Construction and Implementation stages.
[2] The consultees are a multidisciplinary team of experts which interact with national road schemes.

other consultees. Its contents are, by their nature, applied and can be utilised to inform policy, guideline and contractual changes, where practically feasible, within the future development of national road infrastructure in Ireland.

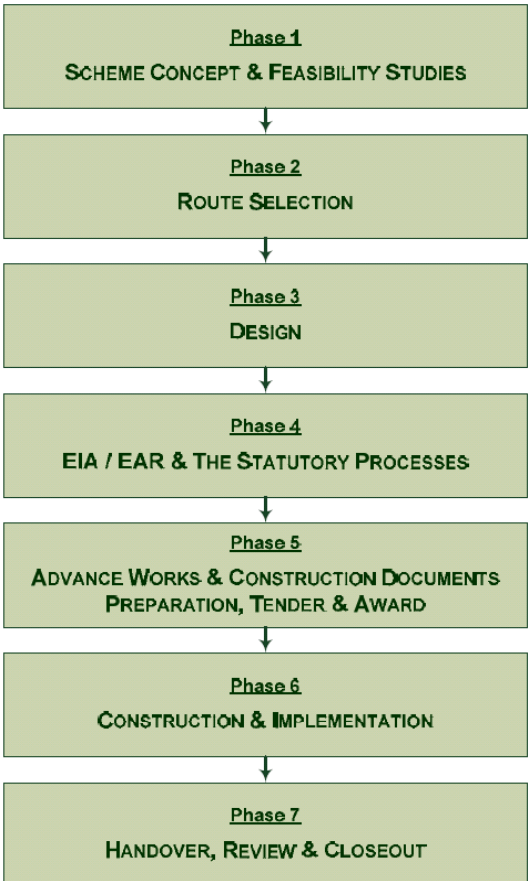

Figure 1: Phases of NRA Project Management (Source: NRA, 2010)

1. Introduction

While there are very few published empirical studies to date on the Irish road landscape, there are many publications which refer to the negative impacts of roads on biodiversity and how roads relate to the wider Irish landscape and ecosystems within (*e.g.* Dolan, 2003; Nairn and Fossitt, 2004; Dolan *et al*., 2005). Road development increases the consumption of natural resources, mainly water and land, both of which are limited, thus impacting on the integrity of ecosystems.

The establishment of new roads can affect ecosystem structure and diversity and lead to a loss of ecological integrity and function in adjacent semi-natural ecosystems, therefore having adverse effects on an ecosystem's ability to provide the flow of natural ecological services within a landscape. For example, during the process of land conversion and soil disturbance, services such as flood control, biocontrol and invasion resistance, provided by functioning ecosystems, may be severely compromised and transformed into dependent ecosystems requiring mitigation, compensation (see Plate 1), management and ongoing monitoring (Dolan, 2003; Dolan *et al*., 2005).

Potential and/or perceived impacts which may arise as a result of new road schemes include habitat fragmentation, loss of native species and habitat, invasion by non-native invasive species, noise and visual disturbance, pronounced soil erosion, and decreased water quality (see Southerland, 1995; Forman, 1995; Lugo and Gucinski, 2000; Dolan, 2003).

Plate 1: Habitat creation for White-clawed Crayfish (Photograph: Lisa M. J. Dolan courtesy of Atkins).

The Irish National Roads Authority (NRA) has published a set of Environmental Assessment and Construction Guidelines (the "NRA EACG") which detail best practice guidance, for example: the assessment of ecological impacts (NRA, 2009), the provision of landscape treatments (NRA, 2006); treatment of noise and vibration (NRA, 2004); ecological surveying (NRA, 2008); management of non-native invasive species and noxious weeds (NRA, 2010); and assessment and treatment of geology, hydrology and hydrogeology (NRA, 2010).

Since the implementation of the EU Environmental Impact Assessment (85/337/EEC as amended), the Habitats (92/43/EEC) and the Birds (79/409/EEC) Directives, national legislation and the respective

NRA 'Guidelines for Assessment of Ecological Impacts of National Road Schemes' (NRA, 2005; 2009), the majority of new roads in Ireland generally avoid ecologically sensitive habitats and mostly traverse intensively managed agricultural grassland (with the exception of roads which traverse the west of Ireland, where the landscape may contain a diverse array of important habitat types and protected species).

In landscapes where much of the former semi-natural ecosystems have been lost due to intensive agricultural practices, it is now recognised that the construction of new roads may actually provide an opportunity to restore in part the former ecological services, habitat and corridors for the dispersal of certain species (see Dolan *et al*., 2004) and support Article 10 of the EU Habitats Directive (92/43/EEC). For example, along with the biodiversity conservation opportunities associated with general landscape treatments implemented on national road schemes, specific habitat creation measures have been put in place for White-clawed Crayfish (*Austropotamobius pallipes*), Smooth Newt (*Triturus vulgaris*), Common Frog (*Rana temporaria*), Small-white Orchid (*Pseudorchis albida*), Meadow Barley (*Hordeum secalinum*), Summer Snowflake (*Leucojum aestivum*); avoidance measures for the Kerry Slug (*Geomalacus maculosus*) and Killarney Fern (*Trichomanes speciosum*) and specific environmental management measures for the Freshwater Pearl Mussel (*Margaritifera margaritifera*).

While it is clear that major advances have been made in relation to the implementation of best practice since the inception of the NRA in 1994, including the preparation of the NRA EACG, it has become apparent in recent years that there remain a small number of key areas where improvements can be made in relation to minimising the impacts of roads on biodiversity in the Irish landscape.

In order to assemble these key areas, and to make recommendations and identify the need for further guidance, a multidisciplinary consultative workshop was held with those involved in the road development process in Ireland in March 2010. Contributions were made by design and management professionals and consultants, academic researchers, NRA staff, National Parks and Wildlife (NPWS) staff which highlighted a number of key areas which need to be addressed in order to ensure the implementation of best practice within the Irish road industry.

2. Ecological Surveys

Ecological surveying techniques are an important tool for determining the presence/absence and habitat of protected flora and fauna, which may interact with a national road scheme.

It is important that the presence/absence of a protected species is identified at an early stage so that the impacts of the route can be properly determined in order to assist in the objective comparison of different route options. Route selection and the design of the preferred route is a difficult and complex balance where numerous impact types and economic and engineering considerations have to be made. On a practical level, for example, decisions may have to be made between bisecting a sports field or a patch of woodland. The NRA EACG, Project Appraisal Guidelines (NRA, 2011) and Project Management Guidelines (NRA, 2010) try to make the process as objective as possible. Values are derived from national and European policy and legislation.

In relation to the route selection stage, it is of utmost importance that the presence/absence of a protected species is identified early on in the planning process and the significance of potential impacts identified, such that a particular species and its habitat may be avoided through the alignment of the route corridor, if required, and where practically feasible.

Until 2008, various approaches and standards were adopted in relation to surveying techniques for protected flora and fauna and the mapping of the habitat types located within the zone influence of a national road scheme. In this regard, the extent of area surveyed for various species or taxa and the level of survey effort deployed varied between individual Constraints studies, Route Selection studies, Environmental Impact Statements (EISs), pre-fencing surveys and pre-construction surveys.

In order to standardise the surveying techniques deployed as part of national road project planning and to meet with best practice, the NRA published guidelines on 'Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes' (NRA, 2008). In 2011, Smith *et al*. (2011) commissioned 'Best Practice Guidance for Habitat Survey and Mapping'.

The NRA Surveying Technique Guidelines sets out guidance on the types of habitat and species which typically interact with road schemes, along with a number of rarer species that require avoidance or specific mitigation or compensation measures, where encountered. In terms of standardising the types of habitats which should be surveyed, for example, the guidelines ensure that habitats such as drainage ditches (see Plate 2) which have been overlooked as part of certain EIS surveys are now included in habitat surveys, in recognition of the fact that such ditches can harbour a number of species protected under Irish and European legislation. These include: River (*Lampetra fluviatilis*) and Brook Lamprey (*Lampetra planeri*); White-clawed Crayfish (*Austropotamobius pallipes*) (O' Donoghue et al., 2009); Smooth Newt (*Triturus vulgaris*); Common Frog (*Rana temporaria*); and, Opposite-leaved Pond Weed (*Gymnocarpium robertianum*), amongst others.

Clear guidelines are also provided as to the extent of the zone of influence of a road scheme on various species. For example, according to the NRA Surveying Technique Guidelines, significant impacts may be likely on populations of amphibians located within 250m of a route corridor where the amphibian population is defined as a key ecological receptor (refer to NRA Ecological Impact Assessment Guidelines, 2008). This zone of influence, generally, determines the extent of area to be surveyed.

The NRA Surveying Technique Guidelines also address key areas in relation to the influences of climatic conditions and seasonality. They stress the importance of undertaking surveys for certain species during the most appropriate time of year when: (1) species are more conspicuous, for example, when the Marsh Fritillary butterfly (*Euphydryas aurinia*) is in flight; (2) at times when the surveyor will not disturb the breeding or spawning period of the species, for example, White-clawed Crayfish; and, (3) recommendations relating to more cryptic species such as orchids. Orchid species including Irish lady's-tresses (*Spiranthes romanzoffiana*) can lay dormant underground for much of the year (and for up to several years at a time).

Plate 2: Drainage ditch containing a large population of Common Frog spawn cordoned off in advance of site clearance for translocation of the spawn (Photograph: Lisa M. J. Dolan).

However, the Route Selection stage, which is the key environmental stage in the road development process, continues to remain the most problematic. It is noted that the NRA guidance is quite onerous in this regard (NRA Ecological Impact Assessment Guidelines, NRA, 2008). The key issues at this stage relate to the level of survey effort that can feasibly be deployed. In circumstances where a number of route corridor options may be under consideration, significant time and costs are required to carry out a full-scale multidisciplinary baseline ecological survey for each route corridor option. Generally, the later any potential ecological issues are identified in the EIA/Design process, the more difficult and costly it is to alter the alignment.

However, for the presence of certain species, such as the Kerry Slug and the Marsh Fritillary, the route selection process is particularly difficult, as translocation and habitat enhancement schemes should be avoided wherever possible. This is due to the sensitive nature of these species *e.g.* the Kerry Slug is particularly vulnerable to changes in its habitat, while the habitat for Marsh Fritillary cannot readily be recreated (NRA, 2010). In this regard, surveys carried out during the Route Selection stage should include species-specific surveys for those species where mitigation and compensatory measures are not feasible and where suitable habitat is known to be present within a route corridor.

In addition to the requirement for guidelines for those surveys carried out during the planning stages on national road projects, specific guidance is also required for post-planning surveys. These include pre-fencing surveys carried out prior to advanced fencing contracts and pre-construction surveys undertaken prior to the commencement of the Construction and Implementation stage. Unless guidelines are put in place, the extent of area and level of survey effort deployed during these surveys may be variable.

Specific guidance for pre-fencing and pre-construction surveys is also required in relation to the requirement for "verification[3]" surveys as opposed to "full" surveys. Where significant time has

[3] Full surveys involve a survey of the entire route corridor and zone of influence, therefore, all activity and presence/absence is recorded. Verification surveys use previously gathered data, where the surveyors only focus on those areas where activity was previously found.

elapsed since the preparation of the EIS a "full" survey, as opposed to a verification survey, may be required in order to determine any changes in population size and the presence/absence of any individuals or populations of a species which may have entered or left the zone of influence of the route corridor since the preparation of the EIS. However, where only a short time period has elapsed, various documents suggest that a verification survey can be undertaken which involves a targeted survey of the previously identified setts, holts or roosts (for example, in the EIS or pre-fencing surveys) to confirm levels of activity. However, there are differing recommendations of between 12 months to 36 months for this time lapse. These time limits require further clarification and guidance.

Plate 3: Disturbed Badger sett (Photograph: Lisa M. J. Dolan courtesy of Atkins).

In addition, guidance is also required where the time frame between both the EIS and the pre-fencing survey and between the pre-fencing survey and the pre-construction survey does not exceed the maximum allowable time frame before a full resurvey is required. This can result in the preparation of two verification studies and no full-scale survey after the preparation of the EIS and in advance of site clearance and construction. However, the time gap that may have elapsed since the preparation of the EIS could be of two years or greater.

Where verification surveys are implemented, new Badgers (*Meles meles*) setts that were created by Badgers in the route corridor since the pre-fencing or EIS survey may be overlooked (and may not be uncovered until the site clearance and construction stages). This may result in damage to setts by plant machinery and delays to the main contract in relation to the need for additional licenses from National Parks and Wildlife Service (NPWS).

While the required level of survey effort and extent of area to be surveyed for the various stages of road project planning has been identified by the NRA EACG, it is the experience of many ecological consultants that the level of survey effort remains restricted by the effects of competitive pricing. In order to acquire or to be awarded contracts, limited budgets are allocated for surveying at Tender stages such that there are insufficient resources to carry out surveys to standards as laid out in the NRA Surveying Technique Guidelines (2010). While detailed methodologies incorporating best practice are proposed in Tender submissions and are described in survey reports on award of tender, there is currently no means of verifying that the required level of survey effort (*i.e.* the number of days in the

field surveying) is actually deployed. However, appropriate legal remedies are available to address such activities where uncovered.

Guidance is also required where additional species are uncovered post-Tender *i.e.* during the pre-construction surveys or indeed encountered during the construction stage. The identification of additional protected species, previously not detected during the planning or the pre-fencing surveys, may affect the construction programme as a result of: delays to site clearance; the requirement to consult with statutory bodies (including Derogation License applications to the NPWS); the preparation of additional Construction and Implementation design and drawings; and the implementation of any associated mitigation and compensatory measures. The requirement to undertake this work can have implications for the main contractor and the detailed designer in terms of delays to the overall construction and implementation programme. Under the precautionary principle, where protected species are found not to be present, but there is potential for such species to occur, based on presence of suitable habitat, the EIS should identify appropriate mitigation measures in the event that these species are uncovered. This will reduce the effect of discovering such a species at the construction stage.

Prior to vegetation clearance, but within the bird nesting season (1st March to 31st August), there may be a requirement to undertake a pre-construction bird nest survey and to cordon off vegetation within the route corridor, where bird nests are found to be present. The purpose of the survey is to protect the nesting bird whilst avoiding delays to the commencement of site clearance activities and construction. A minimum of 10m of hedgerow is generally cordoned off to provide a buffer to the nest sites, whilst accommodating the movement of plant machinery within the LMA. However, it is reported that such surveys are negated by the fact that birds have abandoned nests once construction activities commence, despite the presence of the buffer, due to the proximity of traffic to the nest sites. The approach there does not represent value for money and resources could be more efficiently utilised to provide compensatory habitat *e.g.* through the process of mitigation[4] banking which is widely practiced in the U.S.A for designated protected wetland areas.

[4] Mitigation banking is the restoration, creation, enhancement, or preservation of a wetland, stream, or habitat conservation area which offsets expected adverse impacts to similar nearby ecosystems.

Box 2

Recommendations:

- Insistence on the implementation of best practice survey methodologies as detailed in the NRA EACG is required
- Species-specific surveys should be carried out at the Route Selection stage especially for those species where mitigation and compensatory measures are not feasible

Further guidance is required on:

1. pre-fencing surveys undertaken prior to Advanced Fencing Contracts and pre-construction surveys
2. the maximum allowable time frame between the preparation of an EIS, the pre-fencing survey and the pre-construction surveys
3. the appropriate use of 'verification' and 'full' survey approaches
4. the management of additional protected species where they are uncovered during the advanced site clearance or the construction stage
5. appropriate means of managing/compensating for vegetation clearance

3. Habitat Mapping

The adoption of the recent Heritage Council publication on habitat mapping (Heritage Council, 2010) in the preparation of EISs for national road schemes should assist in addressing inconsistencies in the level of survey effort, information gathered and thus the quality and presentation of GIS habitat mapping figures at the EIS stage.

More specifically, it is important to ensure that the habitat mapping, as presented in the EIS, is consistent in relation to the extent and accuracy of information displayed. The drawings may show the types of vegetation present, highlight habitats of local, regional or national importance, protected areas, potential roosting sites for bats (for example, building and trees) but may not show the location of resting or breeding sites for all of the protected species (in certain circumstances it is understood that this information is not included as it is sensitive in nature) identified in the EIS or certain watercourses and drainage ditches maybe not have been identified and/or displayed. Thus, the biodiversity related information contained within the EIS might not be illustrated on a single drawing but on several drawings across different documents. Furthermore, in order to ensure ease of access to the information and cross-referencing for detailed designers and environmental managers, amongst others, the extent of information and level of detail displayed on these drawings needs to be consistent across all EIS documents prepared.

The requirement for consistent information in the EIS habitat mapping is especially important for those contractors involved in advanced contracts, where the employer's representative may not be on site full-time to supervise works and where an environmental management system is not in place. In addition, informative drawings which include all available information on protected species and habitats present on a scheme such as the "Environmental Constraints on Site Clearance drawings", are

not available until much later in the process, as these are prepared on behalf of the main contractor prior to the commencement of site clearance. Therefore, during the advanced contract stage, the various contractors *e.g.* archaeologists, geotechnical information (GI) teams, topographical surveyors and fencing teams, amongst others (see Section 11), may be solely dependent on the information contained within the EIS Habitat Mapping figures to avoid impacts (such as surveyor vehicles driving through watercourses of ecological importance and locally important habitats) on protected species and habitats.

It is also important for the employer's representative to ensure that the EIS is made readily available to these contractors and that consultations with statutory bodies are undertaken, similar to those at construction stage. Generally, little or no consultation with statutory bodies (*i.e.* with the NPWS and the regional fisheries boards) is undertaken by the contractors at this stage.

In order to make full use of the information contained within the EIS Habitat Mapping drawings, the drawings should also be made readily available in electronic format at the advanced contracts stage such that the relevant information can be extracted and used to avoid or minimise impacts. For example, the drawings should be overlain on areas of potential archaeological importance by the Archaeologists. When preparing the Map of the Ecological Network (MEN) (as per the NRA, 2006), the drawings should also be made readily available to the designer, in order to assist in identifying the core habitat areas and the hedgerow corridors within the zone of influence of the road scheme. Similarly, when preparing the MEN, such drawings should be made available to the detailed designer with respect to the preparation of Environmental Constraints on Site Clearance Drawings and the Landscape Mitigation Masterplan.

Box 3

Recommendations:

- The extent of information displayed in EIS Habitat Mapping needs to be consistent
- EIS Habitat Mapping should be readily accessible at all contractual stages
- Improved Environmental Management Systems are required at the advanced site clearance stage
- Enforcement of EIS and consultation related mitigation measures is required at advanced site clearance stage
- An electronic version of the EIS Habitat Mapping drawings should be made available to the contractors involved in advanced site clearance works and the detailed designer when preparing the Environmental Constraints drawings

Further guidance is required on:

1. Environmental Management Systems (EMS) at the advanced site clearance stage
2. the extent of information illustrated on EIS Habitat Mapping and accessibility to this information

4. Environmental Management Systems (EMS)

In relation to the EMS in place during the construction stage, the NRA has produced "Guidelines for the Creation, Implementation and Maintenance of an Environmental Operating Plan" (NRA EOP Guidelines, 2009). These Guidelines are designed to complement and assist the general main contractor's EMS and procedures by bringing the environmental management system into line with current best practice, standards and legislation.

Box 4

Recommendations:

- Audits of EOPs are required to ensure that they are prepared to meet the necessary standards
- Insistence on the implementation of the NRA EOP Guidelines in relation to the necessary qualifications and experience of the Environmental Manager

Further guidance is required on:

1. The nature (part-time or full-time) of the role of the Environmental Managers on small and larger national road schemes.
2. What constitutes a small and large road scheme.

5. Consultation with Landowners

Both the employer's representative and the environmental manager are responsible for consultations with landowners adjacent to the route corridor in respect of environmental matters. For example, during the site clearance stage, where mature ivy-covered trees are identified as containing, or having the potential for, bat roosts, it has been reported that such trees have been felled. This occurs when landowners enter the LMA in order to acquire the timber for firewood prior to site clearance and disposal of the woody material.

Furthermore, where Badger setts are earmarked for exclusion during the advanced contract stage (by the employer's representative) or the site clearance stage (by the main contractor), the fencing and flagging utilised to identify the setts may attract the attention of landowners with potential risks to setts. The NRA EOP Guidelines (NRA, 2008) are quite specific on the expected role of the environmental manager, the employer's representative needs to ensure that the environmental manager has all the necessary skills to fulfill that role in accordance with these Guidelines. For example, it is also important that environmental managers have knowledge of both ecological and industry-based impacts and mitigation measures such that impacts related to ecology, noise, water quality, vibration and dust can all be appropriately managed. Environmental managers may not have relevant experience of rural ecology, as experience may be primarily related to urban environments. This has repercussions for road schemes that traverse rural landscapes.

Additional guidance is required on the nature (part-time or full-time) of the role of the environmental managers on national road schemes. While the NRA EOP Guidelines (2008) state that "for smaller national road schemes it may not be necessary for the main contractor to engage the environmental manager as a full-time member of staff" a number of larger road schemes are known to have had part-time environmental managers in place. In such circumstances there is over dependency on the construction manager and site forepersons in relation to the avoidance, detection and mitigation of impacts on habitats and species. Guidance as to what constitutes a smaller road scheme is required. Appropriate audits of Environmental Operating Plans (EOPs) should also be undertaken by the employer's representative to ensure that proper reporting procedures and monitoring is being undertaken during the construction stage. The NRA is currently undertaking a review of the audits of EOPs undertaken by employer's representatives to date in order to identify any necessary revisions required to the current NRA EOP guideline document.

It is also clear that there is a lack of understanding of the roles of the Environmental Manager versus that of the Detailed Designer. In some cases the Ecological Designer is involved in site monitoring in relation to pollution prevention on road schemes.

In this regard, consultation between landowners, the employers' representatives and the environmental manager, where appropriate, is important to ensure that landowners are aware of the possible presence of a species protected under the Irish Wildlife Act (1976, as amended in 2000) and under the EU Habitats Directive (92/43/EEC) in order to minimise impacts on such species. It is important to note that the landowner once taken knowledge of this information can be prosecuted for causing deliberate damage to a known resting or breeding site. It should be noted that, to damage or destroy a breeding site or resting place of an Annex IV(A) species is a strict liability offence, i.e. it is an offence regardless of one's intention. In this regard, the requirement to consult with landowners should be re-examined as part of the NRA EOP review and the role of the employer's representative on such matters clarified.

Consultation with landowners is also necessary where protected species, found within the route corridor of a road scheme, are also present in adjacent lands which are not designated protected areas but which contained species listed under the Irish Wildlife Act or Annex I of the EU Habitats Directive. In such circumstances, it is important that the mitigation measures being put in place within the roadside landscape are discussed and agreed with landowners and that the NPWS are involved in this process *e.g.* where mitigation measures, such as underpasses are being put in place to provide for the safe passage of a protected species and/or to maintain optimum habitat conditions. Such work may become ineffective if damage occurs to the habitat of a species due to reclamation activities by the landowner, where the landowner has not been informed of the presence of the species.

Box 5

Recommendations:

- Increased protection of Badger setts and bat roosts is required during Advanced Site Clearance
- Increased protection of habitats and species located adjacent to the LMA fenceline is required

Further guidance is required on:

1. Appropriate and adequate consultation between landowners, the Environmental Manager and the Employer's Representative

6. Aquatic Mitigation Measures

The NRA published 'Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes' (NRA, 2007), detailing design and construction requirements for watercourses which interact with national road schemes. In addition to this guidance, there is also a requirement to consult and comply with the relevant statutory authority *e.g.* Inland Fisheries Ireland and the National Parks and Wildlife Service (NPWS) at the construction and implementation stage. Consultations with IFI generally relate to appropriate culvert sizing to accommodate fish passage, the buried depths of culverts and the appropriate depths of spawning gravels required in newly constructed culverts, realignments and diversions. However, despite the amalgamation of the regional fisheries boards to form the Inland Fisheries Ireland in 2010, these requirements vary across the country. For example, in the former Southern Regional Fisheries Board (SRFB), jurisdiction pipe culverts were specified as 900mm diameter and buried 400mm, while box culverts were to be open-bottomed and buried 300mm with gravel depths of 400mm and 300mm, respectively. In contrast, in the former Shannon Region (ShRFB) the pipe culverts were specified as 900mm diameter and buried 300mm and the box culverts buried 500mm, with gravel depths of 300mm.

Further, contrasting requirements include culvert sizes which are not based on the hydrological calculations but rather on the height:length ratio, in order facilitate light and thus macrophyte growth within the culvert. This can result in very small streams requiring extremely high culverts which are oversized based on the length to height ratio requirements *i.e.* culverts >25m, >50m and >75m in length require 2.4, 2.7 and 3.0m high culverts, respectively. Similarly, there can be conflicting requirements for the side slope requirements in relation to the construction of stream realignments and diversions including 1:1 slopes, 1:2 slopes or, indeed, a combination of both, in order to provide for meanders along the newly realigned channel. These requirements can also affect the design of headwalls of culverts. The slope of cutting/embankment should also be such that stability of cutting/embankment is assured e.g. this will vary in peaty and sandy areas. Where a road scheme passes through more than one former regional fisheries board jurisdiction, these requirements can lead to an unnecessary complex design process for the detailed designer's environmental and

hydrology team. The OPW are currently reviewing all agency specifications regarding culvert sizing and positioning. It is expected that the Central Fisheries Board will also provide standardised guidance.

Further emphasis is also required during the impact assessment and the detailed design stage in relation to the hydrological regime of adjacent wetlands. In addition to the avoidance of these habitats, mitigation measures in the form of "sealed" drains and weirs on culverts are required to maintain the existing or to achieve the former hydrological regime in consultation with a landowner and the NPWS. Such approaches also require post-construction monitoring.

In relation to terrestrial habitat recreation, there continues to be disparity with regards to best practice techniques for the establishment of vegetation on stream realignments and diversions, despite the existence of NRA Watercourse Crossing Guidelines (NRA, 2007) and the NRA Landscaping Guidelines (NRA, 2006) For example, landscape design proposals such as the hydroseeding of realigned channels and diversions with mixes containing up to 15% fertiliser can cause potential impacts on watercourses including localised eutrophication of the watercourse. Furthermore, the commercial seed mixes utilised often contain the seed of non-native species and/or foreign provenance seed of native semi-aquatic and marginal species. Best practice, where soil stability is not a problem, is to utilise natural recolonisation as the most appropriate technique for the reestablishment (NRA, 2006). Assistance can be provided through the use of translocated sods from the former stream beds, hessian fabric and willow twig cuttings to minimise the extent of exposures of bare soil to the prevailing weather conditions. Where silt fences, constructed from natural materials such as hessian are utilised to minimise siltation during 'instream' works, these can be left on the riverbank to assist in stabilisation.

In relation to instream habitat creation, current Irish best practice is to utilise clean rounded gravels in the reinstatement of riverbeds and in habitat recreation post- construction of culverts, realignments and diversions of river channels, as per the Southern Regional Fisheries Board (SRFB) Guidelines 'Maintenance and Protection of the Inland Fisheries Resource During Road Construction and Improvement Works' (SRFB, 2007) and the Shannon Regional Fisheries Board (ShRFB).

Along with the cost implications of sourcing this material, the use of clean gravels contrasts with the approach utilised in the U.S.A. where a mix of 70% gravels and 30% silts, or fines from local quarries, are utilised based on the theory that the gravels will fill with approximately 30% of fines over time (Reeves, R., Oregon Dept. of Fish & Wildlife, pers. comm.). Furthermore, it is more likely to be appropriate, to source gravels and fines from a local quarry because these are likely to match the local bedrock geology of the stream bed (see Plate 4).

The use of any quarried materials in the instream habitat should be examined in the context of the NRA 'Guidelines on the Management of Noxious Weeds and Non-Native Invasive Plant Species' (NRA, 2010) in order to avoid the introduction of non-native invasive species.

Plate 4: Provision of riffle and glide habitat for salmonids on a 1st Order River Nore tributary as part of habitat creation works (Photograph: Lisa M. J. Dolan courtesy of Atkins).

In addition, technology widely available in the U.S.A. and Canada for pollution and silt containment such as the use of "aquadams" for silt containment (see Plate 5) and "curtains" (see Plate 6) for both hydrocarbon and silt containment is now becoming more readily available in Ireland. Aquadams are suitable for smaller watercourses where appropriate method statements are provided. Such technology can facilitate works during the closed season for fisheries, depending on the nature of the works, the sensitivity of the watercourse and the acquisition of permission from the relevant statutory authority. Where such measures are utilised correctly, impacts can be avoided and works allowed to continue where permission is granted throughout the year (see Plate 3).

Plate 5: Aquadam in place for road reconstruction works (Photograph: Lisa M. J. Dolan courtesy of Atkins).

Plate 6: Pollution containment and silt fence within an attenuation pond in Minnesota state (Photograph: Lisa M. J. Dolan).

The use of silt fences is also increasing in recent years (see Plate 7). These are usually constructed from hessian fabric and timber uprights and are fenced across the width of watercourses for the containment of silts released during construction. Guidance on the use of herbicides close of watercourses is also required in relation to the management of noxious weeds on national road schemes.

Plate 7: Silt fence under construction parallel to a 1st Order River Nore tributary (Photograph: Lisa M. J. Dolan courtesy of Atkins).

Box 6

Recommendations

- Review of best practice in relation to management of aquatic systems in road construction is required
- Increased protection and focus on wetlands located adjacent to new road projects is required
- Use of silt fences and aqua dams should be further explored
- Avoidance of hydroseeding on watercourses

Further guidance is required on:

1. Appropriate design of culverts, including sizing and materials and side slopes of realignments and diversions
2. Best practice techniques for the establishment of vegetation on streams

7. Landscape Mitigation Measures

Multidisciplinary walkovers of the route corridor are generally only considered in respect of the ecological surveying of a road scheme. However, multidisciplinary communication is also important at the Construction and Implementation stage where landscape designers, ecologists, geotechnical engineers, construction managers and forepersons can meet to agree on the utilisation of the soil resources on a scheme and the preparation of the "Mass Haul Programme" in order to maximise the potential for habitat re-creation (see Plate 8). Such multidisciplinary meetings can facilitate the identification of low nutrient topsoil and subsoil for the creation of semi-natural grassland and other materials such as calcareous gravels that can form embankments and slopes in esker-dominated and other limestone regions of Ireland.

The 'Guidelines for the Management of Waste from National Road Construction Projects (NRA, 2009) provide examples of road components where subsoil can be utilised on national road schemes. In addition to the areas detailed, low nutrient topsoil, subsoil and gravels can be utilised in wider verge areas and on slopes and embankments to promote areas for natural recolonisation of semi-natural grasslands. Similarly, peat can be utilised on flat wider verges to establish Wet Grassland (GS4) and heath (HH) treatments, where appropriate [habitats categorised as per Fossitt (2000)]. Natural recolonisation as opposed to wildflower mixes should be utilised to establish these grasslands.

The dominance of nutrient-rich topsoil (from agricultural landscapes) on existing road schemes continues to be a limiting factor in terms of the biodiversity potential of roadside landscapes. As the majority of national road schemes to date have utilised topsoil in the final shaping of the verges, slopes and embankments, it is estimated that there are over 5,500ha of roadside (Dolan, 2004) grassland in the Irish landscape which for the most part consists of rank grassland swards. The fastest and effective method of denitrifying soil is soil stripping (Marrs, 1985; Smith *et al.,* 1991; Berendse *et al,.*1992). This approach works in circumstances where soil profile layers have remained undisturbed

and the nutrient rich topsoil layer is removed to expose subsoil. While this is not feasible for the 5,500ha of existing grasslands, the exposure of subsoil during future road construction should be the focus of current policy documents in order to maximise the potential and improve species diversity of future roadside landscapes. Nutrient-rich topsoil can be utilised extensively in woodland and hedgerow treatments, along the 2m wide immediate verge, in licensed permanent soil disposal areas and borrow pits and in more urban roadside environments within the wider verge, slopes and embankments. Where low nutrient topsoil is present on a scheme it should also be retained for the purposes of natural recolonisation leading to a semi-natural grassland. In relation to the existing 5,500 ha of existing grassland, studies to date (e.g. Marrs, 1993) have shown that continuous cropping and aftermath removal of cuttings, in an effort to reduce nutrient levels, could take up to 70 years.

In relation to the design and management of rock faces, there continues to be a engineering requirement for: (1) topsoiling, grass seeding and planting; or, (2) planting direct onto the rock face, as opposed to natural recolonisation as per the NRA Landscaping Guidelines 2006. Topsoiling and seeding are utilised on rock faces in an effort to manage the abundant topsoil on a scheme and to 'blend' the road into the surrounding agricultural landscape. It is also used to avoid the requirement to install crash barriers where rock faces are not finished to meet with health and safety requirements and where the required clear zone is not present. This approach may result in the loss of a 'locally distinctive feature' along a road scheme which may: (1) complement exposed rocky outcrops in the wider landscape; (2) provide orientation and a sense of place along a road scheme; and, (3) support species-rich grasslands, heathlands and a diverse array of ferns and bryophytes and other species (see Plate 9).

Because of the cost and technical difficulty of establishing soil and planted vegetation on rock faces, the NRA Landscaping Guidelines (2006) promotes the use of natural recolonisation on rock faces, as this approach will not only produce more natural patterns but will also allow the development of species rich plant communities and a more specialised biota.

Seeding with non-native or foreign provenance grass and wildflower seed mixes may simply turn the nature of the rock face profile and its scale from grey to bright green and prevent the establishment of native grassland species. Seeding contrasts with the irregular shapes of darker vegetation *e.g.* Heathers (*e.g. Calluna vulgaris*), Bracken (*Pteridium aquilimum*), Gorse (*Ulex europaeus*) and Willows (*Salix* spp.) which are often promoted by natural recolonisation. Natural recolonisation allows the rock face to become an extension of existing hedgerow, scrub or woodland vegetation and to complement any adjacent naturally exposed rock outcrops in the landscape. In this regard an interlocking pattern of shapes is far more likely to be effective and will assist in integrating the road line with the landscape. The approach will also serve to reduce road monotony and to increase driver alertness through the creation of landscape treatments which will break up views to wider verges dominated by grasslands and through the introduction of colour (Dolan et al., 2009).

2006

2007

2009

Plate 8: Habitat creation between 2006 and 2009 (Photographs: Lisa M. J. Dolan).

Plate 9: St. Patricks Cabbage on a rock face, Macroom, Co. Cork (Photograph: Rosalyn Thompson).

While the process of natural recolonisation may take a number of years to establish, the technique is the most sustainable option and the outcome is aesthetically similar to that of planting a rock face with trees and shrubs; due to the cost of and general absence of and accessibility for planting and maintenance. Over time, rock faces become covered with native species through the process of natural recolonisation (see Plate 10).

Plate 10: Natural recolonisation on a rock face where closed cover was achieved within 5 to 10 years (Photograph: Rosalyn Thompson).

Overall, greater consideration is required in relation to cost versus environmental benefit of establishing landscape treatments and mitigation measures. "Value for Money "assessments are required based on audits of landscape treatments and the result of post-construction monitoring.

The factors that influence the selection of landscape treatments for national road schemes are described in the NRA Guidelines (2006). This information should be utilised to form a baseline for the value for money assessments and in determining whether treatments reflect the desirable habitats and engineering functions as described in the guidelines.

Box 7

Recommendations:

- Multidisciplinary walkovers should be undertaken at the implementation and construction stage disciplines involved in landscape design and related elements
- Workshops on the use of natural recolonisation on rock faces, gravel and soil slopes should be provided for those disciplines involved in landscape design

Further guidance is required on:

1. The use of subsoil, gravels and peat in side slopes and wider verges in terms of waste management and earthworks standards
2. The use of natural recolonisation on such slopes

7.1 Use and Availability of Irish Provenance Plant Material

The new landscaping policy as adopted by the NRA Landscaping Guidelines (2006) provided an avenue to contractors to acquire certified Irish provenance plant material through the adoption of the Native Woodland Scheme of the Forest Service and associated certification scheme. This resolved the previous difficulties on the absence of a certified source and lack of availability of planting stock of Irish provenance in whip[5] sizes (*i.e.* 50mm – 1200mm). However, despite the guidance given to contractors to order certified native Irish provenance plant material from nurseries early in the construction stage (to ensure that such plant material is available for planting), many of the designers and contractors involved in road landscaping have not implemented this approach to date. The result is that road schemes continue to be planted with foreign provenance plant material (or with a combination of both native and foreign provenance material where there is a shortfall in the availability of Irish provenance material). The main reasons hindering incorporation of Irish provenance material are the cost (as it is slightly more expensive than foreign material) and the fact that the approach warrants major changes in practice for the Irish landscaping industry, which prior to 2006, mainly supplied foreign provenance plant material. While the use of Irish provenance plant material is more expensive, the overall costs are lower, as best practice would advocate lower stocking rates than is currently the case with the use of foreign provenance plant material where failures are generally higher (Declan Little, pers. comm.). In addition to the above reasons, there also continues to be a misconception that plant material grown in Ireland (from seed of foreign provenance) and plant material acquired from non-certified Irish sources can qualify as Irish provenance plant material, which is not the case.

[5] A whip is a slender, unbranched shoot or plant. This term is used in forestry to refer to unbranched young tree seedlings of approximately 0.5-1.2 m in height and 2–3 years old that have been grown for planting out.

Additional to these misconception and implementation issues, is the lack of availability of Irish provenance seed for certain species i.e. Guelder Rose (*Viburnum opulus*) and Spindle (*Euonymous europaeus*), where seed has not been gathered in Ireland in recent years. In relation to Holly (*Ilex aquifolium*), the recent shortfall in seed has been the result of the wet weather conditions experienced in recent years. There are also a number of species such as Gorse (*Ulex europaeus*), Dog Rose (*Rosa canina*), Honeysuckle (*Lonicera periclymenum*), Broom (*Cytisus scoparius*) and Ivy (*Hedera hibernica*) which are currently not certified under the Native Woodland Scheme. As demand for native species grows, it is envisaged that a certification scheme will be developed by the relevant stakeholders for the remaining species, such that hedgerows and other treatments can be established with a full complement of species.

In circumstances where certain species are, as yet, unavailable or there is a shortfall in stock, these species should be allowed to colonise woodland and hedgerow treatments naturally over time, as opposed to planting foreign provenance plant material on national road schemes (Dr. John Cross, Woodland Specialist, NPWS pers. comm.). A study of hedgerows in Central Bohemia (Czech Republic) found that three quarters of the 41 plant species present are limited to within 200 m of woods; however, the remaining species can extend along corridors as far as 250-475m. Wind was found to disperse 63% of the plant species, but vertebrate dispersal was found to be most important over short distances (<25m) (Haskova, 1992). In addition, the current landscape contract documents specify a number of native species for planting for which there is no certified Irish provenance plant stock available and for certain types of planting material i.e. feathered[6] and standard[7] trees for which there is none, or limited, certified Irish plant stock available. This has led to the planting of foreign provenance plant material.

Feathered and standard trees are often specified for use in landscape treatments; however, there is limited requirement for this type of plant material in a rural landscape. Feathered trees should only be considered in the urban environment or in more formal aesthetic planting schemes, while the use of standard trees should only be considered necessary in circumstances where mitigation measures are required for bats, the screening of road design elements such as overbridge structures and views to residences, where there are severe negative impacts. Until such time as the market can meet with the demands of the landscape design plans for national road schemes, currently, the only option available is to plant smaller trees in the form of whips.

The necessity to utilise standard trees, in general, across the rural roadside landscape should be reviewed. As, on examination of the growth rates of trees, it appears that the majority of native trees in larger whip sizes (900-1200mm) will grow to standard sized (10-12cm girth) trees within 2 or 3 years (Mr. Patrick Doody, Coillte, pers. comm.) or the Defects Rectification Period for a national road scheme, the necessity for planting standard trees on road schemes is debatable. Furthermore, the use of standard and feathered trees is less 'sustainable' than the use of whips in that there is a higher consumption of natural resources in the propagation, establishment and maintenance of a more

[6] A young - typically container-grown - tree with side branches down the main stem. These branches should be removed to the desired height/level upon planting.

[7] A tree of natural size supported by its own stem, and not dwarfed by grafting on the stock of a smaller species nor trained upon a wall or trellis.

mature plant. Therefore, the cost per plant is much more expensive. Also whips have a higher establishment and survival rate than standard trees.

In other circumstances, where there is a shortfall in the availability of Irish provenance plant material, there is currently no specific guidance given to landscape architects as to what should be done to address the shortfall. This has led to substitutions with inappropriate plant material.

Furthermore, where designers/contractors are implementing the NRA Landscaping Guidelines, there are ongoing difficulties with policy enforcement. Site supervision, inspections, and checks on the Provenance Declaration Forms which accompany the plant material to site are required in order to ensure that the correct plant material with the appropriate documentation is planted. The responsibility for enforcement of the policy needs to be clearly allocated through contractual requirements to either the Detailed Designer or the Employers Representative. In such circumstances where contractual obligations are not being met appropriate contractual remedies are available and should be sought.

The above issues and key areas are hindering the use of Irish provenance plant material on national road schemes, as foreign provenance plant material is currently being planted in these instances. The planting of this material negates the use of Irish provenance whips utilised elsewhere on a scheme and does not meet with current international and national best practice as detailed in Section 2.4 of the NRA Landscaping Guidelines (NRA, 2006).

Additional guidance is available from the Woodlands of Ireland and the Forest Service in relation to the establishment of woodland treatments through natural recolonisation and planting. These best practice guidelines documents should be utilised in conjunction with the NRA Landscaping Guidelines (NRA, 2006) e.g. Woodlands of Ireland (2008a,b; 2010).

These guidelines advocate the use of native trees at lower planting densities allowing natural recolonisation by other natives, especially shrubs, which result in more cost effective and ecological sound landscape treatments.

7.2 Use of Non-native Species

Despite a dramatic reduction in the use of non-native species since the adoption of a ‘native only’ landscaping policy by the NRA in 2006, there have been a number of instances where non-native species have been planted on national road schemes up to and including 2010. Further environmental education and communication are required to ensure that only native species are planted.

The current NRA Guidelines for Traffic Calming for Towns and Villages on National Routes Rev B. (NRA, 2005) also specifies predominantly non-native species for planting in traffic calming areas in towns and villages, a number of which are cultivars and could lead to cross contamination with native Irish species or considered invasive or which have potential for invasion. These guidelines need to be revised to incorporate a greater proportion of native Irish species and certified Irish provenance plant material and to remove any non-native invasive species from the recommended list of species for planting.

Box 7.1/7.2

Recommendations

- Insistence in addition to environmental education and communication on the implementation of a native only policy and the use of Irish provenance plant material is required
- Updating of NRA landscape contractual documents to meet with NRA Landscaping Guidelines (2006) and Native Woodland Scheme Manual 2008
- Establishment of a certification process for native species currently not covered in the Native Woodland Scheme
- A review should be undertaken of best practice for landscaping of urban areas and the transition zone between urban and rural areas
- Increase the number of native trees and shrubs recommended for planting in urban towns and villages and the gateways or transition from urban to rural
- 00-1200mm whips should be utilised instead of standard trees for screening purposes on national road schemes

Further guidance is required on:

1. Use of native planting in urban areas e.g. towns and villages
2. The use of native species and Irish provenance plant material where there is a shortfall in the Irish horticultural market
3. Site supervision, inspections of Provenance Declaration Forms is required for the use of native and Irish provenance plant material

7.3 Availability of Grass and Forb Species

In addition to the challenges already faced by the landscaping industry in relation to Irish provenance tree, shrub and climbing plant material, another challenge is the absence of a certification scheme for Irish indigenous grass and wildflower seed mixes, heath and wetland species. Until such time as a source becomes available, there will be pressure to use non-native grass and wildflower species mixes on road schemes, in urban parks, private gardens and wildlife gardens in schools. This is a missed opportunity in terms of biodiversity conservation (Dolan *et al.*, 2009).

The planting of wetland and heath treatments are often detailed in the EIS and contract documents for national road schemes. However, there is no certification scheme for wetland marsh (GM1) plants *e.g.* Yellow Flag (*Iris pseudacorus*) and heath (HH) plants and, often, this material is imported from abroad or grown in Ireland but of a foreign provenance. To overcome this, there are two options: (1) to allow natural recolonisation; or, (2) to translocate material wet grassland (GS4), marsh (GM1) or Heath (HH) sods from elsewhere on a road scheme. Where areas, on a road scheme which are to be subjected to natural recolonisation, are located close to donor sites, regeneration will be much faster (Dolan *et al.*, 2009).

Box 7.3

Recommendations

- Establishment of a certification system for native grassland forb and wetland species
- Use of natural recolonisation and translocation as an alternative to the use of foreign provenance grass species mixes and wetland plant species

8. Availability of Land for Wildlife

Roadside landscapes offer an opportunity to establish new ecological corridors in the wide agricultural landscape. Some 95% of national road schemes interact with Improved Agricultural Grassland (GA1). Therefore roadside landscapes provide an opportunity to link remnant habitats for wildlife and to complement Article 10 of the EU Habitats Directive (92/43/EEC).

As the majority of the permanent road boundary fencing may be mammal resistant fencing, the larger landscaped areas within severance cut-offs may not offer potential habitat for larger species such as Hedgehogs, Foxes, Badgers *etc*. thus reducing the potential biodiversity use of these areas. This is often the result of advanced fencing contracts.

In this regard, where severance cut-offs are identified for landscaping purposes, new fencing may need to be put in place (see Figure 2), where clear zones and maintenance strips permit, and the mammal resistant mesh wire removed from the permanent fence boundary in order to allow the planted habitat to be utilised by larger native mammal and other species (see Figure 2).

The policy of utilising mammal resistant fencing at the advance contract stage for road schemes, where a concrete centre median is proposed in the design, has led to situations where Badger populations have been isolated on either side of a scheme for the duration of the construction stage. This is leading to a short term (in terms of duration) but major negative impact on Badger populations as their habitat is fragmented for a number of years due to lack of accessibility to their territories on the opposite side of the road corridor until the mammal underpasses are constructed.

Furthermore, the specification of fencing for attenuation ponds needs to be undertaken with an awareness of permeability to species that may utilise such areas. Until relatively recently, attenuation ponds were not fenced. However, due to health and safety requirements, palisade or mesh fencing is now specified for use. As attenuation ponds can provide habitat for protected species such as amphibians, fencing specifications need to be examined with a view to permeability with a minimum of a 50mm gap between panels or 50mm diameter mesh width to provide passage. Similar guideline documents to those which have been prepared for Badgers and Otters (*Lutra lutra*) are also required for amphibian, and indeed, invertebrate species.

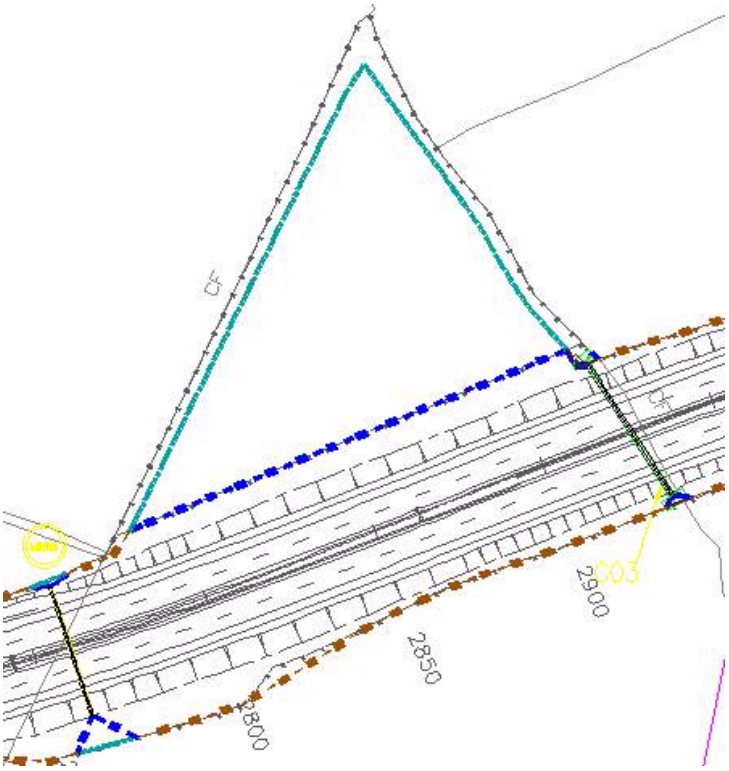

Figure 2: Example of a Severance Cut Off on a road scheme. The Dark blue line indicates where new mammal resistant fencing is to be constructed while pale blue line indicates where mesh is to be removed below the bottom rung of the mammal resistance fencing on the permanent boundary fence of the severance cut off (Screen Shot: Courtesy of Atkins).

9. Flood Control and Attenuation

While attenuation ponds are an important element of the drainage design on national road schemes, there has been a move away from the use of attenuation ponds, in order to reduce the extent of land take on new road schemes in the U.S.A. The use of bioswales[8] lined with compost and wood mulch have been utilised to remove pollutants and silts from road run-off. Due to the volume of rainfall in Ireland, such systems are not always suitable, but should be considered in more sensitive landscapes to reduce the land take. Alternatives which have been utilised in Ireland are linear attenuation ditches.

While spillage containment measures are required on all outfalls, they are especially important for watercourses of fisheries importance, as petrol/hydrocarbon interceptors are not designed to mitigate chemical spills or spills of substances such as milk. In this regard, spillage containment tanks are generally specified for road schemes. An alternative to such tanks is the use of on-line attenuation

[8] Bioswales are landscape elements designed to remove silt and pollution from surface runoff water. They consist of a swaled drainage course with gently sloped sides (less than six percent) and filled with vegetation, compost and/or rock armour.

through the mainline carriageway drainage, whereby shut-off valves are placed on sections of the carriageway drainage with 50cm3 capacity. In the event of a spillage this shut-off valve can be closed and the chemical pollutant removed from the carriageway drainage by means of a pump (Martin Jennings, Atkins, pers. comm.).

Attenuation ponds can be utilised for habitat compensation areas. Optimal design would provide for hydrocarbon or oil interceptors at the inflow into the pond to provide treated water for amphibians. However, there is a higher cost associated with providing these on the inflow (as opposed to the outflow) due to the higher flow rate. Natural helophyte filters in the form of native plant material can be extracted from old stream beds as a bio-engineered alternative *e.g.* Marsh (GM1) material can be utilised to provide a natural biofiltration of road run off, whilst providing cover for wildlife. Overwinter sites or hibernacula can also be constructed around the edge of ponds, close to known spawning grounds. These can be made of recycled stone and timber waste (product of building demolitions undertaken during the site clearance stage).

Box 9

Recommendations:

- Increase the extent of land accessibility to wildlife through a more considerate fencing design
- Use of linear flood attenuation measures should be considered
- Attenuation ponds should be designed with biodiversity conservation measures where feasible
- Explore the use of alternative spillage containment facilities

10. Ecological Monitoring

Currently, while it is recognised as best practice (and guidance is present in the NRA EACG), there appears to be no legal mechanism or contractual requirement to undertake post-construction ecological monitoring of mitigation and compensation measures for wildlife on national road schemes. Some recent EIS documents include the requirement for post-construction monitoring of mammal underpasses and fencing for Otters and Badgers. This has led to circumstances where mitigation measures such as mammal underpasses and ledges have not been installed as per the NRA EACG. One of the most common defects (or 'snags') is the failure to remove fencing at the entrance of the mammal underpass to allow wildlife to access.

1. All mitigation measure should be audited to ensure fit for purpose
2. Systems should be in place for recording road casualties of wildlife
3. Structures should assessed as to ensure fit for purpose
4. Guidance is required on how to close gaps in fencing and at tie-into structures where identified during audits

Furthermore, the success of alternative design practices such as the use of "parallel pipes" to provide an underpass for mammals in situations where a road is almost "at grade" and the wide variety of bridging systems for mammals which have been installed in circumstances where drainage ditches are located at the entrance to mammal underpasses, have yet to be examined.

Ecological monitoring is generally only undertaken as part of the conditions placed on Derogation Licenses granted by the NPWS for the capture and relocation of species *e.g.* Smooth Newt and the destruction of Badger setts and bat roosts. However, the level of survey effort and detailed report writing prepared for License Return reports has been variable to date. Therefore, it is hard to acquire consistent information as to the success of the relocation and the extent of ecological monitoring undertaken. In this regard, it is recommended that a set of guidelines be prepared by the NPWS in relation to the preparation of License Returns so that the information gathered may be utilised for monitoring purposes and subsequent reviews of mitigation and compensation on road schemes.

In respect of the extent of the monitoring of road kill of wildlife on road schemes, the use of concrete crash barriers on centre medians on national road schemes remains a contentious issue amongst the public and the wider ecological community in terms of the perceived impacts on protected species; especially the Irish Badger population.

Box 10

Recommendations:

- Incorporate post-construction monitoring into the contractual documents for national road schemes

Further guidance is required on:

1. Extent and level of survey effort for ecological monitoring required post - construction
2. The level of information which should be contained in a NPWS license return

11. Habitat Loss

While it is recognised that disturbance of habitats and habitat loss should be avoided, greater emphasis is required in guidance documents in relation to the fact that the ecological value of existing habitats is far greater than the creation of new habitats through landscape treatments. Often landscaping is seen as the mitigation measure for a habitat, despite the fact that if reasonable measures were undertaken during the construction stage, habitats of local importance could be retained. The protection of habitats should take account the strategic aims of the National Biodiversity Plan 20120-2015 in this regard.

The establishment of borrow pits and temporary and permanent soil storage areas outside the permanent fenceline boundary of a road scheme is often utilised for the disposal, temporary storage or for obtaining materials for road construction. Such facilities are subject to the granting of planning

permission by the relevant local authority, Waste Facility Permits from the EPA (where the quantities exceed certain limits) and, in some circumstance, an EIS may be prepared or volunteered in respect of a facility. While the extent of infilling of lands adjacent to road schemes (see Plate 11), as with other construction projects, in Ireland, has declined in recent years due to environmental management systems and enforcement measures, there is evidence to suggest that a certain amount of illegal infilling activities associated with such facilities have not discontinued completely.

Plate 11: Infilling of a Wet Grassland habitat (Photograph: Lisa M. J. Dolan).

For ease of transportation and costs, the majority of borrow pits and storage areas are often established immediately adjacent to a road scheme and, as such, any infilling activities should be readily identifiable by the environmental manager, site ecologist (where present) and the employer's representatives. However, while such facilities are located adjacent to the route corridor, associated land filling activities may not necessarily take place at that location. For example, agreements can be made with landowners to undertaken infilling activities some distance away from the route corridor in lieu of part-payment.

Infilling activities are generally more prevalent where facilities are located some distance from a road scheme and where Waste Facility Permits and planning permission are sought and granted. Agreements can be made with landowners in lieu or as part of the landowner agreement to infill land elsewhere so that it may be made suitable for agricultural use.

In this regard, it is important that all site-won material *i.e.* topsoil, subsoil and unsuitable material for road construction can be accounted for such that any illegal activities can be prevented by the employers representative and environmental manager.

Box 11

Recommendation:

- A specific monitoring system should be in place to ensure that site-won material is not utilised for illegal land filling. This should form part of the EOP or the Quality Plan

12. Design and Build Contracts

12.1 Advance Works Contracts

Advance Works Contracts on Design and Build Schemes include non-intrusive archaeological surveys, intrusive archaeology surveys, excavation works, in service diversions, topographical proof surveys, additional GI contracts, and where required, advance hedgerow clearance and fencing contracts.

While these contracts post-date the preparation of the EIS for a road scheme and are subject to the all environmental considerations under the EIS, including the requirement to consult and comply with statutory bodies such as the Fisheries Boards and the National Parks and Wildlife Service, it appears that environmental management systems are not in place during these works and impacts can occur on habitats and species.

For the most part, in order to facilitate these works, suitable temporary crossing should be in place for vehicle access. It has been found, however, that water courses are traversed by vehicles or, where installed, that the temporary crossings are undersized such that they do not have the carrying capacity to maintain the flow or are constructed from unsuitable materials *e.g.* plastic piping covered in soils. In this regard, advanced contracts can lead to environmental damage. In particular, advanced fencing contracts which are deployed to delineate the fenceline boundary of the route corridor have been found to place fencing across watercourses of ecological importance, while the root protection areas of trees and tree-lines, which were identified for retention in the EIS, have also been fenced through. Additional impacts can also occur where the type of fencing installed is mammal-resistant and results in fragmenting the habitat of species which cannot climb or jump over the fencing or pass through the wire mesh. Where there are delays in the tender and the appointment of the Main Contractor, this fence can be left in place for several months, or longer, thus having an impact on small mammal species such as Hedgehogs and larger mammals such as Badgers and Otters. It would be expected that Deer, Pine Marten, Stoats and Foxes could manage to pass over this fencing type.

As the location of Badger setts and Otter holts, in particular, will be known as a result of the EIS and pre-fencing surveys, it is possible to leave the fenceline open at the known crossing points for these

species. However, this would not accommodate other species that do not follow ancestral pathways and whose resting places and crossing points would not be known.

Once mammal underpasses are constructed, often the mesh is not removed, to facilitate access to the mammal underpass, and, therefore, the habitat continues to remain fragmented post-construction.

Plate 12: Mesh on fence covering entrance to mammal underpass (Photograph: Eugene Finnerty).

Box 12.1

Recommendations:

- Environmental management, monitoring and consultation should also be undertaken at the Advanced Contract stage

Further guidance is required on:

1. An Environmental Management System for Advanced Contracts

12.2 Role of the Designer and Design Checker

Under the current Design and Build contract format, Design Certificates and Design Check certificates are signed by members of the same team *i.e.* the Team Leader for the Environmental and Landscape Team, the Drainage Team or the Highways Team *etc*. at the Construction and Implementation stage. Therefore, both the designer and the checker are from within the same discipline. While in most instances this appears reasonable there are a number of design elements prepared by Environmental and Landscape Team that require design and design check activities and input by other design disciplines such as the Drainage Team. For example, in the design of mammal underpasses the

Drainage Team will provide input in relation to: the minimal depth of cover to a culvert: appropriate bedding details (*i.e.* the appropriate buried depth, gravels and concrete required to protect the culvert from crushing beneath the weight of the road bed overhead and vehicles): hydrology (in relation to the ground water table and flooding) and in circumstances where the requirement for the installation of a mammal underpasses may conflict with proposed pre-earthworks drainage and mainline carriageway drainage *etc*.

In this regard, the current design check certificates, and indeed the design certificates, should be changed to incorporate the signature of the Team Leader for Drainage.

Given the extent of resources being utilised to design site-specific mitigation measures, a suitable qualified ecologist should be present on site to translate the design standard details and to audit the adequacy of mitigation measure which are being put in place.

Along with post-construction monitoring, on-site ecological supervision will ensure that ecological mitigation measures are adapted to specific site conditions and are fit for purpose. Greater clarity is required in guidance documents as to on-going maintenance and as to what bodies are responsible for such maintenance. In this regard, a catalogue of the existing mitigation measures on national road schemes is required in order to assess the current status of mitigation measures on national road schemes in relation to ecological function.

Design in order to provide proper ownership and clarity in relation to the design process such that the named designer and checker have the appropriate level of engineering experience to ensure that the mammal underpass design will function correctly.

Box 12.2

Recommendations:

- Certification of environmental design should be multidisciplinary where disciplines outside of the environmental design team are involved in the design.

12.3 Consultations with Statutory Bodies

Consultations with statutory bodies are undertaken as part of the EIA/EAR stage of national road project planning in order to acquire information pertaining to mitigation and compensation measures for any species identified within the route corridor. However, there is also a requirement to consult and comply with statutory bodies as part of the Construction and Implementation stage. This process may result in additional mitigation and compensation measures being imposed which were not

previously identified in the EIS and as such can result in additional costs and delays being incurred on the Main Contractor.

The requirement to consult and comply with statutory bodies at the Construction and Implementation stage, should only remain in place, for an event where additional species or populations of species are not detected during the pre-construction surveys or construction stage. However, the latter may not be required where precedence has been set for mitigation and compensation measures in the EIS for another and similar sized population of the same species.

Additional implementation difficulties may arise during the Construction and Implementation stage in which mitigation and compensation measures, described in the EIS, are too detailed and where it is found that such mitigation measures cannot be implemented by the Main Contractor. This should be taken into account when preparing details of mitigation measures for the EIS.

In order to ensure that mitigation measures meet with their intended functions, there should also be stipulations in the EIS in relation to mitigation and compensation measures which are performance-based, such that additional works can be undertaken post-construction, where it is found that the mitigation measures are not functioning correctly during post-construction monitoring.

Box 12.3

Recommendations:

- Identification of all environmental mitigation and compensation requirements at the EIS stage
- Ensure that any proposed environmental mitigation and compensation requirements can be implemented

Further guidance is required on:

1. Consultations and the identification of additional populations or additional species identified at the Construction and Implementation stage
2. Performance based criteria which should be detailed in the EIS in relation to the monitoring of the effectiveness of mitigation and compensatory measures.

13. Biodiversity Database for Roadside Landscapes

The authors consider it necessary to establish a national biodiversity database for roadside landscapes in an effort to identify areas rich in flora diversity (hot spots) on Irish road schemes in Ireland (see Plate 12). The purpose of the database is to identify the type and extent of biodiversity present on road schemes so that appropriate management measures can be put in place to protect existing

biodiversity and encourage greater levels of biodiversity. The hotspots are defined by the presence of a species protected under the Flora Protection Order (1999), a red data book species (Curtis and McGough, 1988) or a declining habitat such as a semi-natural grassland. It is intended that such information will be utilised to prepare Management Plans for the various road networks which are species-specific in terms of identifying appropriate timing of maintenance regimes, based on flowering period of target species and habitats present within the roadside landscape. It is also intended that such information can be utilised to designate Roadside Nature Reserves (RSNRs) by local authorities in an effort to meet with Article 10 of the EU Habitats Directive 92/43/EEC. A pilot database has been circulated to a number of consultees which should be made available online on the National Biodiversity Data Centre (NBDC) webpage (www.biodiversityireland.ie) and through the EPA.

14. Conclusion

This document is intended to provide specific information to inform amendments to the existing NRA EACG guideline documents, contractual documents and management systems which focus on biodiversity conservation in national road project development.

It is hoped that the recommendations and the need for further guidance, as highlighted in this document, can be utilised to increase the existing standards of biodiversity protection currently in place on national road schemes and build on national capacity in the area of road project planning, design, construction/implementation and post construction monitoring going forward.

Box 13

Recommendations:

- The pilot database should be presented to the National Biodiversity Data Centre on completion in order to complement their data set
- The database should also be retained by the relevant local authorities so that they may adopt measures to protect these hot spots.

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