

ROYAL ORDNANCE SITE, BISHOPTON

BADGER MANAGEMENT PLAN

on behalf of

BAE SYSTEMS



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1 Introduction

- 1.1 The impact and management of badgers was identified at an early stage as a major logistical problem in the planning of the proposed redevelopment of the former Royal Ordnance factory at Bishopton. It was clear from the limited surveys and empirical evidence available that there was increasing colonisation by badgers of this former explosives manufacturing site. This followed the gradual shifting of centres of production activity and latterly shutting down of operations and cessation of landscape management (only one section of the site, the Environmental Test Facility (ETF), located towards the south-east boundary of the site, remains active).
- 1.2 Survey by JDC Ecology in 2003 (Survey and Bait Marking Report, JDC Ecology, 31st March 2003) of the Bishopton site to establish the extent of badger colonisation identified 5 tribes and their territories (see appendix). Recent survey by Starling Learning (2010) of the distribution of badgers on the site and in the surrounding fields show that the colonisation is, effectively, complete (see appendix). Several badger clans now occupy contiguous territories over the majority of the 923 ha of the planning application site and large tracts of the surrounding land at a density believed to be exceptional for the area. It was pointed out by JDC Ecology that the quality of the foraging habitat available for badgers has, in fact, declined over this period, from short-mown, managed grassland, to rank grassland and scrub. The expansion, therefore, can be largely attributed to the lack of disturbance, with main setts established in the site and a significant portion of the apparent foraging of badgers taking place in the farmed fields surrounding the site.
- 1.3 The proposed remediation will seek to make safe for public access all of the site, with the exception of the still-active Environmental Test Facility (ETF). The work will be destructive in areas, and include the demolition of buildings, the localised stripping of 'contaminated' soils as well as creation of 'borrow pits' for the removal of capping materials and land-raise sites for the safe containment of site-generated materials. The disturbance will also be extensive, and impact the majority of the site to a greater or lesser extent. Creation of new infrastructure, including access roads and redevelopment for housing and light-industry for community expansion will transform approximately $\frac{1}{4}$ of the site, principally in the north-east section (the area most recently colonised by badgers). Taken together over a proposed span of 15 years, these activities will create major logistical problems in accommodating and minimising disturbance of the existing badger population. The remainder of the site will be developed for nature conservation and informal recreation in the creation of a Community Woodland Park.
- 1.4 This potential conflict was identified by Scottish Natural Heritage (SNH) and the Renfrewshire Council (the Local Planning Authority), who made the creation of a suitable Badger Management Plan a condition of planning permission. Badger licensing for development is also one of the areas of licensing for which SNH is directly responsible and the one for which they would have greatest input. The following Badger Management Plan has been produced to discharge this planning condition. The Badger Management Plan represents an element in the management of all site wildlife, and will sit within an overarching Ecology Design and Management Plan (EDMP). The latter is informed by the Construction (Design and Management) Regulations 2007, in assigning responsibilities for the accommodation and welfare of wildlife in the construction, design and management of the development site throughout the entire development process. Embedded within this system will be the ECOplan, a GIS, web-based viewing platform for the storage and interrogation of species records, including current and historic badger data set against the site base plans and proposed development.
- 1.5 Both the EDMP and ECOplan are described separately. It is the intention that the following Badger Management Plan will be one of a number of dedicated and generic species management plans set within the EDMP.

2 Site Location

- 2.1 **Location:** The site is centred on OS grid reference NS 433 633 (Dargavel House) and lies to the south and west of the village of Bishopton, to the west of Glasgow, approximately 5 km to the north-west of Glasgow Airport.
- 2.2 **Area:** The Outline Planning Area is 923 ha, with the total BAE Systems' ownership of approximately 1000 ha. The site takes in a range of habitats, including coniferous and broad-leaved woodlands, scrub, rank grassland, streams, ponds and marshy areas, as well as derelict buildings, access roads and hard standings.
- 2.3 **Ownership:** The site is wholly owned by BAE Systems (see red line boundary). Its ownership also includes some of the surrounding farmland immediately beyond the security fence to the north, west and south. This land is currently tenanted, with the likelihood that the tenancy will remain in place through the lifetime of the redevelopment.
- 2.4 **Access:** Access to the site is currently restricted and maintained by security patrol. A security fence takes in the former factory site, with an additional security fence around the still active Environmental Test Facility (ETF). Currently, main vehicular access is from the east, from a road running adjacent to the Bishopton Railway Station. There are several other emergency access points, accessible from the roads running around the site.



Fig 1. Aerial Photograph showing of the BAE Systems site. The village of Bishopton can be seen to the north-east of the railway line.

3 Ecological Management Infrastructure

3.1 The proposed management infrastructure is illustrated below. There will be overall project management for the remediation and redevelopment of the site, but with an Ecological Project Manager appointed to oversee the conservation of site wildlife and the application of the Badger Management Plan. The roles and responsibilities of the key staff are described following.

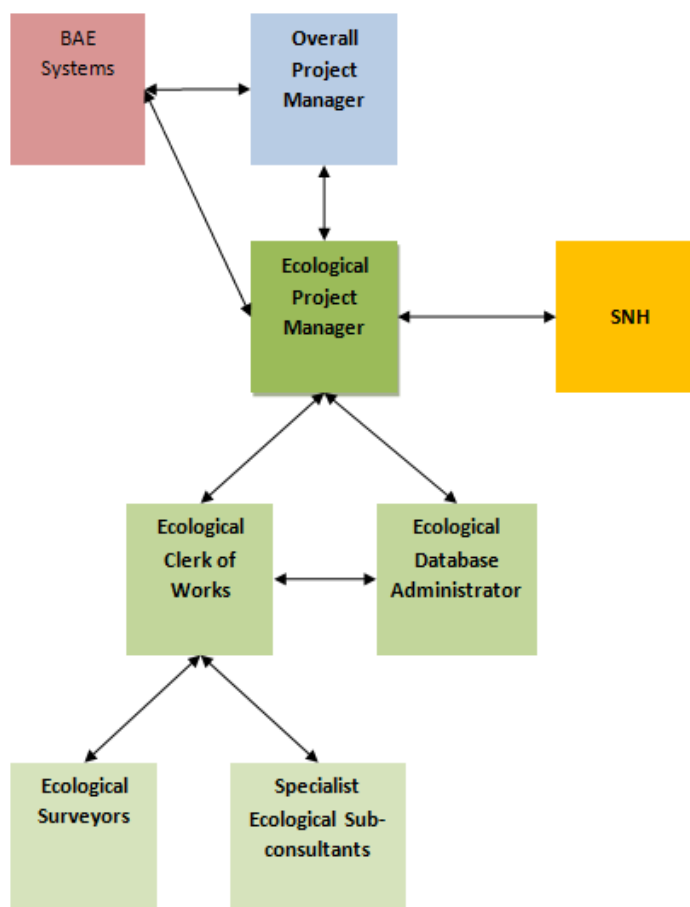


Figure 2. Proposed ecological management structure

3.2 Ecological Project Manager

3.2.1 The Ecological Project Manager will be a fully qualified and experienced ecologist with an overview of the project, in its various phases and integration with the other disciplines, who can be called on by the Ecological Database Administrator or the Ecological Clerk of Works for advice and guidance. This Ecological Project Manager should be a member of the Institute of Ecology and Environmental Management and bound by its code of conduct. It will be the Ecological Project Manager's responsibility to:

- Provide specific ecological overview to inform the phasing of the remediation and redevelopment of the site and develop ecological mitigation strategies, working closely with the specialist Ecological Surveyors, site engineers and the Masterplanner, in particular.
- Provide timely advice on the phased creation of habitats and advance application for protected species licencing.

3.3 Ecological Database (ECOplan) Administrator

3.3.1 The database administrator will be an experienced GIS specialist with a good understanding of environmental management and ecological priorities. The Ecological Database Administrator's responsibilities will be finalised once the scope of the ecological database is finalised, but are likely to include:

- Design and create the GIS web-accessed ecological database (ECOplan), working closely with the Ecological Project Manager.

- Update, develop and maintain the ecological database, working closely with the Ecological Project Manager. Liaise with the Ecological Clerk of Works regarding survey updates.
- Advise the Ecological Project Manger where there are apparent conflicts or where the information provided has implications for the conservation status of species on site.

3.4 **Ecological Clerk of Works**

3.4.1 A qualified ecologist with good experience of managing complex development sites, the Ecological Clerk of Works should be a professional ecologist and bound by the IEEM's code of conduct. The Ecological Clerk of Works will be critical in the day-to-day management of ecological issues on the remediation/ construction site and will be required to:

- Provide advice and guidance, particularly on the resolution of ecological issues as they arise, to protect the on-site features, habitats and species.
- Provide on-site guidance and induction on protected species issues to remediation/ construction subcontractors.
- Provide guidance to remediation/ construction subcontractors on the interpretation of the ecological database as required.
- Maintain the site-based log of wildlife incidents
- Recommend and initiate wildlife surveys where there are gaps in the survey records or in response to report of findings.

3.5 **Ecological Surveyors and Licensed Badger Ecologist**

3.5.1 There will be regular updating of the survey of badger activity and numbers on site, to inform the Badger Management Plan and to inform the licensed activities. The work will be carried out on the ground by an experienced, licensed badger ecologist with assistance from an ecological surveyor with experience in badger survey. The findings of the surveyor and recommendations from the licensed ecologist will be fed back into the Badger Management Plan via the Ecological Clerk of Works.

3.5.2 Where there is report of new setts or a badger incident on site, the Ecological Clerk of Works may be called on to investigate and take records or request further survey where necessary.

3.6 **Wildlife Management Group**

3.6.1 It is suggested that a Wildlife Management Group is formalised to review the progress of wildlife management on site, to take stock of changes in legislation and to examine the accommodation of wildlife within the proposed site works programme in a review of the programme and the guidance set out in this document. Such a body might comprise the Overall Project Manager, the Ecological Project Manager, the Ecological Clerk of Works, BAE Systems and a representative from SNH. The body might meet once per annum, or as requested, depending apparent need. Such a body would ensure that work programmes that impact on site wildlife are reviewed against both the detail and spirit of existing legislation from the point of view of the regulator, as well as bringing together a body of expertise across the professions represented in the project.

4 Badger Biology

- 4.1 Adult badgers grow up to a metre long and males can weigh up to 14 kg. They accumulate fat reserves in late summer and autumn and lose weight over the winter. Though they have powerful jaws and sharp teeth, their preferred food are earthworms (up to 200 in a single meal); they are omnivorous and also eat grains, acorns, insects and fruit. Badgers live in family or social groups of related mature and young adults and cubs, sometimes known as clans. It has been estimated¹ that on average there are 4 – 6 adult animals per social group, although in upland areas they often live singly or in pairs. In Scotland, in areas of good quality habitat (i.e., with plenty of improved and semi-improved pasture), the size of the territory is typically around 70 – 120 ha. However, in the more marginal and unproductive areas represented by the intensive arable monocultures in the east and north-east, the range sizes can be much greater than this². On the Bishopton site, larger territories, typically, within the centre of the site, are approximately 130 – 150 ha, reducing to around 100 ha or less where there is access to good foraging, represented by arable fields, around the site.
- 4.2 Badgers are highly territorial animals and the individuals within a clan co-operate to defend their territory. Latrines may be used to mark the boundary of this area, where a well-marked path may also be present; this is regularly 'patrolled', particularly by males. Badgers will defend a territory, which contains water and a variety of food sources, to support the clan throughout the year. Fighting in defence of territory can cause serious injury to badgers.
- 4.3 Although taxonomically classified as carnivores, badgers eat a wide variety of foods. While a large proportion of their diet consists of earthworms, they are opportunistic foragers and will also feed on fruit, berries, small mammals, birds, carrion, insects and other invertebrates at various times of the year, often when earthworms are difficult to find. In view of the importance of earthworms in their diet, badgers commonly rely on grassland that is kept short by grazing or mowing, and the loss of such feeding areas can have a major impact on the long-term viability of a social group.
- 4.4 Badgers typically live within their territories in a number of underground tunnel systems called setts, which provide safety and shelter from the weather and may vary in nature from tunnels beneath woodland to occupied pipework beneath buildings. Some setts are always occupied and are used also for breeding and raising young in the winter and spring. These main setts can be very extensive, with over forty entrances, whilst smaller ones may have as few as two entrances. Some main setts are ancient, having been in use for many centuries. Badgers are extremely loyal to these setts and will often continue to occupy them despite considerable disturbance. Other types of sett may be classified as annex, subsidiary, or outliers according to how they are used and how important they are to the social group. Their preferred sett location is under cover, usually woodland, on a slope, but setts can be built and occupied in a wide variety of locations, including railway embankments, gardens and under buildings.
- 4.5 Badgers have powerful claws and legs with which they can dig and move earth. Opening up new setts and maintaining and extending old setts is a constant occupation, with bursts of activity at certain times of the year. The pattern of setts and their use can, therefore, change steadily over the years, or very quickly in response to short-term problems such as drought or flood. Badgers need access to foraging areas, such as woodland and open grassland. Travelling routes are usually along established tracks, often under the shelter of hedgerows or trees. In general though, badgers are creatures of habit. They tend to use the same pathways to foraging areas and will continue to try to do so despite any obstacles that are placed in their way. New fences may be broken down and new roads crossed despite any difficulty or danger presented. Badgers do not hibernate but they often stay below ground for long periods in winter, especially during very cold or wet weather.

¹ Neal & Cheeseman (1996) : *Badgers*

² Scotland's Wildlife: Badgers and Development, SNH (2001)

4.6 Badgers mate throughout the year but pregnancy starts around the end of November or early December when the previously fertilised embryos implant into the sow's uterus. Often only the most dominant sow in a family group will produce cubs, usually two or three per litter. These are born underground, usually towards the end of January or beginning of February, emerging for the first time after about eight weeks. The cubs remain dependent upon the sow for a further few weeks while they are weaned and learn how to fend for themselves. For these reasons, disturbing badgers in setts and damaging setts should be avoided completely between the beginning of December and the end of June.

5 General Classification of Protected Structures

5.1 The following sett classifications follow Kruuk (1978) and Thornton (1988) and are provided as a general guide. Badger surveys have shown that the majority of setts can be found on sloping ground, typically under cover of woodland or hedgerow. This is less common with Highland badgers where there is usually less cover and fewer disturbances.

5.2 Main Sett

- Often a large sett, with 5 or more entrances
- The focal point for social group activity throughout the year, and can be many decades old.
- Often displays significant amounts of bedding in spoil heaps, extremely large spoil heaps and continuous excavations
- Spoil heaps and paths, usually very well trodden.
- 'Play' areas may be observed at this location in summer when cubs are about.

5.3 Annexe Sett

- Often a large sett, but usually smaller than a Main Sett
- Lies within 100 m of main sett and clearly connected to the Main Sett by paths.
- Usually displays significant use.

5.4 Subsidiary Sett

- Smaller than Main or Annexe Setts, often 2 – 5 entrances
- Lies within 200 m of the Main Sett

5.5 Outlier

- Small setts, often with only 1 or 2 entrances and only occasionally used.
- Often inhabited by rabbits or foxes during badger absence.
- Usually found towards territory edges

5.6 Nests

- Bedding piles found above ground, which badgers use mainly during the summer
- Can be located in tree hollows, under bushes, under rocky outcrops etc.

5.7 Setts vary in appearance and the distance between the main sett and others is dictated by the size of the social group's territory. Sett classification is often dependant on the skill and experience of the surveyor and can only be stated with confidence from knowledge of the social group and its activity.

6 Legislation and Policy

- 6.1 Badgers (*Meles meles*) are protected under the Wildlife and Countryside Act (1981) and the Protection of Badgers Act (1992), as amended by the Nature Conservation (Scotland) Act 2004. Where setts are, *unavoidably*, to be lost through, for instance, essential remediation works, they will need to be destroyed under licence. A licence is required to exclude any 'active' badger sett, and this can be obtained from SNH. Licences are not generally issued between the months December to June, as this represents the period of breeding for badgers, when they are most sensitive to disturbance. Further and continued survey work is necessary to fully establish the linkage of setts prior to any exclusion. The general procedures for sett exclusion are set out in the Appendix.
- 6.2 The purpose of the Protection of Badgers Act (1992) is to protect the animals from deliberate cruelty and from the incidental effects of lawful activities which could cause them harm. Under this legislation it is an offence to:
- *wilfully kill, injure, take, possess or cruelly ill-treat a badger, or attempt to do so*
 - *interfere with a sett by damaging or destroying it*
 - *obstruct access to, or any entrance of, a badger sett*
 - *disturb a badger when it is occupying a sett*
- 6.3 Note that if any of the above resulted from a person being **reckless**, even if they had no intention of committing the offence, their action would still be considered an offence. A person is not guilty of an offence if it can be shown that the act was **'the incidental result of a lawful operation and could not have been reasonably avoided'**; only a court can decide what is 'reasonable' in any set of circumstances.
- 6.4 Penalties for offences under this legislation can be up to six months in prison and a fine of up to £5,000 for each offence.
- 6.6 A badger sett is defined in the Act as **'any structure or place which displays signs indicating current use by a badger'**. This can include culverts, pipes and holes under sheds, piles of boulders, old mines and quarries etc. 'Current use' does not simply mean 'current occupation' and for licensing purposes it is defined as **'any sett within an occupied badger territory regardless of when it may have last been used'**. A sett therefore, in an occupied territory, is classified as in current use even if it is only used seasonally or occasionally by badgers, and is afforded the same protection in law.
- 6.7 It is generally considered that an artificial sett is likely to be required in mitigation for loss of main setts and possibly for annexe/subsidiary setts. As size and distribution of the site population are constantly changing, this assessment will be dependent on the results of further survey. The general procedure for sett exclusion will be followed as summarised in the Appendix. The loss of an outlying sett is very unlikely to require the construction of an artificial sett. Any setts that will not be directly affected by remediation and subsequent redevelopment should be retained. Where there is to be unavoidable disturbance to setts, SNH guidelines state that any activity within 30 m of a sett may require a licence.
- 6.8 The consideration of biodiversity and wildlife management is a 'material' planning consideration. The management of badgers throughout the proposed remediation and redevelopment of the site was identified by SNH as being a potential major consideration and the production of an effective Badger Management Plan was therefore made a condition of the planning permission for this work.

Table 1. Relevant Documentation

Document	Nature	Publisher
<i>Protection of Badgers Act (1992)</i>	Legislation	HMSO
<i>The Nature Conservation (Scotland) Act (2004)</i>	Legislation	HMSO
<i>Forest Practice Guidance No. 9: Forest Operations and Badger Setts</i>	Guidance	Forestry Commission
<i>Scotland's Wildlife: Badgers and Development (2001)</i>	Guidance	SNH
<i>Mitigating Against Effects on Badgers (1997)</i>	Guidance	Highways Agency

6.9 Badger Disturbance

6.9.1 Work that disturbs a sett occupied by badgers is illegal without a licence. Badgers could be disturbed by work near the sett even if there is no direct interference or damage to the sett. Disturbance is difficult to determine and only the Courts can decide what constitutes disturbance under the Act. In order to aid developers in planning work SNH has guidelines on the types of activity which it considers should be licensed within certain distances of sett entrances. For example the following may require a licence:

- using very heavy machinery (generally tracked vehicles) within 30 metres of any entrance to an active sett;
- using lighter machinery (generally wheeled vehicles), particularly for any digging operation, within 20 metres;
- light work, such as hand digging or scrub clearance within 10 metres.



Figure 3. Zones of disturbance for badgers

6.9.2 There are some activities which may cause disturbance at greater distances (such as using explosives or pile driving, which may, for instance, be restricted to beyond 100 m from an active sett) and these should be given individual consideration. In assessing whether or not a licence is necessary, SNH should be contacted for advice. SNH will take into account the likely affect on badgers, so that a clear and accurate picture of use, not just of individuals but of the clan generally, will help inform this decision.

6.10 Licenses

6.10.1 Provision is given in the legislation for licences to be granted to undertake actions that would otherwise be illegal under this legislation. Licences can only be issued for a limited number of stated purposes. Licences are issued either by Scottish Natural Heritage or by the Scottish Executive, depending on the purpose.

6.11 Licences for Development

6.11.1 SNH is the authority responsible for issuing licenses for the purpose of development as defined under Section 26(l) of the Town and Country Planning (Scotland) Act 1997. Licences issued for development can permit the license holder to interfere with a badger sett in a specified area and by specified means. Licences cannot be issued for the purpose of development to carry out any other actions including killing or taking badgers.

6.11.2 A licence must be obtained from SNH for any work that may cause disturbance to a badger or involves the damage or destruction of a sett. What constitutes disturbance depends on the nature of the activity proposed: as a rule a licence is normally required for any works within 30 metres of a badger sett, but this distance may increase for more disruptive activities such as blasting or pile-driving. Licences are generally, but not exclusively, issued to badger experts, whose role is to provide on-site advice and, where necessary, supervise all the licence work. To whom the licence is issued is dependent on the development, but also on what and who is involved in the necessary works. Should there be any uncertainty over the respective roles and responsibilities in this regard the developer should contact SNH for clarification.

6.11.3 Licences are not normally issued during the breeding season, which is between 30th November and 1st July, and cannot be issued retrospectively. Activities that necessarily involve disturbance should therefore be programmed to take place outwith this period. Licences are usually only issued after full planning permission has been granted.

6.12 Exclusions

6.12.1 The exclusion of badgers from their setts for development purposes must be licensed by SNH. Successful exclusion normally involves one-way badger gates and appropriate fencing and needs to be carefully planned and installed.

6.12.2 Licences to exclude badgers from main or annexe setts will normally only be issued if a suitable programme of mitigation has been developed. A mitigation programme in these cases should include the provision of an artificial badger sett and, if necessary, appropriate measures implemented to maintain the badgers' foraging resource. Licences to exclude badgers from larger setts will not be issued if they are likely to directly result in badger mortality.

7 The Badger Calendar

7.1 The following table summarises breeding cycle of badgers and the associated SNH licensing periods.

Month	Activity	Licensing Status
January	Females are pregnant	Closed
February	Cubs are born. Territorial behaviour begins and can result in sever fights on territorial boundaries. Latrines are kept topped up (presenting a good time for bait marking). Peak mating time.	Closed
March	Late cubs are born. Badger activity increases as they search for food. Territorial behaviour high and new setts are created. Peak mating time.	Closed
April	High activity on all fronts.	Closed
May	Cubs begin to emerge. Territorial behaviour begins to subside, but badgers are generally now active as the summer forage season begins.	Closed
June	Cubs above ground and learning to forage with their mothers.	Closed – although applications for licenses to run from 1 st July will be accepted
July	Summer foraging	Issued
August	As above	Issued
September	As above	Issued, although consideration will be given to the end of the licensing period on 30 th November
October	Another peak in territorial behaviour and optimal time for bait marking. Badgers feeding hard for the winter. Mating peak again.	Issued, with expiry dates of 30 th November
November	Feeding and preparing for winter. Some females will implant foetal cells and become pregnant.	Closed
December	Females implanting foetal cells and becoming pregnant.	Closed

8 Designing the Development

8.1 General Principles of Management

8.1.1 The following are the broad aims and general principles of the Badger Management Plan, to be referred to and guide future decisions regarding the badgers on the Bishopton site.

- Maintain the badgers in situ within their existing territories as far as possible and where setts must be destroyed or moved, create suitable alternative setts within the existing territories
- Maintain or create forage grounds to ensure support of the existing population
- Maintain or create access to forage grounds
- Maintain or create access to other social groups
- Maintain safe access for badgers beneath or around new roads or other hazardous obstacles
- Minimise disturbance to badgers or their setts throughout the life of the project.
- Encourage understanding and raise awareness among site personnel about badgers within the site and their responsibilities towards the continued wellbeing of these badgers.
- Encourage the understanding that best practice on-the-ground work and full consideration within the design process will allow integration of badgers and their activities within the site.
- Feeding by site workers or otherwise 'taming' of badgers is to be discouraged.
- Obtain commitment from contractors and sub-contractors that these principles will be adhered to in their contribution to the remediation and redevelopment of the site.

8.2 Potential Impacts

8.2.1 The following impacts could occur during development

1. Closure of a sett to allow destruction for development purposes
2. Temporary closure of a sett to allow development nearby
3. Indirect disturbance by the creation of protection areas (exclusion zones) around a sett to ensure that neither sett nor badgers are unduly disturbed by works nearby
4. Fragmentation and loss of habitat as a result of development
5. Loss of important forage grounds
6. Isolation of social groups
7. Creation of obstacles, such as road, that pose a potential threat to individual animals
8. Disturbance during the badger 'closed season'
9. Loss of habitat as a result of restricted access and subsequent colonisation by other clans

8.2.2 Points 4 to 8 would threaten the survival of the social group and the viability of the local population. The badger 'closed season' runs from 1st December to 30th June in any year, and is the period during which licence to disturb badgers is closed (see badger calendar), so timing and early preparation are critical in the achievement of the aims stated above.

8.3 Likely Effects of the Development.

- 8.3.1 The badgers on site have become used to a low level of disturbance. As a matter of course, there will be natural migration of badgers as the population grows and outstrips the sustaining habitat. Observation of early, limited works suggest that there may, however, be enhanced displacement of badgers as a result of increased traffic etc on the site, even where territories and setts are not directly impacted by physical disturbance. There may, as a consequence, be knock on effects on neighbouring badger territories and potential for conflict with traffic on roads around the site.
- 8.3.2 The development will change the nature of the site, and will bring increased hazard for badgers, via traffic movement along new and existing roads. In the longer term, existing territories will be reduced through development and there will a resident population with full access to the site, for informal recreation, walking dogs etc. The lack of security and removal of the security fence will also open the site to unlawful badger bating.
- 8.3.3 It is likely that badgers will colonise the village extension, either as a forage land – taking earthworms from gardens and public open spaces – or creating setts where the opportunity arises, in shelter areas. The management plan will have to address the interface between residents and badger activity as this area is developed and populated.

8.4 **Potential Mitigation Options**

8.4.1 **Avoidance**

- 8.4.1.1 Badger setts and their territories are avoided through design, eliminating the need for extensive mitigation. Where development must occur within a territory, the setts themselves are avoided and access to forage areas ensured.
- 8.4.1.2 Avoidance occurs during the 'closed season' as a matter of course. All works likely to disturb badgers are kept at a minimum of 30 m from any sett or following the guidance as set out above. Where there is doubt, SNH will be consulted for guidance.

8.4.2 **Sett Protection**

- 8.4.2.1 Where setts cannot be avoided and will be disturbed by proximity of a development during the construction phase, an exclusion zone of 30 m is erected around each sett using stock-proof fencing.
- 8.4.2.2 Unless permitted by licence and under supervision of the Ecological Clerk of Works, no site personnel are to enter this exclusion zone.
- 8.4.2.3 No machinery, equipment or other materials are placed within the exclusion zone.
- 8.4.2.4 Where works are needed within the zone, e.g., tree felling or minor operations, this is licensed and supervised. Tree works are undertaken in accordance with the Forestry Authority's *Forestry Guide 9, Forest Operations and Badger Setts*.
- 8.4.2.5 If night works are to be conducted in or adjacent to the exclusion zone, use of lighting and working methods are to be approved by the Ecological Clerk of Works before commencement of these works.

8.4.3 **Artificial Setts**

- 8.4.3.1 Artificial sett construction is used where the level and proximity of the works is thought to be sufficient of a disturbance that the badgers are likely to abandon a sett temporarily, or where a sett must be closed or partially closed down for the purposes of site remediation.
- 8.4.3.2 The artificial sett is created nearby within the existing territory, preferably adjacent to a travelling route, but at a safe distance from the development. It is created to a high specification (see Appendix), designed by persons who are aware of the natural profile of a sett, and use is encouraged by feeding in and around the sett. The site contours have been surveyed to an

accuracy of 0.5 m. This level of detail, in conjunction with vegetation mapping, can be used to help identify suitable alternative locations as well as design setts into the new landscape in such a way that aspect, topography, travelling routes, foraging area, drainage and likely disturbance are all taken into account.

8.4.3.3 A period of time is left from construction of the sett to commencement of works to allow the sett to weather in and to lose human scents, and for badgers to find and begin to use the sett. This is particularly important if the artificial sett is to replace a sett scheduled for closure. Artificial setts have been known to be used within one or two nights of completion, but it is generally recommended that a minimum period of 6 months is allowed before closure of existing setts.

8.4.3.4 Care needs to be taken to locate the artificial sett within the social group's territory. To move it into another group's territory would be to risk injury or death of the animals.

8.4.4 **Sett Closure**

8.4.4.1 Sett closure can be undertaken as a full closure or destruction, or partial closure. Sett closure is used where the sett lies in the direct line of the development and cannot be avoided. In all instances, the design layout will be examined in advance by the design team, with specific advice from the Ecological Project Manager, to minimise potential impacts.

8.4.4.2 Badgers are excluded from the sett (following construction of the artificial sett) over a period of 2 – 6 weeks. Electric fencing may be used as an option. One-way gates, sand trays and movement sensors may be employed to ensure that animals have left the sett or to confirm that the sett is not active. Exclusion can be difficult, particularly where a main sett is concerned, and it is likely that badgers will attempt to re-enter the structure. The sett is then destroyed, carefully and systematically under licence, under the supervision of a suitably qualified individual. All material that constituted the sett is either removed from the site or buried deeply. Badgers can easily smell the ground in which the sett lay and would simply re-excavate the ground where this not done.

8.4.4.3 Destruction should occur immediately before the development is due to utilise the ground and should be completed in one day so as not to leave the ground undefended from re-incursion by the animals. Destruction of setts has to be a last resort.

8.4.4.4 Setts can be partially closed. This usually occurs when some minor works are needed, such as road repairs or installation of a footpath. Again, badgers are excluded and the part of the sett that must be destroyed is taken apart and the remaining sett is opened again. Partial closure to facilitate such features are not common as it may result in a sett lying immediately adjacent to a built structure, road or pedestrianised area, possibly bringing the animals into conflict, with dog-walkers, vehicular traffic etc. Such work can be carried out with badgers in the sett, but this is difficult in practice.

8.4.5 **Roads: Underpasses and Fencing**

8.4.5.1 Where new roads or railways are to be laid, or existing routes are under repair, and where these bisect a badger territory, crossing badger paths, it is now common practice to consider installing badger underpasses and badger fencing, or to make existing culverts accessible to the animals. Underpasses are necessary where a sett or setts, or two social groups are in effect separated from each other or forage grounds by the introduction of the road.

8.4.5.2 Underpasses provide safe crossing points beneath the route and have proven to be successful in their use by badgers (see Appendix). A minimum of funnel fencing would be used at each underpass to ensure that animals are steered to the underpass. It is important to ensure that the underpass is placed directly in line with the existing badger path and that covering vegetation is maintained around the line of the path up to that point.

8.4.5.3 Where a road line is of considerable length and in effect bisects a territory, badger fencing to the Scottish Executive specification is erected to discourage the animals from crossing the road at

any point except the underpass. The fencing will not guarantee that the animals will not gain access to the road. Fencing is not regarded as an automatic solution in every case as it can create more of a hazard on short stretches or where obstacles such as complex junctions occur. The difficulty in sealing the road from the badgers can allow the badgers to become trapped inside the corridor by the fencing. One-way gates can be introduced as a measure against this kind of incident to allow badgers to leave the road corridor.

8.4.5 **Translocation**

8.4.5.1 Translocation is the action of taking a badger social group and moving them entirely to another area, not simply relocating them within their original territory. Translocation as such has consequences on the welfare of badgers, spread of disease, issues of land ownership, and high costs. It is actively resisted in Scotland by licensing authorities and the SSPCA. However, the physical extents of the site, the detailed knowledge of the existing clans and their territories and the scale of reworking of the site raise possibilities in accommodating badgers beyond their existing territories in an extension or redefinition of these territories.

8.4.5.2 Translocation is normally only considered under extreme circumstances and would require significant interaction and discussion with SNH and other relevant parties.

8.4.5.3 The Badger Management Plan seeks to facilitate the development of the site through use of all other options before considering this option.

8.4.6 **Habitat Assessment, Supplementing Habitats and Redefining Territories**

8.4.6.1 Recent surveys indicate that the site is near to carrying capacity for badgers. With increasing loss of grassland to scrub, there will, however, be a decrease in the habitat necessary to support resident badger numbers. There will also be a loss of feeding habitat in both the short and longer term, with incidental clearance of vegetation as well as removal of hard surfacing that has vegetated over in the remediation process. To help prevent famine and/or migration of the resident badgers, the proposed strategy is to attempt to balance the species numbers against the availability of food throughout the development process. This would involve initially:

- Identifying the main foraging areas and foraging habitat
- Calculation of the existing Badger Carrying Capacity of the clan territories by assigning numerical values to the habitats making up these territories in proportion to their ability to support badgers (e.g., coniferous woodland would be assigned a low score, e.g., 0.1 and managed grassland a high score, e.g., 0.7, on a scale of 0.1 – 1.0) and multiplication with the known extents of these habitats. This work might be supported by the examination of, for instance, earthworm numbers in trial excavations within the habitat or from an estimate of the likely density of earthworms in the habitat (see Appendix). An alternative approach might be to attempt an estimate of the total earthworm biomass (earthworms are the main food source) in any given territory, based on research assessments, supported by field observation, as is used in Badger Foraging Audits (see Appendix).
- Adjusting these values by comparison of habitats between territories and from knowledge of the numbers of animals sustained within the known territorial ranges. Where equal numbers of animals are supported, the total figures for the clan territories should be approximately equal. The mechanism would, it is hoped, also help flag up where there is greatest imbalance and famine and migration, therefore, most likely to occur.
- Provide timely enhancement of habitat sufficient to support badgers in their territories where development has restricted their forage areas and to ensure that there is unrestricted access to these forage areas.
- Where there is temporary disturbance, restricting access to these forage areas, there may be supplementary feeding of animals to minimise the risks of starvation.

8.4.5.2 The GIS system used (MapInfo) to map these areas has a facility to be able to calculate the Badger Carrying Capacity of the existing territories in the way described, once figures are assigned against the habitat type. The GIS system could also be used to calculate the areas and identify the suitable locations for the creation of new habitat. This would also allow the 're-centring' of badger foraging within their exiting range.

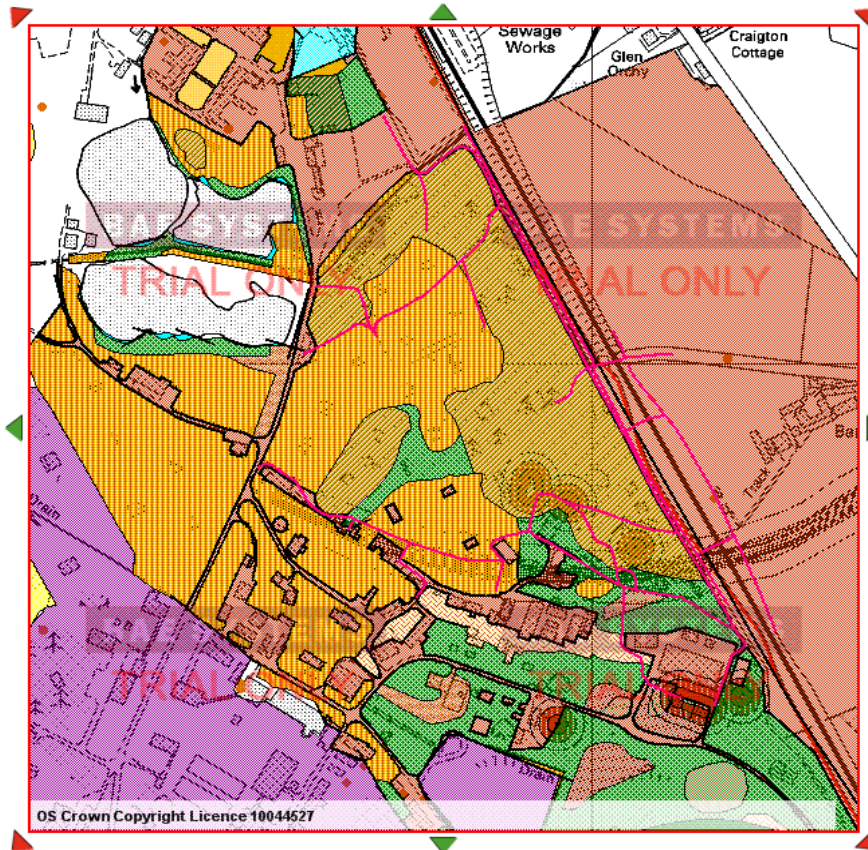


Figure 4. Extract from ECOplan, showing habitats. The area illustrated shows the southern access road and badger setts beneath the habitat shading.

8.4.5.3 There would also be an opportunity following this approach to redefine sett boundaries to coincide with physical barriers (badgers tend to do this naturally) e.g. where territories are close to the proposed road lines it may be possible to:

- a/ adjust the limits of the territory to sustain the badgers within the road line and encouraging existing clans to move into the remnant territories or to
- b/ realign the roads to suit the badger territories.

8.4.5.4 It may be possible to move latrines and other scent markers to help re-establish territories, but the efficacy of this and other techniques would be discussed and agreed with SNH in advance of any such work commencing.

8.4.6.1 Habitat enrichment/creation may include the provision of earthworm-rich soils/growing media to existing habitat (where this will not detrimentally affect the existing biodiversity) and the introduction of an appropriate seed or shrub mix. Creation of such soils could be established as part of on-site composting programme, including the use of a wormery, and recycling and blending of suitable organic materials with recycled subsoils or impoverished topsoils. The placing of suitable soils may be as part of the process of badger management:

- Where there is habitat enrichment, which might include supply and planting of additional plant materials, including bramble, elder, crab apple and cherry, and where this does not detrimentally affect biodiversity and where this would not attract flocking birds.

- Where hard standing has been removed, to provide a suitable depth of earthworm-rich topsoil as a basic growing medium.

8.4.6.2 Where there is direct conflict between remediation and reclamation, however, (this occurs in a small number of locations), there may be early preparation of green corridors (eg planting of fast-growing hedgerows with bramble, elder etc leading to alternative sett locations and localised habitat enhancement) to allow sheltered passage of badgers.

8.5 **Estate Management**

8.5.1 Other on-going estate management work might include the localised removal of scrub and other tall vegetation (but only when it would not be disruptive to nesting birds) and where it might provide cover in the creation of new setts, which might exacerbate the current situation vis-à-vis the large number and spread of setts throughout the site.

8.5.2 Generally, estate management should seek to create a balance in the vegetation types to satisfy all of the wildlife concerns,

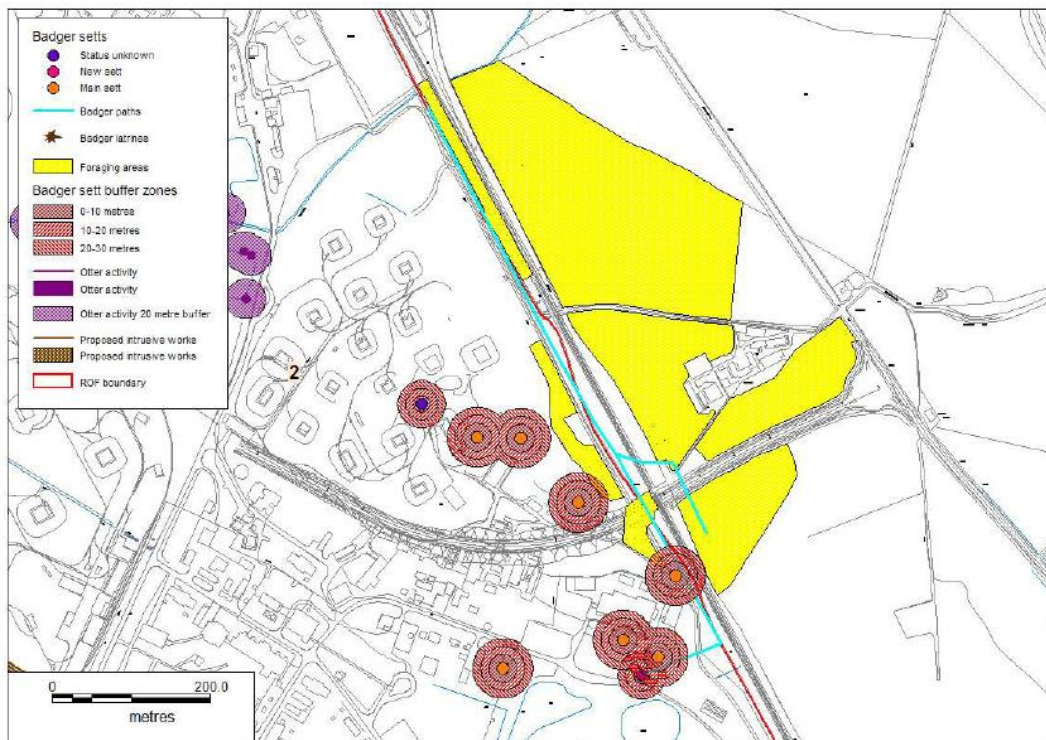
9 Development Programme and Mitigation Strategy

- 9.1 The site remediation works programme has being formulated in some detail for 2011, but with increasing uncertainty in the following years up to a predicted completion date of 2026. This programme will undoubtedly change throughout the life of the project for a variety of reasons, including:
- Site findings: responding to unknown hazards, variation in the nature of the materials etc found on site.
 - Best practice and available technology: over a 15 year period this is going to evolve, particularly with the exponential change in available technology.
 - Legislation: as certain species become rarer or their status changes and with the advent of new case law, there will be changes in the legislation. This happened recently with a review of European Legislation and implementation of the Conservation of Habitats and Species Regulations (2010), and in England with the extension of protection under the Wildlife and Countryside act to water voles as well as their habitat (April 2008). The change in legislation is likely to apply to working practices and all other aspects of site work.
 - Species dynamics: including expansion within the site through colonisation and recruitment of new species and the responses of species to global warming, which is likely to benefit species such as the barn owl, an animal currently at the limit of its northern range.
 - Development goals: changing markets, acceptable designs etc will also evolve in the predicted 15 period.
- 9.2 The proposed method of accommodating wildlife protection has, therefore, been to provide a flexible system with a range of responses and best practices that can be applied depending upon the circumstances, but within the context of a thorough understanding of the status of the particular species on the site. With regard to badgers, this has included monitoring of setts and badger territories, as illustrated in the Appendix. Best practice methodologies for the creation of setts and fencing are also included in the Appendix. It is proposed that badger mitigation works and licensing will be agreed a year in advance of the necessary works and reviewed against the continuing developing picture of badger activity on the site.
- 9.3 Examination of the process surrounding the creation of the Southern Access, due to begin in 2011, illustrates the stages that will be followed. Having identified the creation of the Southern Access as work that would impact on badgers, Starling Learning were commissioned to survey on the 21st of June 2010 to provide information of site usage by a clan of Badgers whose territory will be bisected by the building of a proposed southern access road into the site. The results of the survey are given in Figure 5.
- 9.4 The route of the proposed access road was walked and surveyed for evidence of Badgers; areas where Badger paths would be bisected were noted as were the condition of setts along the route. Additional information about Badger usage of the site was gained from a bait marking survey carried out at the site by Starling Learning in April 2010, which included establishment of forage areas. All target note locations were obtained using a GPS system.
- 9.5 This information was installed on the GIS database together with earlier survey by Starling Learning to establish forage areas. The resultant plan is illustrated in Figure 6. The mapping of results and the translation of findings raised a series of queries regarding the precise location of the setts and their status. As a result, a further round of survey was initiated to accurately pinpoint entrances and clarify status, where there had previously been in doubt. The use of night cameras, sand for marking etc, are all tools that have been and will be used to establish sett status and badger activity.

9.6 Following this iteration, the final map, showing the accurate location of badger entrances, together with disturbance zones is shown as an extract from ECOplan in figure 6.



Figure 5. Mapping of badger setts and badger paths in relation to the proposed Southern Access



Solum
ENVIRONMENTAL

Badger and Otter Survey Plan - illustrating potential impact on badgers (sett activity to be confirmed)

Figure 6. Gis mapping of badger setts and forage areas

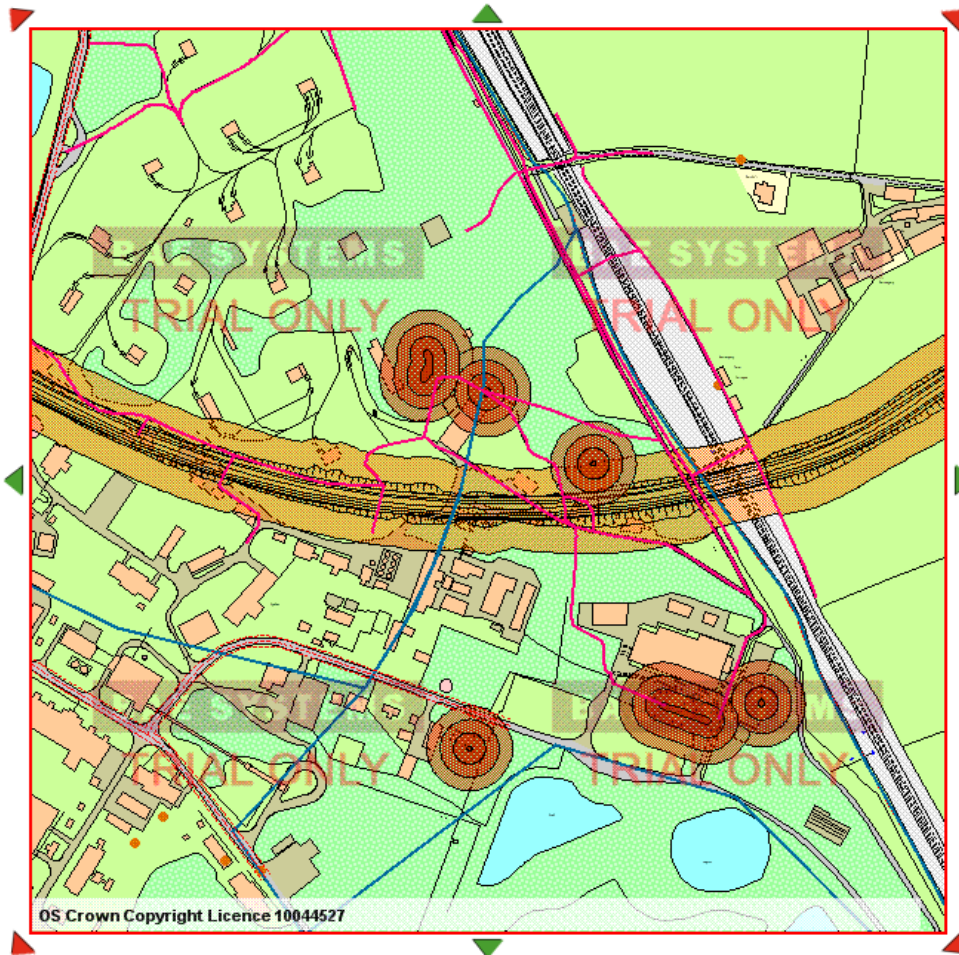


Figure 7. Badger setts and badger paths illustrated against base plans and proposed Southern Access road. Extract from ECOplan.

- 9.7 Figure 6 illustrates the evolution of the survey data, with clarification of locations and the status of setts within this area. The plan clearly illustrates the potential impacts with the main sett to the north of the Southern Access road being separated from the outliers to the south. Figure 5 shows that the majority of the foraging areas are to the east of the railway line and highlights the importance of maintaining links across the line (in addition to walking over the line, badgers are currently using an underpass and footbridge to cross the line). The survey notes also made it clear that the badgers will use man-made structures, following rail lines and using stairs to change levels where there is an option.
- 9.8 Figure 4 illustrates the attempt at analysing the habitats and potential forage in this area. There are areas of coniferous plantation as well as hard standing that can be converted to earth-worm rich grasslands that would mitigate for loss by the incursion of the access road. Also, there would have to be new structures included in the design to allow for passage of badgers north-south beneath the new road and to maintain links east-west across the railway line. All of these proposals will be subject to detailed discussion and agreement under license with SNH.
- 9.9 The location of the access road was driven by over-riding engineering constraints in crossing an active railway line. A number of the setts illustrated will have to be disturbed/shut down (either temporarily or permanently) because of concerns regarding decontamination and the level of disturbance from engineering works. Many of the setts on site are either established in loose-tipped material of various origins or are established under the foundations and hard standings of buildings to be demolished. In this case, alternative setts will be provided where there is judged to be a need for alternative structures (particularly for main or annex setts) at suitable locations within the badgers' territories. Design of the new landscapes will ensure that there will be minimal disturbance from traffic, both vehicular and pedestrian and provide detail to

accommodate badgers through the creation of screening, vegetation cover and additional areas of forage within the decontaminated landscape. Wherever possible, additions to the forage areas provided by the addition of new soils and planting will represent early application of the new landscape plans and will therefore represent permanent features.

9.10 Wherever possible, new setts will be created at least six months ahead of disturbance of badgers and existing setts reopened on completion of the works where this would not lead to future conflict with site usage.

9.11 There are other remediation and engineering works, including the Northern Access road construction, that will commence in 2011 that will impact on badgers (Figure 8). Similar problems arise as with the Southern Access, but with greater flexibility in the mitigation options in that the work will cross badger paths (the precise location of which are being surveyed and which will be accommodated through the provision of underpasses) but will, initially, have little impact on setts through disturbance or division of the territory.

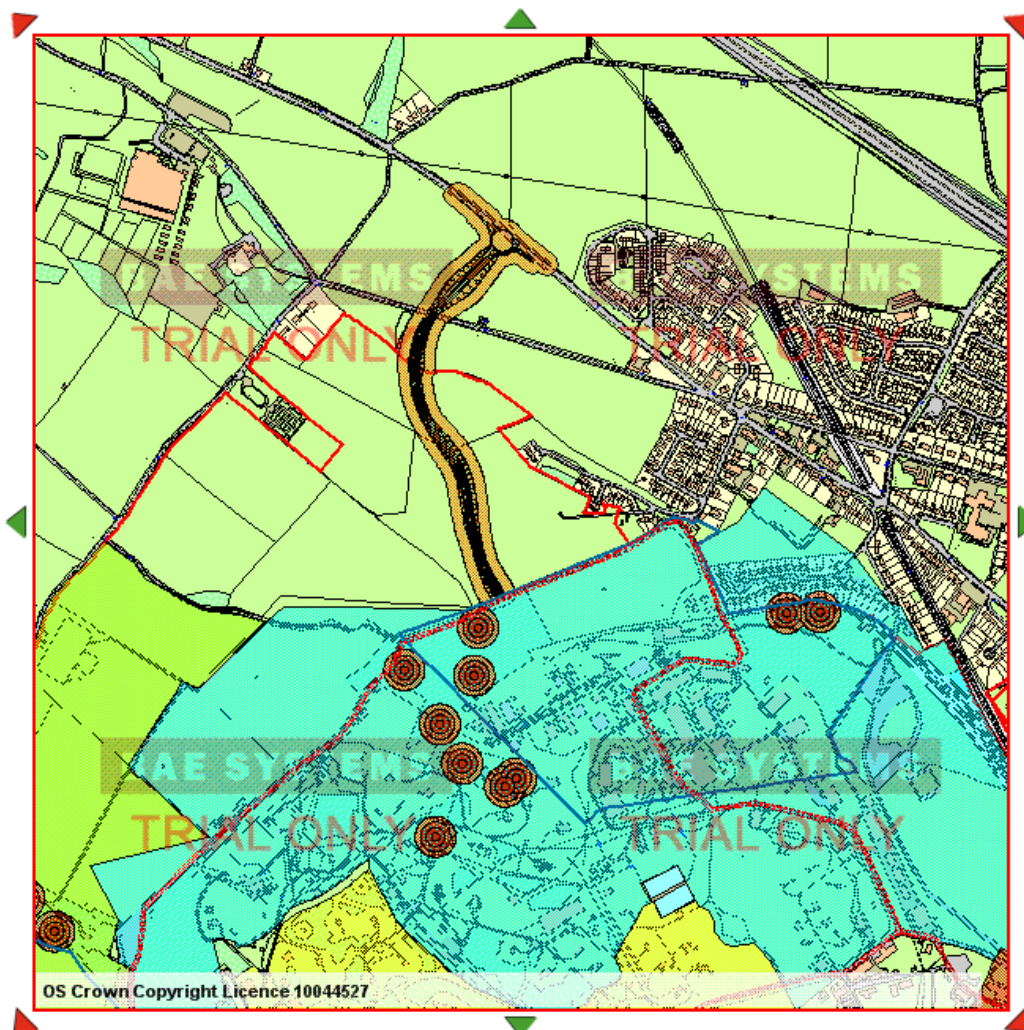


Figure 8. Badger setts and territory illustrated against base plans and proposed Northern Access road. Extract from ECOplan.

9.12 Remediation works will also commence in this corner of the site (line edged blue in Figure 8). The strategy proposed to be adopted will be to maintain the setts in the mature woodland that is to be retained and to maintain links to habitat and setts to the north-east corner of the site, while developing territory and ensuring sufficient forage area in the fields to the north of the site to compensate for loss within the factory fence. All of this work, including the appropriate approach

to the short and long-term accommodation of badgers within the site, will be subject to agreement under licence with SNH.

10 Badger Monitoring, Recording and Predictive Modelling

- 10.1 There will be regular and timely update through survey of the badger activity on site, including confirmation of activity, change of status of setts, new sett creation and alignment of badger territories. The information gathered will be used to build up a picture of the dynamics of the badger clans and constantly refine the avoidance and mitigation programmes throughout the life of the redevelopment programme.
- 10.2 Each of the badger setts will be assigned a unique identifier within ECOplan, with information recorded describing its status (active/non-active) and its significance within the clan territory (eg. main or annex sett). ECO plan has a 'search-for' facility, which would allow the rapid location of any nominated setts together with its OS grid reference. This facility will become more important as the site features and points of reference, such as buildings, begin to change through demolition, creation of new landscape features and planting.
- 10.3 Previous badger surveys have relied on reference to site features and GPS to record sett locations. Practice has shown that these records may be greater than 10 m from the actual location. GPS will become increasingly accurate over the coming years, particularly with the advent of the European Galileo satellite system, due to come on stream in 2013. BAE Systems has committed to accurately surveying all known badger sett entrances, and has initially completed survey of the setts around the Southern Access (the proposed road entrance across the railway line, to the east of the site).
- 10.4 There is a disparity between the accuracy required by engineers in establishing disturbance zones and the alignment of new roads etc and the accuracy with which the ecologist can measure the actual levels of disturbance, which will vary with time of year, location, particular animals etc. Ecological information generally, therefore, has an inherent degree of uncertainty not just because it deals with the peculiarities of living organisms: while the position of the entrances to setts can be established with a high degree of accuracy, the extent of the setts beneath ground is harder to establish, with tunnels possibly running for distances over 10 m in directions which are uncertain. There has to be, therefore, an element of informed judgement by the badger ecologist, based on knowledge of the materials in which the structures have been excavated, age and status of sett etc. Although in all instances of accurate sett-entrance survey, a default 5 m zone has been applied around the polygon connecting the outer sett entrances and subsequent zones of disturbance established as described in 6.9.1, the badger ecologist will be consulted for informed decisions to help define these limits where site operations are likely to conflict. Continual monitoring and recording of activity will help build up a better picture and greater confidence in where these limits lie.
- 10.2 The ECOplan system could allow access at all times of the licensing agency (SNH) to the ecological database, and would allow rapid comment and advice throughout the life of the project. Such a system, it is hoped, would help facilitate the formulation and granting of licences, which would be submitted against the information provided in this database as well as the guidance sett within this document.
- 10.3 Monitoring and mitigation on this geographic scale and period is unique. This has presented challenges in the handling and dissemination of these data. However, the decisions made and recording and interpretation of the outcome could be used to establish best practice principles and inform future development. It is hoped that the monitoring work, if carried out rigorously and in a structured manner will help establish predictive modelling, so that the impacts of proposed phases can be accurately modelled to establish the best practical option or to review the proposal and seek alternatives where the likely effects are unsupportable. Some of the mechanisms suggested for assessment and mitigation, such as realignment of badger territories are novel but, again, it is hoped that effective techniques can be quickly identified and reapplied and less effective ones either improved or rapidly abandoned in the advancement of badger management on this site.

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Thornton, P. (1988). *Density and Distribution of Badgers in South-west England – A Predictive Model*. Mamm. Rev.; 18, 1 – 23

APPENDICES

Appendix 1

Badger Territories: JDC Ecology March 2003

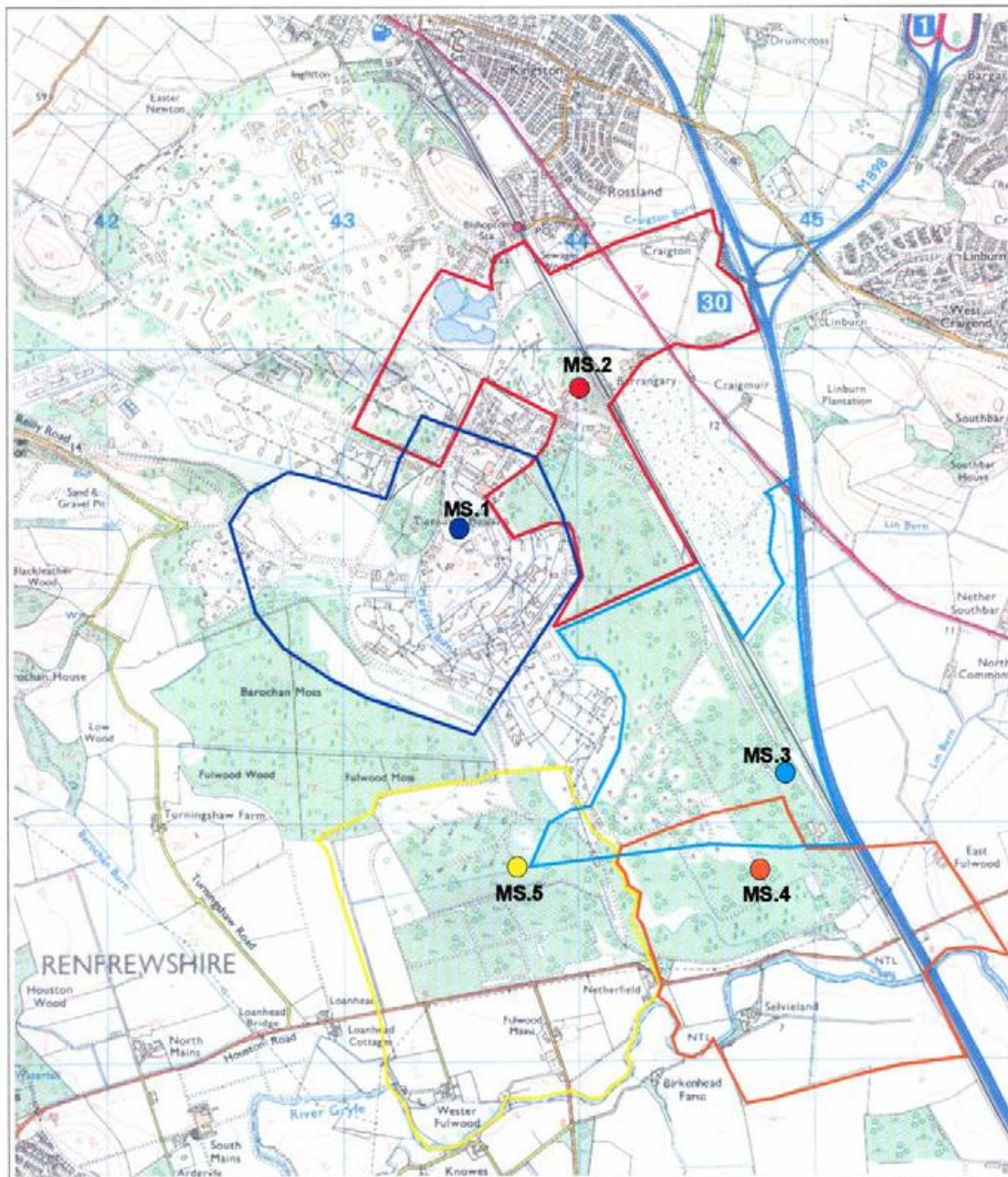


Figure 2a: Estimated territories
 Royal Ordnance, Bishopton
 NS 433 693
 31 March 2003

● Main Setts
 Indicative core territories based on baitmarking returns, surrounding habitat, location of paths through the perimeter fence and an estimate of the likely territory size in this area.
 NB: Territories are likely to be larger than usual because of the general lack of high quality forage on-site.
 Individual badgers will range outwith territory boundaries.

Figure 1: Site Location

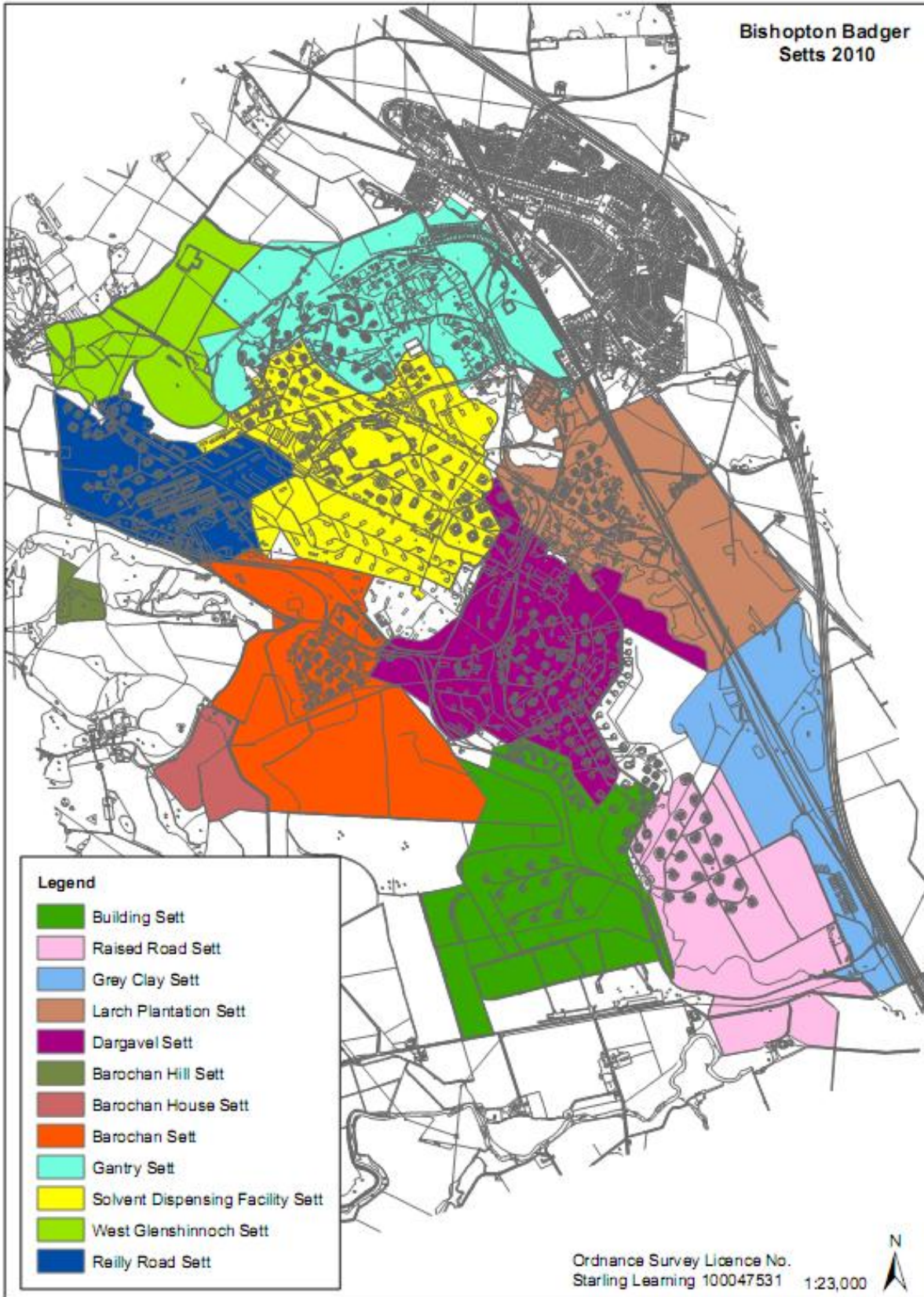


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Badger Territories: Starling Learning June 2010

Bishopton Badger
Setts 2010



Appendix 2

Working Practices and Standard Details

There may be restrictions to the timings of certain works, e.g., December to June inclusive is the sensitive period for badgers, and licences are generally not issued for work within this time (see Chapter 7 The Badger Calendar). The outline remediation/development strategy has now been proposed. Once detailed working plans and methods are available, SNH will be consulted and a site visit(s) will be undertaken to discuss the need for licensing and any restrictions to workings at any potentially sensitive areas.

Following best practice guidelines, exclusion areas will be set up a minimum of 30 m will be established around any setts that are to remain and likely to be affected by the remediation works. Where work is to be carried out within this 30 m radius, a licence will be applied for by the badger ecologist. Exclusion areas will be marked out on the ground with suitable fencing either wooden stakes and high-visibility plastic barrier mesh or exceptionally, Heras fencing, where there high volumes of traffic movement. NB, not all setts on site will be marked, only those in proximity to the proposed activity within the current season. ECOplan will be consulted for records of all active setts not in this area. Where there is any doubt in locating badger setts, such as in scrub or woodland, a coloured post will be placed at a suitable, surveyed location as a marker to indicate the proximity of the badger sett(s).

The following working practices will also follow SNH recommended guidelines where possible:

- a) avoidance of use of noisy plant and machinery in the vicinity of the setts (30 m) at least two hours before dusk;
 - b) security lighting to be directed away from setts;
 - c) chemicals or other hazardous materials to be stored away from badger setts and paths;
- and
- d) deep trenches to be covered at the end of each working day, or include a means of escape for any animal falling in; trees are to be felled away from known badger setts.

EcoPlan is to be examined to identify active setts. Where there is any doubt about the status of a recorded sett or observed burrow, the Ecological Clerk of Works is to be contacted before commencing work.

Where an incident occurs involving the possible harm to badgers or their setts, the Ecological Incident Reporting Form is to be used.

There will be a number of instances where fencing will have to be installed for operational purposes. Any fencing used will follow the SNH specification (SNH 2001). Appropriate fencing is available as Scottish Patent Sentinel Badger fencing. Rolls are to be joined at posts using suitable u-nails. Soils are to be compacted on both sides of fence. Fence Posts are to be 1800x100mmx100mm, with post centres @ 1800mm, manually driven into the ground. Where tunnels are necessary, under access roads, for instance, these will be concrete pipes, a minimum of 600 mm diameter, ideally, larger, with wider flared entrances and to be effective will be situated on an existing badger path.

Similar attention will be paid to the location of badger paths to ensure the continued free movement of badgers. Where works cross badger paths, unlit or dimly-lit corridors will be left open during the evening to allow the passage of badgers. Where tunnels are installed under roadways and other traffic routes, attention will be paid to maintain continuity of cover, possibly in the early creation of new hedgerows, embanking etc to provide cover and to encourage badgers to follow particular routes to and from crossing places where existing routes have been disturbed by site work.

BADGER POLICY GUIDANCE NOTE:

BEST PRACTICE GUIDANCE - CREATION OF ARTIFICIAL SETTS SNH(2006)

INTRODUCTION

The flow diagram of the badger Policy Guidance Note describes the circumstances under which it may be necessary to construct an artificial badger sett. Although such structures are not complicated, careful consideration needs to be given to aspects of sett location, design and construction. The information which follows provides appropriate guidance in these respects and, if adhered to, will improve the likelihood of a successful outcome. A suitably qualified Ecological Clerk of Works should oversee the process from the start, i.e. from design to installation. A period of monitoring will be required in order to determine use of the artificial sett by badgers. The duration and frequency of monitoring will be site-specific, depending on when and if badgers colonise, and will be agreed between the Ecological Clerk of Works, SNH and the client.

REASONS FOR CONSTRUCTING AN ARTIFICIAL BADGER SETT

There are two reasons for the construction of an artificial sett:

- To facilitate the relocation of badgers within their existing territory in those cases where a main or annexe sett is to be destroyed.
- To facilitate the release of badgers into new areas i.e. the translocation of badgers outside of their territory.

This guidance is concerned with the former circumstance i.e. those situations in which badgers are to be relocated within their existing territory as a consequence of main or annexe sett loss due to development.

Main and annexe setts are normally the most important setts within a badger territory. The removal of any badger sett is only possible under licence. In most situations such a licence will stipulate that replacement artificial setts must be provided. Where badgers are present in low density, or where the status or functionality of setts is difficult to establish, subsidiary or outlying setts may also assume a pivotal role in badger social organisation. Where this is suspected, the construction of artificial setts should also be considered an appropriate mitigation measure where such setts are to be lost to development.

SELECTION OF SITE

Many criteria must be considered with respect to the location of an artificial sett, particularly when the sett is to be provided as an alternative to a natural sett that will be destroyed and where badgers will be excluded.

• Social Group Territory

Badgers are territorial; therefore, any alternative artificial sett must be located within the appropriate social group territory. If there is any uncertainty, the construction of the sett must be preceded by a territorial bait marking survey.

- **Proximity to Existing Setts.**

Badgers must be able to locate the replacement sett without any difficulty. A site must be selected as close to the existing sett(s) and/or area of badger activity as is practicable. However, the site must not be so close to the new development that disturbance could distract badgers from using it.

- **Size of Site.**

The size of the site required for artificial sett construction will depend upon the size of the natural sett which it replaces. Regardless of the artificial sett size, a minimum area of 30m radius should be demarcated from the outlying holes of the artificial sett to prevent damage and disturbance. An area 10m x 10m would accommodate a small artificial sett comprising two entrances with tunnels leading to at least two chambers. Small artificial setts, even though physically capable of accommodating the appropriate number of badgers excluded from larger setts, generally tend not to work. Therefore, it is important to construct a structure with adequate chambers and tunnels which replicates as much as possible the bulk of the natural sett it replaces. A mechanical digger is normally used to prepare the site and the amount of soil excavated during this procedure can necessitate a construction area considerably larger than the dimensions of the artificial sett itself.

- **Profile of the Sett.**

The exact shape of the sett can be varied to accommodate local topography. For example, sett footprints can be adapted to fit into long thin strips of ground or, within woodland, can be designed to integrate with existing trees. Sett design is flexible.

- **Gradient of the Site.**

It is important that there is sufficient drainage to avoid the artificial sett becoming flooded. Soil type plays a part in this. However, it is also important to ensure that tunnels slope away from the sett chambers such that water flows towards the sett entrances. It is also important to ensure a depth of at least one metre of soil above the chambers. There are two ways this can be achieved. The preferred way is to build the sett on or into a sloping site with the pipes emerging at the lowest point. If this is not possible, the whole sett can be covered with a mound of soil

The licensed destruction of an occupied sett will necessitate the exclusion of the resident badgers, again under license. In order to ensure that the excluded badgers have an alternative sett to go to, and that they are familiar with the artificial sett, timing is critical. The artificial sett should therefore be constructed at least 6 months prior to exclusion. An exclusion of a main or breeding sett will generally only be licensed to occur between the end of June and the end of November.

SETT DESIGN: GENERAL PRINCIPLES

- **Chamber Design**

The chambers should always be constructed at the end of branches off the main pipe run as badgers like the security of a defendable 'end' situation. Chambers are constructed using concrete slabs with either concrete or breeze blocks or alternatively wood and plastic. The basic design of the chamber reflects the shape and size of the materials used for construction. Thus, 3' x 2' concrete paving slabs can be used in association with 6" bed concrete. Alternatively, wood chambers

typically measure 450mm to 750mm square. Completed chambers should always be filled generously with dry hay or straw.

- **Tunnels.**

The tunnels are constructed from 12" (300mm) diameter pipes throughout - reduced at entrances to 9" (225mm) pipes. The 9" pipes at the entrances restrict the size of any dog that could enter into the sett, but allow badgers easy access. Pipes can be of clay or concrete, collared or not, and of any length that can be obtained. However it should be remembered that long pipes are difficult to handle and make curves more difficult to construct. Preferred pipes are clay at 1500mm long with collars. These are the lightest and easiest to handle, fit together well and make the straightness of the trenches less critical. One, or possibly two, pipe branches with one branch left open to the surrounding soil allows the badgers to excavate and expand the sett if they wish. Plastic piping, 250mm – 300mm in diameter, can also be used and is easy to handle. If preferred, a mixture of all material types could be used.

- **Construction.**

A mechanical digger is usually used to excavate the sett. Chambers and pipe runs should be buried at a depth of at least 1250mm. Pipe trenches should be excavated using a 600mm wide digger bucket.

Normal Health and Safety guidelines apply, particularly with respect to working in trenches. Therefore, trench sides should be sloped back or stepped to comply with guidelines.

The time taken to construct an artificial sett is determined by how well the construction has been organised. Assuming that all materials and labour are readily available (including an excavator driver), the sett can be constructed, backfilled and landscaped within two to four days.

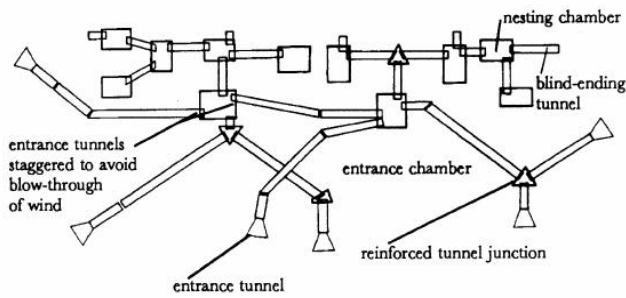
SPECIFIC SETT DESIGNS

Details of two types of design are considered below. Both are modular in construction and can be readily adapted to suit site and size requirements. The size of either design type should reflect the size and status of the sett which is to be replaced.

The Type 1 design probably more closely replicates the chamber conditions found within a natural sett. The Type 2 design benefits from an easier build, additional durability and security from persecution or interference. In all cases, badgers should have time to familiarize with replacement setts, which should be in position at least six months prior to any natural sett exclusion.

Type 1 Design

Comprising 450mm to 750mm square or similarly sized rectangular nest chambers constructed of wood and with a height of 300mm to 450mm. The chambers are connected by a 300mm to 400mm diameter plastic pipe tunnel system.



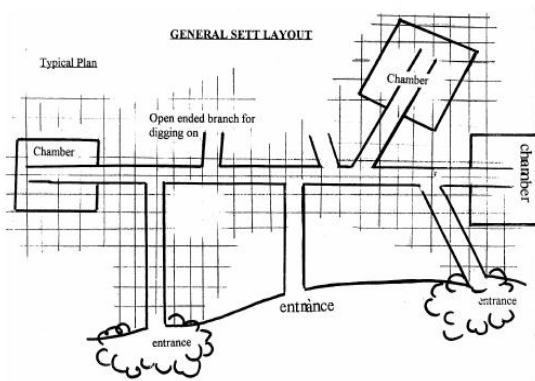
Above: plan of a medium size Type 1 Design artificial sett. Right: Type 1 Design artificial sett under construction, A97, Aberchirder, Scotland (Grampian Badger Surveys for Aberdeenshire Council 2000).

Type 2 Design

Comprising concrete block and paving slab nesting chambers with 225mm-300mm diameter clay or concrete piping tunnel system.

Above: plan of a small size Type 2 Design artificial sett. Right: Type 2 Design artificial sett at completion, Tarbot Hill, Aberdeen, Scotland Grampian Badger Surveys for Shanks Waste Solutions 1998).

Above: plan of a medium size Type 1 Design artificial sett. Right: Type 1 Design artificial sett under construction, A97, Aberchirder, Scotland (Grampian Badger Surveys for Aberdeenshire Council 2000).



Above: plan of a small size Type 2 Design artificial sett. Right: Type 2 Design artificial sett at completion, Tarbot Hill, Aberdeen, Scotland Grampian Badger Surveys for Shanks Waste Solutions 1998).

QUANTITIES, LABOUR & COSTS

Typical materials, equipment, labour and costs required to construct a Type 2 Design artificial sett with three chambers are listed below. Costs for a Type 1 Design are likely to be of a similar order. Specific costs will depend on site characteristics, materials used etc.

Materials

- Thirty eight 3' x 2' concrete paving slabs.
- One hundred 18" x 9" x 6" (bed) concrete blocks
- Eight 12" (300mm) diameter clayware pipes, c.1500mm long.
- Two 9" (225mm) diameter clayware pipes, 1500mm long.
- Two 12" (300mm) diameter clayware right angle junctions.
- Hay or straw sufficient to fill the chambers.
- Soil: may need to be imported for the purpose of covering and landscaping the completed artificial sett.

Pipes can be seconds, with or without collars. 1500mm long pipes are easiest to use; longer ones become very heavy to handle and shorter ones more expensive and difficult to use. Right angle junctions are easiest to use but if these are not available, 120 degree angles will suffice.

Machinery

A mechanical digger (JCB or a 360 degree excavator) is generally suitable for sett construction.

Shovels, picks and hand tools are required. A masonry cutting saw may be beneficial where pipes or block work need to be cut to size.

Labour & Time

Minimum: two men (excluding digger operator) for a minimum of two days will be required for the construction of one artificial sett. It will be essential to ensure that all materials are on site prior to starting if this timetable is to be met.

Cost

Budget for a minimum of c. £4,500 per 3-chambered sett, excluding labour (prices estimated in 2006).

BEST PRACTICE GUIDANCE - MANAGING LAND AS A FORAGING RESOURCE FOR BADGERS SNH (2006)

INTRODUCTION

Badgers are omnivorous, feeding on a wide variety of food from invertebrates, small mammals and birds to plant foods such as fruit, nuts and crops. The distribution and abundance of these food resources can have a profound influence on badger ecology. For example, the size of a badger social group territory is dependent upon the distribution of key food resources such as earthworms. The density of these key food resources within the territory determines the number of animals within each social group¹. The sensitive management of these key resources can therefore be a useful tool in mitigating the adverse effects of development.

GENERAL PRINCIPLES

In a development context the management of land as a foraging resource for badgers should embody the following three basic principles:

- Key foraging habitat should be identified at an early stage in the evolution of development proposals and retained wherever possible by preferentially locating built environments on less preferred badger foraging habitat. However, it is important to bare in mind that these less preferred habitats may have other inherent natural heritage value and these should be taken into account.
- Where there is a loss of key foraging habitat to development every effort should be made to enhance the capacity of those habitats which remain within and adjacent to the built environment to support foraging by badgers.
- Where on-site habitat retention or enhancement is not possible compensatory habitat creation should be undertaken offsite.

WHAT CONSTITUTES KEY BADGER FORAGING HABITAT?

Within the Inverness area earthworms are likely to figure prominently in badger diet. Accordingly, the protection, enhancement or creation of those habitats which support good earthworm populations will be pivotal to a successful badger mitigation plan. Some habitats are better than others in this respect – these are illustrated in the following Table:

Habitat	Worm biomass (kg/ha)
Beechwood	123 ²
Coniferous plantation	175 ³
Rough grassland	230 ³
Mixed plantation	278 ³
Cereal fields	482 ⁴

Deciduous woodland	837 ³
Improved pasture	971 ⁴

While all the habitats shown in the above Table are likely to be used by foraging badgers those that support the highest earthworm biomass are preferentially exploited. Improved grasslands and deciduous woodlands are therefore favoured by badgers, the former habitat being of particular importance, especially when grazed by livestock or mown for amenity purposes. In the latter context sports fields and golf courses can provide a rich source of earthworms, but only in the absence of the use of vermicides (chemicals which kill worms). Grazing or mowing produces a short sward from which earthworms can easily be predated. Longer swards, such as those associated with rough un-grazed grasslands are of relatively less value: worm biomass is reduced and the worms are more difficult to predate.

Although worm-rich grazed or mown grasslands are a primary foraging resource for badgers, other habitats are also of importance. These alternative or “secondary” habitats may be crucial under certain weather conditions such as drought and frost when earthworms may be difficult to obtain. At such times arable crops such as grains and root crops, and woodlands, scrub and rough ungrazed grassland will be readily exploited by badgers.

BADGER FORAGING HABITAT AUDIT

Before any development proposals are considered, it is important to assess the existing habitat value for badgers. This should consist of an audit of the areas of habitat of primary and secondary importance using published data on worm densities for the different habitats present. Please see Table below.

Primary foraging habitat	<ul style="list-style-type: none"> • Short grazed or mown grassland i.e., improved grassland
	<ul style="list-style-type: none"> • Golf course
	<ul style="list-style-type: none"> • Broadleaved woodland
Secondary foraging habitat	<ul style="list-style-type: none"> • Arable
	<ul style="list-style-type: none"> • Rough grassland (not grazed by domestic stock)
	<ul style="list-style-type: none"> • Scrub
	<ul style="list-style-type: none"> • Mixed woodland
Other	<ul style="list-style-type: none"> • Coniferous woodland etc

The audit should be repeated based on the areas of anticipated post-development habitats and a balance sheet prepared showing gains and losses. This balance sheet will provide an indicative assessment of the shortfall in primary and secondary badger foraging habitat that needs to be created elsewhere in the territory by either habitat creation or enhancement.

¹H. Kruuk (1989). *The Social Badger*. Oxford University Press, Oxford.

²Cuendet, G. (1984). *A comparative study of the earthworm population of four different woodland types in Wytham Woods*, Oxford. *Pedobiologia*, 26, 421-439.

³Hofer, H. (1988). *Variation in resource presence, utilisation and reproductive success within a population of European Badgers *Meles meles**. *Mammal Review* 18, No.1, 25-36.

⁴Kruuk, H. (1978). *Foraging and social organisation of the European badger *Meles meles**. *Journal of Zoology*, 184, 1-19.

MEASURES FOR RETAINING, CREATING & ENHANCING BADGER FORAGING HABITAT

In attempting to mitigate the loss of badger foraging habitat the following measures should be considered:

- Avoid locating built environments on primary badger foraging habitat.
- If topsoil is to be removed from primary or secondary badger foraging habitats it should be stripped and piled during dry conditions to avoid compaction. It should also be handled with care and not mixed with subsoil and loose tipped (i.e. not run over by machines as they tip). Piles of soil should be a maximum height of 2m. It should then be seeded within 10 days with a leguminous seed mix and thereafter care should be taken not to contaminate it with chemicals or waste.
- Subject to the value of other natural heritage interests on site, consider the conversion of some areas of "secondary" or "other" habitat to primary badger foraging habitat, e.g. introduce grazing or mowing to rough grassland; convert arable or coniferous plantation to broadleaved woodland.
- Avoid the use of vermicides (chemicals which kill worms) on areas of amenity grassland and golf courses.
- Ensure that habitats of importance for foraging badgers are not fragmented or isolated by development, such that badgers can move freely between them and their setts. Maximum landscape connectivity should be developed by retention of known badger pathways and the retention/development of a network of hedgerows and tree lines that incorporate native species with a high proportion of fruit-bearing species such as Rowan and Elder. Where possible wildlife corridor networks should link with Greenspace (ex/ Inverness's "Green Wedges") and with any badger tunnels or passes installed to prevent road mortality.

Details of Underpass Construction and Badger Fencing

Introduction

A steady increase in the density of roads, among other factors, contributed to a crash in badger (*Meles meles*) numbers in the Netherlands, in the 1970s. As a consequence, badger underpasses were increasingly included in the construction of new roads. A review was subsequently undertaken to identify the best badger underpass designs based on 30 years of experience. The research was published by Broekhuizen & Beek (1996) as *Durchlässe für Dachse un ihre Effektivität* (Criteria for Effective Badger Passages) in *Zeitschrift für Jagdwissenschaften*, 42, 134-142. The following is a summary of the background and findings.

Research

Over a period of 30 years, numerous surveys were undertaken to assess the efficacy of different badger underpass designs; more than 200 underpasses were constructed and examined in this period. Experiments included trials using fencing (of various length and design) aimed at preventing access to roads whilst leading animals to the underpass entrances; the efficacy of unfenced 'control' passages were included for comparison.

Results

Passage design: it was found that badgers preferred simple tubes (diameter of 30-40 cm) with a slightly rough inner surface. Concrete pipes were effective and highly durable; (Armco) steel tubes provided an alternative where ground subsidence was expected. This design was successfully used by badgers to pass beneath roads, even if over 100 m in length. In some instances, where the passages were lying below ground level, a cornice was fitted to the entrance to help prevent water from entering and flooding the passages.

Fence design: Underpass effectiveness was found to be highly dependent upon the quality and the length of fencing either side of the underpass entrance. Experience indicated that galvanised, spot-welded wire mesh netting (mesh size 2.5 x 5 cm) was a good fencing material. Fencing around 1 m high (with posts positioned on the road-facing side) proved effective in preventing badgers from climbing over; digging the fence 20 cm deep into the ground with a 30 cm wide, horizontal strip of mesh attached to the bottom prevented badgers from burrowing beneath.

It was also found that the longer the fence, the more effective the underpass, with a notable decrease in effectiveness for fences less than 250 m long. Integrating one-way flaps allowed any animals on the road-side of the fence to pass through.

Defects in fences (e.g. holes allowing animals through) reduced the number of underpasses used by nearly 50%; it follows that regular fence inspections are required, with defects promptly repaired. It was also found that fences generally need replacing every 15–20 years. Surveys further revealed that 35-40% of the underpasses examined were not used by badgers at all. As well as ensuring fence maintenance, passages appeared more effective when positioned near existing badger crossing points.

Badger mortality on roads: Despite the construction of more than 200 underpasses, the numbers of badgers killed rose annually by more than 12% during 1990-95 (from 216 in 1990 to 273 in 1995). However, both the density of traffic and the number of badgers increased during this period, resulting in a higher probability of accidents. It is believed that without these underpasses, these figures would have been much larger.

Use by other mammals: Red fox (*Vulpes vulpes*), stone marten (*Martes foina*), polecat (*Mustela putorius*), weasel (*Mustela nivalis*), American mink (*Mustela vison*), hedgehog (*Erinaceus europaeus*), rabbit (*Oryctolagus cuniculus*), cat (*Felis catus*) and a number of small rodents, were also recorded as using the underpasses, thus, reducing the road kill of wildlife more generally.