

APPLIED ECOLOGY

GlasgGLOW 2023

Ecological Sensitivities and Opportunities Report

Produced for itison

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1 Introduction

Background

- 1.1 In August 2023, Applied Ecology Ltd (AEL) was commissioned by itison to provide ecological support for their autumn sound and light event known as GlasGLOW (“the Event”), to be held in October and November 2023 within the Glasgow Botanic Gardens (“the Site”), in the West End of the City of Glasgow. A plan showing the location of the Site is provided in **Figure 1.1**.
- 1.2 GlasGLOW has run annually within the Botanic Gardens since 2018. Although sustainability has always been a consideration in the design and planning of the Event, in 2023 itison has taken this further with the appointment of a dedicated sustainability specialist to advise on all stages of their event planning and delivery. In parallel with this, and as part of recognising that the Event takes place within public greenspace with its own intrinsic sensitivities, Glasgow City Council (GCC) has required itison to engage with an independent ecological consultant to provide objective advice regarding how the 2023 GlasGLOW event could be designed and run so as to minimise its biodiversity impact.

Purpose of this report

- 1.3 This report provides details of the likely ecological sensitivities and opportunities arising from the 2023 GlasGLOW event in the Botanic Gardens. It provides a description of the approach taken to identify those sensitivities, an evaluation of the possible biodiversity impacts that could arise as a result of the Event, and details of the mitigation hierarchy that should be put into place to avoid those impacts in the first instance, and then to mitigate any residual effects where it is not possible to design them out. It also provides recommendations relating to the opportunities presented by the Event and the Site in which it occurs, to offer enhancements for biodiversity wherever practicable.
- 1.4 The purpose of this appraisal is not to provide an exhaustive review of the potential effects of sound and lighting events in urban areas. A brief synopsis of key findings relating to this topic area is however provided, with signposting to bodies of academic research where more information can be found.

Report qualification

- 1.5 The ecological work described here was undertaken in accordance with the best practice methodologies current at the time of commissioning. Site circumstances, scientific knowledge or methodological requirements can change during the course of a project, and these external factors may impact on the scope of subsequent work requirements.
- 1.6 All survey work and reporting was undertaken by experienced and qualified ecologists in accordance with the Code of Professional Conduct of the Chartered Institute of Ecology and Environmental Management (CIEEM), as well as guidance provided by the Bat Conservation Trust (BCT) and that contained within BS 42020:2013 (Biodiversity).



- 1.7 All ecological surveys have an expected validity period, owing to the tendency of the natural environment to change over time. This validity period varies from feature to feature, and is also dependent on the degree of change in a site's management and overall landscape ecology. Where the potential for change is considered to be relevant to the Site, this is highlighted in the appropriate section.
- 1.8 This report does not purport to provide detailed, specialist legal advice. Where legislation is referenced, the reader should consult the original legal text, and/or the advice of a qualified environmental lawyer.





GlasGLOW 2023

Site Location

 Site boundary

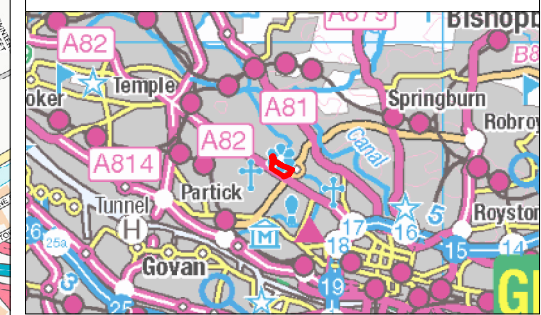



Figure 1.1

Map Scale @ A3: 1:15,000



Surveyed by: -	 APPLIED ECOLOGY
Survey date: -	
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Checked by: SH	
Status: Final	

2 Methodology

Pre-existing data records

Designated sites

- 2.1 Details of nearby statutory sites designated for nature conservation were obtained from the NatureScot Natural Spaces website¹ and plotted in a Geographical Information System (GIS). Sites listed on the NatureScot Ancient Woodland Inventory (AWI) were also obtained from this source and plotted in GIS. GCC maintains a register of local non-statutory designated sites known as Sites of Importance for Nature Conservation (SINCs), and these were transcribed from an online database² into GIS. The boundaries of Scottish Wildlife Trust (SWT) reserves were also obtained from an online resource³.

Other biological records

- 2.2 The Biological Records Centre (BRC) for Glasgow City, run out of the Glasgow Museums Resource Centre (GMRC), is currently not providing a data record supply service. Pre-existing biological data relevant to the Site were therefore searched for online, and in online databases to which the authors had access and for which there were no issues associated with their use in a commercial setting. These were augmented by lists of records obtainable online, although the copyright status of some of these resources could not be ascertained.

Extended Scottish EUNIS habitat survey

- 2.3 NatureScot has adopted EUNIS, the European Nature Information System, as the standard habitat classification scheme for terrestrial habitat data and mapping in Scotland⁴. A habitat survey of the Site was therefore undertaken in August 2023 using Scottish EUNIS, during which all habitats present within the Site were classified and mapped according to the standard EUNIS categories. Habitat patches were mapped as polygon features, and linear features (such as walls and fences) as lines where this provided added value and if sufficient space on the map. Point features were recorded where there were notable isolated trees or scrub. Target notes were used to describe areas of both typical and unique botanical character. Plant species abundance was noted using the DAFOR⁵ system, and the minimum mappable unit (MMU) was 10 x 10 m except where features marked on the base map allowed mapping to be more precise.
- 2.4 The standard habitat survey approach was "extended" to include a search for evidence of or potential for the presence of protected species or species of nature conservation

¹ <https://sitelink.nature.scot/home> accessed July 2023.

² <https://glasgowgis.maps.arcgis.com/apps/webappviewer/index.html?id=f8a6a37c9c324f268f896dd59fcd6477> access July 2023.

³ <https://scottishwildlifetrust.org.uk/our-work/our-evidence-base/our-data/> Accessed July 2023.

⁴ **Strachan, I.M. (2017)** *Manual of terrestrial EUNIS habitats in Scotland*. Version 2. Scottish Natural Heritage Commissioned Report No. 766.

⁵ DAFOR: whereby species occurrence may be classified as being **d**ominant, **a**bundant, **f**requent, **o**ccasional or **r**are. Rare in the context of a DAFOR score should not be confused with species rarity in the more widely accepted meaning of general scarcity.



interest within the Site. This was not a detailed survey for such species, but included noting the presence of habitats suitable to support such species, and where seen, any evidence of presence such as droppings, mammal tracks and footprints, shelters (or nests/roosts), hair caught on fence-wire, foraging signs, and so on.

Potential limitations of the Scottish EUNIS habitat survey

- 2.5 The walkover survey was undertaken within the core botanical survey period, and the majority of the Site was accessible without any restrictions. There were therefore no limitations to the survey.

Other relevant sources of information

- 2.6 A range of information sources were consulted during the preparation of this appraisal, including:
- The Bat Conservation Trust and the Institute of Lighting Professional (2023) Bats and Artificial Lighting at Night. Guidance note 08/23, available online at www.theilp.org.uk
 - Brownlie, S., Bull, J.W. and Stubbs, D. (2020). Mitigating biodiversity impacts of sports events. Gland, Switzerland: IUCN. xiv+80 pp.
 - GCC (undated). Glasgow Botanic Gardens Management Plan 2011-2016. Land and Environmental Services, Glasgow.
 - Echoes Ecology Ltd (2016) Humpback Bridge – Ecological Constraints Survey. Unpublished contract report produced for Covanburn Contracts, November 2016.
 - Weddle, R.B. (undated) Bats in the West End of Glasgow (Chiroptera: *Pipistrellus* sp., *Myotis daubentii*, *Plecotus auritus*). The Glasgow Naturalist, 25 p. unknown.
 - GCC (undated) Glasgow Local Biodiversity Action Plan. Available online at <https://www.glasgow.gov.uk/biodiversity> (accessed August 2023).
- 2.7 Information was also collected informally from Botanic Garden staff and biodiversity personnel at Glasgow City Council.



3 Findings

Pre-existing data records

Sites designated for nature conservation

- 3.1 A map showing the location of designated sites within 2 km of the Site is provided in **Figure 3.1**.
- 3.2 The closest statutorily designated site to the Site is the Hamiltonhill Clay Pits Local Nature Reserve (LNR), which is 1.2 km to the east of the Site at its closest point. The Event is not anticipated to have any impacts on sites at such a distance, and therefore statutorily designated areas are not considered here any further.
- 3.3 However, in terms of non-statutory designations, the River Kelvin City-Wide SINC overlaps the Site boundary along its north-eastern edge.

Habitats

- 3.4 The Scottish EUNIS habitat map is shown in **Figure 3.2**. A summary of the habitats recorded is provided in **Table 3.1** below, and target notes can be found in **Appendix B**. A selection of habitat survey photographs can be found in **Figure 3.3**.

Built environment

- 3.5 Just over 30 % of the Site was **built** features, being either buildings, or roads, paths or other areas of **hard standing**.

Grasslands

- 3.6 Two main grassland types were identified within the Site, and the majority of these were **improved (amenity)** swards as would be expected for a managed garden. These were regularly mown, short and species-poor habitats, dominated by grass species typical of lawns such as perennial rye-grass *Lolium perenne* and red fescue *Festuca rubra*, with occasional herbs such as white clover *Trifolium repens*, common chickweed *Stellaria media*, common mouse-ear *Cerastium fontanum* and black medick *Medicago lupulina*.
- 3.7 Less intensively managed areas of grass, which had been allowed to grow taller with a relaxed mowing regime, occurred around the edges of the Site and were classified as **permanent mesotrophic grasslands**. The majority of these areas, whilst more species-rich than the formally managed lawn, were still grass-dominated habitats, with abundant Yorkshire fog *Holcus lanatus*, perennial rye-grass and common bent *Agrostis capillaris*, but a number of herbs were occasional, including common hogweed *Heracleum sphondylium*, creeping buttercup *Ranunculus repens*, meadow buttercup *R. acris*, ribwort plantain *Plantago lanceolata*, common ragwort *Jacobaea vulgaris*, common bird's-foot-trefoil *Lotus corniculatus*, common hawkweed *Hieracium vulgatum*, perfoliate St John's-wort *Hypericum perforatum* and rarely spikes of common spotted orchid *Dactylorhiza fuchsii*.



- 3.8 However, along the western boundary of the Site there was an area of neutral grassland which was being managed in order to maximise its suitability for pollinators. This sward also had abundant Yorkshire fog, but other grasses were frequent, including cock's-foot *Dactylis glomerata*, crested dog's-tail *Cynosurus cristatus*, Timothy *Phleum pratensis*, and common bent. There was a wide range of herbs conspicuous at the time of survey, including fox-and-cubs *Pilosella aurantiaca*, common knapweed *Centaurea nigra*, yellow rattle *Rhinanthus minor*, tufted vetch *Vicia cracca*, white clover, common bird's-foot-trefoil, red clover *Trifolium pratense*, common cat's-ear *Hypochaeris radicata*, curled dock *Rumex crispus*, ribwort plantain, meadow buttercup and germander speedwell *Veronica chamaedrys*.

Woodland, tree-ed and scrub habitats

- 3.9 The majority of the tree-ed habitats within the Site were classified as **small anthropogenic woodlands**. These areas supported a range of mature trees but were clearly of plantation origin having been established as a key feature of the Botanic Gardens. Many of the trees were therefore non-native specimens, although a number of native species did also occur. Although of plantation origin, the age of some of these trees meant that the close canopy areas where the field layer was not under regular mowing management had a semi-natural character, and these areas typically occurred around the periphery of the Site.
- 3.10 A small area of **mixed native woodland** fell within the Site boundary, along the strip of the northern boundary where the River Kelvin SINC entered the Site (see above). The native woodland category was used even though beech *Fagus sylvatica* was a frequent species here (western Scotland would be considered outwith the normal native range for beech and most stands in this geographical area are likely to be plantation in origin). Other species present included lime *Tilia x europaea*, and holly *Ilex aquifolium*, with abundant non-native rhododendron in the shrub layer, broad buckler fern *Dryopteris dilatata*, pendulous sedge *Carex pendula* and a garden privet *Ligustrum ovalifolium* hedge along the fenceline.
- 3.11 Being a botanic garden, **ornamental shrubs** were frequent throughout the central, more intensively managed garden areas. **Individual trees** were also frequent, including topiaried specimens along the main paths, and well managed mature specimens throughout (see also *anthropogenic woodlands* above).
- 3.12 Small areas of native scrub were restricted to the edges of the Site. These were dominated by bramble *Rubus fruticosus* agg. and saplings of tree species such as alder *Alnus glutinosa*, ash, a species of *Ribes*, birches *Betula* spp., *Prunus* sp. and horse-*Aesculus hippocastanum*.

Other habitats

- 3.13 Just over 5 ha of the Site comprised formal **garden** areas with herbaceous borders and beds, some of which also contained ornamental shrubs (see earlier).

Non-native plant species

- 3.14 The Site was a botanical garden. To that end, non-native shrubs occurred throughout the Site, along with specimen non-native trees, and non-native herbaceous displays. During the walkover survey, the only invasive non-native species seen was Japanese knotweed *Reynoutria japonica*, although it is well known that the Kelvin corridor to the north has



extensive infestations of Himalayan balsam *Impatiens glandulifera*, both Japanese and giant knotweed *R. sachalinensis*, and giant hogweed *Heracleum mantegazzianum*.

Table 3.1: Summary of habitat types recorded on the Site

Habitat types	Area within Site (ha)	% of Site
C1.2: Mesotrophic pond	0.01	0.2
E2.1: Permanent mesotrophic grassland	0.75	10.6
E2.6: Improved (amenity) grassland	2.10	29.8
F3: Dense scrub	0.05	0.7
FB.3: Ornamental shrubs	0.46	6.6
G1.A: Mixed native woodland	0.05	0.7
G5: Small anthropogenic woodland	0.90	12.8
I2: Cultivated areas of gardens and parks	0.40	5.6
J2: Buildings and other structures	0.71	10.0
J4: Roads, paths and other hard standing	1.47	20.9
Not surveyed	0.15	2.1
Total	7.05	100.0

Faunal sensitivities

Mammals

- 3.15 The Site supported a range of woodland habitats which may have had some suitability for **badger** sett creation. However, no signs of setts were seen during the survey, and there are no pre-existing records for this species within the Botanic Gardens. It was considered more likely that setts would be present within the adjacent River Kelvin corridor. The amenity grasslands within the Site would present good foraging habitat for badger, but again no signs of foraging, or any other evidence of badger presence (such as latrines) were seen. It was thought likely that badger was absent from the Site but present in the wider area, and unlikely to be a sensitivity in the context of the Event.
- 3.16 **Otter** is known to be present on the River Kelvin, and it was possible that shelters associated with this species would be present within the less accessible parts of the wooded corridor to the north and east of the Site. Given the high levels of use of the Kelvin Walkway, including for the exercising of dogs (of which otter are particularly intolerant), any otter holding territory along this part of the River Kelvin would be habituated to a degree of anthropogenic disturbance. Otter is unlikely to be a sensitivity in the context of the Event.
- 3.17 There were no habitats on the Site or within appropriate buffers of it which would be suitable for **water vole**, neither riparian water vole nor fossorial. There are no pre-existing records of this species for the Botanic Gardens. This species is unlikely to be a sensitivity in the context of the Event.



- 3.18 The Site contained both structures and trees considered to have suitability for roosting **bats**. A large maternity-style bat box was noted in the north-east of the Site, although no information could be provided by GCC regarding whether or not roosting bats were known to be using it. The exposed sections of the underground station within the Botanic Gardens were considered unlikely to support bat roosts, being well lit in daylight hours. However, the darker recesses, and the covered tunnel system would have high suitability for both summer roosts, and hibernation. Both Daubenton's bat and common pipistrelle have been recorded in flight in or close to the Site, and it was thought likely that soprano pipistrelle would also be present.
- 3.19 Bats should be treated as a sensitivity on the Site in the context of the Event.
- 3.20 The mosaic of lawns and dense scrub within the Site provided high suitability for **hedgehog**, and there are recent records of the species as being present in the Botanic Gardens. Hedgehog should therefore be considered a sensitivity in the context of the Event.
- 3.21 Evidence or sightings of **fox** and **grey squirrel** indicated that they were present within the Site, and it was thought likely that other common mammal species would also be resident, such as **rabbit**, **field vole**, **wood mouse** and **brown rat**. However, none of these species are specially protected or of notable conservation importance. They will not be considered any further in this appraisal.

Birds

- 3.22 A number of common bird species were seen or heard during the walkover, including **woodpigeon**, **carrion crow**, **magpie**, **chaffinch**, **pied wagtail**, **robin**, **blue tit**, **great tit**, **wren** and **blackbird**. It is possible that a wider range of species would be recorded during the core nesting bird season, and if a wider variety of habitats was included (e.g. the River Kelvin corridor). These common species are only specially protected during the breeding season (see **Chapter 4** for more information), and the Event will occur well outwith that key time. There are recent records for **tawny owl** for the Site, which is a species known to be well adapted to living in urban parks and gardens and which would be expected to be active during the hours in which the Event will operate. However, it is not clear as to whether these records refer to hunting or resident birds⁶. There was a general lack of dead wood features within the Site suitable for tawny owl, and those that were seen were occupied by grey squirrel. More extensive suitable habitat for this species would be expected to occur along the River Kelvin. Nevertheless, best practice would dictate a number of considerations in relation to minimising the potential impacts on birds as a result of the Event, and to that end they should be treated as a sensitivity in the context of this appraisal.

Herpetofauna

- 3.23 There were no habitats suitable for common reptile species present within the Site, and generally these species are accepted as being absent from the densely built-up areas of Glasgow. Similarly, specially protected amphibian species such as great crested newt (GCN) are also absent from this locality. There was suitability however for common amphibians

⁶ Pre-existing records for tawny owl are usually of calling birds, and these would indicate territoriality. It is likely that a tawny owl territory therefore at least overlaps the Gardens.

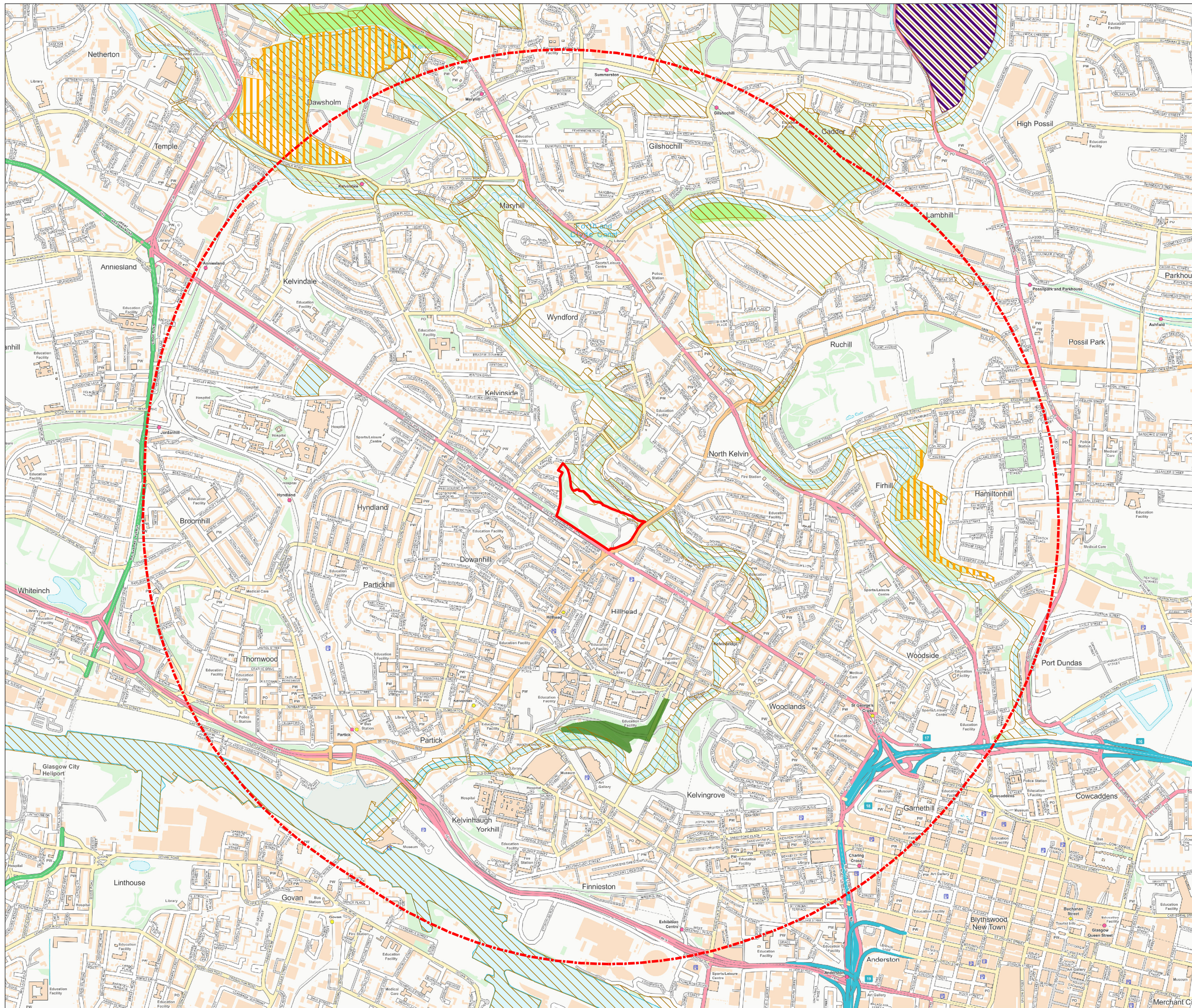


such as **common frog** and **common toad**, in particular in composting areas and piles of brash. Although not subject to any special protection, best practice would be to consider these species to be sensitivities in the context of this appraisal.

Invertebrates

- 3.24 Detailed invertebrate survey would be beyond the scope of this assessment, but it was thought likely that the mosaic of woodland, grassland and herbaceous plantings would support a relatively high diversity of invertebrates for such an urban location, including butterflies and bees (and other pollinators), and day- and night-flying moths. Although the Event will occur at a time towards the end of the flying period of these species, climate change is altering the phenology of autumn events, and to that end invertebrates should, in generic terms, be considered a sensitivity in the context of this appraisal.





GlasGLOW 2023

- ### Sites Designated for Nature Conservation
- Site boundary
 - 2 km from Site boundary
 - SSSI
 - LNR
 - GCC SINC
- ### Ancient Woodland Inventory:
- Ancient (semi-natural origin)
 - Long-established (plantation origin)

SSSI, LNR and AWI data Copyright NatureScot.
 Contains Ordnance Survey data © Crown copyright and database right (2023).
 SWT boundary data © Scottish Wildlife Trust (2023)
 Ancient Woodland data may exclude some woodlands present on 1st Edition OS maps.

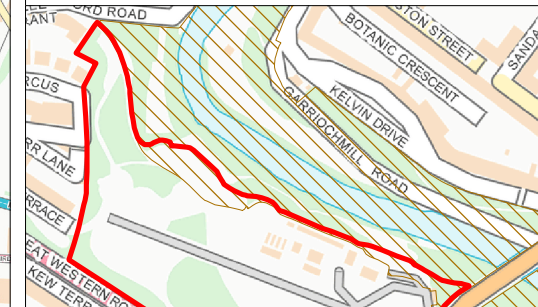



Figure 3.1
 Map Scale @ A3: 1:18,000

Surveyed by: -	 APPLIED ECOLOGY
Survey date: -	
Drawn by: RAH	
Checked by: SH	
Status: Final	

Scottish EUNIS Habitat Map

- Site boundary
- Scottish EUNIS habitat types:**
- C1.2: Mesotrophic pond
- E2.1: Permanent mesotrophic grassland
- E2.6: Improved (amenity) grassland
- F3: Dense scrub
- FB.3: Ornamental shrubs
- G1.A: Mixed native woodland
- G5: Small anthropogenic woodland
- I2: Cultivated areas of gardens and parks
- J2: Buildings and other structures
- J4: Roads, paths and other hard standing
- Not surveyed
- Individual tree (indicative location)
- Target notes



Figure 3.2

Map Scale @ A3: 1:2,000



Surveyed by: AEL

Survey date: August 2023

Drawn by: RAH

Checked by: SH

Status: Final



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Figure 3.3: Selection of ecological appraisal photographs



(a) Buildings of traditional construction containing potential (bat) roost features.



(b) The disused underground station, with suitability for roosting bats.



(c) Remnant spikes of common spotted orchid in unmown grassland west of the underground station.





(d) Compost heaps with suitability as refuges for hedgehog and common amphibians.



(e) Broad-leaved helleborine in scrubby undergrowth.



(f) Remnants of former ash trees. No PRFs remaining.





(g) Species-rich meadow area in north of the Gardens.



(h) Bird box and compost heap along northern boundary of Gardens.



(i) Potential roost features in white poplar on north-eastern edge of the Gardens.



(j) Large colony bat box on Scots pine in north-eastern edge of Gardens.



(k) Potential roost features in ash tree in centre of the Fern Garden.



(l) Hard standing areas and glasshouses, with limited intrinsic biodiversity importance.



4 Discussion and Recommendations

Identifying Important Ecological Features

- 4.1 The sensitivity, value or importance of ecological features can be related to a wide range of ecosystem services that they can provide to the environment, people or wider society. These benefits can include the conservation of genetic diversity, people's enjoyment or understanding of biodiversity, or the health benefits of biodiversity. A summary of an approach to evaluating the importance of ecological features in Scotland can be found in the table provided in **Appendix C**. The Appendix shows how ecological importance can be ascertained using a combination of statutory measures (legally protected sites and species) and non-statutory but widely accepted measures, such as the presence of notable habitats and species listed in biodiversity lists of local Biodiversity Action Plans (LBAPs). Use can also be made of the Ratcliffe assessment criteria for the selection of sites with nature conservation value (Ratcliffe, 1977⁷) and certain protected species have their own frameworks for the assessment of the importance of on-site populations. All these criteria can vary at different geographical scales.

Ecological sensitivities at the Glasgow Botanic Gardens

- 4.2 A summary of the main generally areas of ecological sensitivity within the Site is provided in **Figure 4.1**.

Designated sites

- 4.3 Glasgow City has 95 SINCs within its administrative area. These are considered to be the best areas for wildlife within the city, and although not meeting the criteria for statutory designation (for example as a Site of Special Scientific Interest – SSSI) they are all notable for having one or more of ecological, scientific, recreational or educational value. SINCs such as the River Kelvin are also important wildlife corridors, and play a crucial role in maintaining functioning integrated habitat networks throughout the city.
- 4.4 The River Kelvin SINC is therefore not only important for the river itself, but its associated riparian woodland and grassland within the predominantly built up environment of the West End. It is also important for the protected species it supports, such as otter, kingfisher and various type of bat. These species are present in part due to the non-built nature of the SINC, and low levels of artificial night time lighting.
- 4.5 Care has therefore been taken to locate the Event in parts of the Site which are outwith the SINC. None of the designated area will be directly lit, and those locations on its periphery which will border ground through which there will be footfall associated with the Event represent the marginal buffer zones which regularly experience pedestrian disturbance. It

⁷ Ratcliffe, D.A. (1977) *A Nature Conservation Review: Volume 1: The Selection of Biological Sites of National Importance to Nature Conservation in Britain*, Cambridge University Press, Cambridge, UK.



is therefore considered highly unlikely that the Event will result in negative impacts on the SINC and this area can be discounted as an IEF in the context of this appraisal.

Habitats and flora

- 4.6 The habitat mosaic within the Site is predominantly composed of improved (amenity) grasslands, long-history planted woodland and trees, and ornamental shrubberies and herbaceous planting. Areas immediately outwith the Site, in particular to the north-east into the SINC (see above) have significant issues with invasive non-native species (INNS), including Japanese knotweed, Himalayan balsam and giant hogweed. However, these species are generally scarce within the Site. Based on the information sources inspected, there are no Nationally Scarce or Rare native species within the Site which would need special attention during the Event.
- 4.7 Some infrastructure for the Event will however be located in and amongst non-hard standing habitats, including props, cabling, lights, speakers and staging, and specific sections of the Event route will result in pedestrian access over existing lawns. Disturbance could result in localised soil compaction or erosion, or direct damage to ground vegetation or shrubs/scrub. Vegetation and soils will be less resilient to disturbance during and after rainfall. To this end, habitats should be considered to be IEFs needing consideration.

Trees

- 4.8 The Glasgow Botanic Gardens are well known for their mature tree resource, and the lighting of some of these trees forms a part of the aesthetics of the Event. However, whilst the lighting or use of sound in the vicinity of a tree is unlikely to harm it *per se*, BS5837:2012 requires consideration of other aspects of trees, such as canopy spread and root protection zones (RPZs). Trees that have taken many decades to grow to a significant size, can be unwittingly damaged through misjudged movement of plant, or compaction of soil in RPZs. Younger trees are less resistant to damage, as relatively small magnitude events can result in significant damage or death. There is a risk that branches or stems of trees may be damaged during the installation and subsequent removal of in-canopy lighting, and root plates damaged through repeated trafficking of personnel, or the temporary storage or equipment.

Bats

- 4.9 The precise nature of the bat population in the Botanic Gardens appears not to have been quantified via a static detector survey. Even if not resident in roosts, at least two species of pipistrelle (common and soprano) have been recorded foraging within the Gardens, as well as Daubenton's bat closer to the River Kelvin. A colony bat box is located within the Site, but no formal monitoring data was available for this. Bats should therefore be considered a sensitivity in the context of this appraisal.

Relevant legislation

- 4.10 All British bats are EPS, protected in Scotland by the Conservation (Natural Habitats &c.) Regulations (1994) (as translated into domestic legislation post-Brexit) and the Wildlife and Countryside Act (1981, as amended). This legislation makes it an offence to capture, harass, injure or kill a bat; obstruct access to, damage or destroy a breeding or other resting



place of a bat; disturb bats in such a way as is likely to affect their distribution or abundance, or disturb bats in such a way as is likely to impair their ability to survive or breed. Each of these actions is considered to be an offence whether the action is deliberate or reckless, except in the case of damaging or destroying a breeding site or resting place which is a strict liability offence. A licence is required for all developments which will affect areas known to contain bat roosts.

- 4.11 A bat roost is defined as any structure or place which is used for shelter or protection by bats, irrespective of whether or not bats are resident. Buildings and trees may be used by bats for a number of different purposes throughout the year including resting, sleeping, breeding, raising young and hibernating. Roost use depends on bat age, sex, condition and species as well as the external factors of season and weather conditions. A roost used during one season is therefore protected throughout the year whether or not bats are actually present at the time of inspection, and any proposed works that may result in disturbance to bats, or loss, obstruction of or damage to a roost are licensable.

Habitat requirements

- 4.12 Different bat species have different habitat requirements at different times of year. Classic foraging and commuting habitat requires connected networks of invertebrate-rich open greenspace, preferably unlit and with water sources close by for drinking. However, some species (see below) successfully persist in built up areas where these features are scarce. Breeding roost locations need to have sufficient space for a number of female bats (10-1000s) to gather and birth/bring up their young. Non-breeding roosts used by males (usually less than 10 bats, often singletons), as well as opportunistically used or transient roosts, can be much smaller features. Many bats have adapted to roosting in the built environment, preferring crevices in stonework or under tiles/slates; and others in open loft spaces. Equally, many species are still found in tree roosts, although often in smaller numbers than those found in roosts in buildings. It is not possible therefore to be highly prescriptive about bat habitat requirements, although the conventions provided by the Bat Conservation Trust⁸ for the assessment of habitats for bats provide a useful framework (see **Table 4.1**). Using these criteria, the Site would be considered to represent **High** suitability foraging/commuting habitat for bats, and **Moderate** suitability for roosting.
- 4.13 The tree resource within the Site offered surprisingly few PRFs for bats, outwith the dedicated bat box. This was likely to be because the status of the Site as a well-used public space and curated garden means that potential rot or broken tree features which would normally be utilised by tree-roosting bats need in this instance to be removed or managed for health and safety reasons.

⁸ Collins, J. (2016) *Bat Surveys: Good Practice Guidelines, 3rd Edition*. Bat Conservation Trust.



Table 4.1: Categories of habitat suitability for bats (after Collins, 2016)

Suitability	Description of roosting habitats	Description of commuting and foraging habitats
Negligible	Negligible roosting features likely to be used by roosting bats.	Negligible habitat features likely to be used by commuting or foraging bats.
Low	<p>A structure with one or more potential roost sites that could be used by individual bats opportunistically. However, these potential roost sites do not provide enough space, shelter, protection, appropriate conditions and/or suitable surrounding habitat to be used on a regular basis by larger numbers of bats (i.e., unlikely to be suitable for maternity or hibernation).</p> <p>A tree of sufficient size and age to contain potential roost features, but with none seen from the ground, or the features seen have only very limited roosting potential.</p>	<p>Habitat that could be used by small numbers of commuting bats such as a gappy hedgerow or unvegetated stream, but is isolated i.e., not well connected to the surrounding landscape by other habitat.</p> <p>Suitable, but isolated habitat that could be used by small numbers of foraging bats such as a lone tree (not in a parkland situation) or a patch of scrub</p>
Moderate	A structure or tree with one or more potential roost sites that could be used by bats, due to its size, shelter, protection, conditions and surrounding habitat, but unlikely to support a roost of high conservation status (with respect to roost type only – the assessments in this table are made irrespective of species conservation status, which is established after presence is confirmed).	<p>Continuous habitat connected to the wider landscape that could be used by bats for commuting, such as lines of trees and scrub, or linked back gardens.</p> <p>Habitat that is connected to the wider landscape that could be used by bats for foraging, such as trees, scrub, grassland or water.</p>
High	A structure or tree with one or more potential roost site(s) that is/are obviously suitable for use by larger numbers of bats on a more regular basis and potentially for longer periods of time due to its/their size, shelter, protection, conditions and surrounding habitat.	<p>Continuous, high-quality habitat that is well connected to the wider landscape which is likely to be used regularly by commuting bats, such as river valleys, streams, hedgerows, lines of trees and woodland edges.</p> <p>High-quality habitat that is well-connected to the wider landscape and which is likely to be used regularly by foraging bats, such as broad-leaved woodland, tree-lined watercourses and grazed parkland.</p> <p>Site is close to and connected to known roosts.</p>



Potential impacts on bats – lighting

- 4.14 Bats are nocturnal animals and therefore tend not to be active during the day. This is primarily thought to be a predation avoidance strategy, as well as being related to niche availability and an adaptive preference for foraging on insects that are active at night.
- 4.15 Illuminating roost sites is generally considered to be “disturbance” in the context of the current legislation protecting bats in Scotland, as doing so can cause bats to desert a roost or potentially become entombed. If not dissuaded from using the roost, lighting a roost exit point can delay emergence times, thereby decreasing the available time for foraging.
- 4.16 With respect to foraging and commuting, the relationship between bat behaviour and lighting is more complex. Many night-flying insects on which bats feed are attracted to light sources, in particular those with an ultraviolet component or a high blue spectral content. Fast-flying species such as pipistrelle bats can therefore congregate around these types of white light sources, hawking the insects attracted to the lights. Being fast-flying, these bats trade off being conspicuous with predator avoidance and the hunting benefits of these areas. In contrast, slower-flying broad-winged bat species, such as Daubenton’s bat avoid commuting or foraging in areas lit in these ways, being more vulnerable to predation. Consequently they are at a foraging disadvantage in lit environments which can then affect fitness and breeding success. A single light source in an otherwise unlit environment can therefore create a vacuum effect which benefits the faster flying species over the broad-winged species, the latter often being species of particular conservation concern. It has also been shown that for some species (which may not be relevant in the context of the Site under consideration here), dense tree cover above the height of street lighting without UV components (e.g. LEDs) provided some mitigation for lighting situated below the canopy.
- 4.17 As indicated above, the spectrum of the light is also a consideration when determining potential impacts on bats. The likely harmful impacts on blue-spectrum lighting has been known for a number of years, but other aspects of the colour spectrum are now becoming better understood. Research in the Netherlands has shown that slower-flying species such as *Myotis* bats avoid white and green spectrum light sources, but that faster flying species such as pipistrelles were more abundant in these conditions⁹. However, both groups of species were found to be equally abundant where red spectrum lighting was utilised, consisting of light above 600 nm and with an RA value of 60. The same effect has been observed in Daubenton’s bats in Scotland¹⁰.

Potential impacts on bats – noise and vibration

- 4.18 The BCT states that noise or vibration in the vicinity of a bat roost may disturb bats and therefore should be avoided¹¹. However, empirical evidence for this is lacking, in part

⁹ Barré, K., Kerbiriou, C., Ing, R., Bas, Y., Azam, C., Le Viol, I. & Spoelstra, K. (2021). Bats seek refuge in cluttered environment when exposed to white and red lights at night. *Movement Ecology*. 9. 10.1186/s40462-020-00238-2.

¹⁰ Gemma Grossart and Neil Middleton. The impact of different lighting colours on the foraging activity of Daubenton’s bat, *Myotis daubentonii*, at a site in Midlothian, Scotland. *British Island Bats Volume 2* https://cdn.bats.org.uk/uploads/pdf/Resources/Bat-Groups/Accessing-journals/BritishIslandsBats_VolTwo_2021.pdf?v=1625915928 Accessed September 2023.

¹¹ [https://www.bats.org.uk/advice/im-concerned-about-bats/events-and-bats#:~:text=Excessive%20noise%20and%20vibration%20\(such,to%20help%20us%20protect%20bats](https://www.bats.org.uk/advice/im-concerned-about-bats/events-and-bats#:~:text=Excessive%20noise%20and%20vibration%20(such,to%20help%20us%20protect%20bats). Accessed September 2023.



because experimentally it would require licensing and could have negative conservation consequences. However, a PhD looking at these issues is due to commence at the University of the West of England in October this year¹². It is recognised that many bat roosts do occur in very noisy environments (e.g. church belfries, or electrical substations), where presumably the benefits of the place of shelter outweigh the drawbacks of noise. However, the effect of the introduction of noise into otherwise quiet environments is not well understood; to date the precautionary principle has been adopted and this type of disturbance is generally avoided wherever possible.

- 4.19 There has been a larger body of work investigating the effects of noise on foraging and commuting bats, and it has generally been shown that bats avoid environments with regular noise, such as busy roads, and/or have lower foraging success in these areas¹³. This may be because of acoustic conflict with echolocation techniques, or because bats become distracted by the noise source. However, autocorrelation with other factors such as light pollution and decreases in air quality mean that these relationship can be quite complex.

Hedgehog

Relevant policy and legislation

- 4.20 Hedgehogs are native and widespread across the UK. They require a mixture of habitats for foraging, nesting and mating, and a connected landscape through which they can move to reach their required habitats. Hedgehogs are currently rapidly declining, with at least a third lost from Britain since 2000 (State of Britain's Hedgehogs Report, 2022¹⁴). They appear to be faring better in urban areas rather than rural locations, with urban populations potentially improving. They are one of the few animals well adapted to surviving alongside humans, actually preferring gardens and amenity grassland habitats, and therefore, enhancing and connecting urban and suburban areas is key to enabling this species to survive.
- 4.21 Hedgehog is listed on the Scottish Biodiversity List (SBL) as a species of principal importance in Scotland, for which there is a watching brief on its conservation status. It receives limited protection under Section 6 of the Wildlife and Countryside Act (1981, as amended), namely that it is illegal to kill or capture hedgehog using certain methods. They are also protected in Britain under the Wild Mammals Protection Act (1996), prohibiting cruelty and mistreatment.

Potential impacts on hedgehogs

- 4.22 Hedgehogs are relatively mobile animals that tend to move away from disturbance sources. However, the timing of the Event is such that it will occur at a time of year when these animals are seeking or have sought shelter for a winter hibernation. The peripheries of the Site, as well as areas of stacked brash and leaf and compost heaps, would provide good

¹² <https://www.uwe.ac.uk/research/postgraduate-research-study/how-to-apply/studentship-opportunities/the-impacts-of-anthropogenic-noise-on-bats> Accessed September 2023.

¹³ Finch, D., Schofield, H. and Mathews, F. (2020) Traffic noise playback reduces the activity and feeding behaviour of free-living bats. *Environmental Pollution*, 263.

¹⁴ Wembridge, D., Johnson, G. Al-Fulaij, N. and Langton, S. (2022) The State of Britain's Hedgehogs 2022. Online publication available at <https://www.britishhedgehogs.org.uk/> Accessed September 2023.



locations for hedgehogs to shelter. Although unlikely to be significantly bothered by sound or light at this time, physical disturbance of hibernation sites could seriously affect these animal's subsequent survival through the winter. In addition to disturbance of places of shelter, cabling, barriers and other potential sources of entanglement at ground level could present hazards to hedgehogs moving around the Site. It should be noted that similar impacts and effects would also be relevant to **common amphibians**.

Birds

Relevant legislation

- 4.23 All wild birds in the UK, their nests and their eggs are protected by the Wildlife and Countryside Act 1981, (as amended). Under this legislation it is an offence, with certain exceptions, to:
- intentionally or recklessly kill, injure or take any wild bird;
 - intentionally or recklessly take, damage or destroy the nest of any wild birds while it is in use or being built;
 - intentionally or recklessly take or destroy the egg of any wild bird.
- 4.24 A number of bird species have been highlighted as priorities for bird conservation in the UK (Stanbury *et al.*, 2021¹⁵), and allocated Red or Amber status. All other species not of conservation concern are considered to be Green-listed. Certain bird species also have additional protection under the terms of the EC Birds Directive, and may be local priorities for conservation action via local BAPs.

Habitat requirements

- 4.25 Given the timing of the Event, disturbance or destruction of nest sites is not a consideration, as set up, operation and dismantling the Event will all occur outwith the key nesting bird season. Leaf-drop will be in progress, and some deciduous trees and bushes will likely to have lost the majority of their leaves, reducing their cover value for birds. However, more dense areas of scrub and woodland on the edges of the Site, in particular those with evergreen species, could continue to provide some cover for birds throughout the autumn and winter months, although this is unlikely to include bird species considered to be of conservation concern. Nevertheless, props and cabling in habitats utilised by birds during the autumn and winter months could result in undesirable disturbance or entanglement.

Potential impacts on birds – lighting

- 4.26 The impacts of artificial light at night (often abbreviated to ALAN in academic literature) on birds is fairly well researched, including both point-sources (e.g. street lighting) and skyglow as a result of broader-scale light pollution in some urban environments. Song birds have

¹⁵ Stanbury, A., Eaton, M., Aebischer, N., Balmer, D., Brown, A., Douse, A., Lindley, P., McCulloch, N., Noble, D., and Win I. (2021). The status of our bird populations: the fifth Birds of Conservation Concern in the United Kingdom, Channel Islands and Isle of Man and second IUCN Red List assessment of extinction risk for Great Britain. *British Birds* 114: 723-747.



been found to alter their patterns of song behaviour in response to elevated light levels^{16,17}, and there have been high profile cases of mortality caused by collision with event or structure lighting, such as ceilometers or the stationary “search beams” used to light the September 11th monument in New York^{18,19}. However, research to date has generally focussed on long-term implications of increased background levels of lighting, on changed response in the dawn chorus, and with respect to migratory bird collisions relating to search beams and other night-sky lighting.

- 4.27 None of these situations are directly transferable to the Event under consideration here. Lighting impacts on birds as a result of GlasGLOW will be, comparatively speaking, short-term, time-limited and in a location and at a time of year not associated with the movement of flocks of migratory birds or species of conservation concern. Birds residing around the south, east and western parts of the Site are likely to have behaviour patterns that are influenced by close proximity to artificially lit streets and vehicle lights. The Event is timed within the hours of darkness, and this is not a time when birds would typically be active within the parts of the gardens which will be utilised by the Event. Nocturnal species such as tawny owl will be more likely to hunt along the less disturbed, darker areas where longer grass habitats will have a high small mammal population. Impacts on hunting success are therefore unlikely to occur.

Potential impacts on birds – noise and vibration

- 4.28 Different bird species have different tolerance levels for a response to noise disturbance, and a distinction is usually drawn between the volume and distance from the noise source sufficient to put a bird on “alert”, and that which causes movement away. The Botanic Gardens is a well used public space, and birds which choose to utilise the more heavily frequented areas for foraging will have become accustomed to the presence of humans, dogs and various other noise sources. Those which reside in the more peripheral areas of the Site will be less tolerant of noise, but in all cases these are not species which would be expected to be active at night.
- 4.29 Notwithstanding the above, a precautionary approach to the use of music and the placing of noise generating plant should be adopted during the design of the Event.

Nesting birds

- 4.30 Although the Event will take place well outside the core bird breeding season woodpigeon is present on the Site and it is not uncommon for this species to have an extended breeding season into October, sometimes with nestlings into November. Woodpigeon are very tolerant of human presence in urban settings, and frequently nest in gardens and close to buildings and footpaths. Therefore disturbance is not likely to be a major issue if this species is nesting. Nevertheless, the legislation relating to nesting birds (see above) would

¹⁶ Da Silva, A., Samplonius, J.M., Schlicht, E., Valcu, M. and Kempenaers, B. (2014) Artificial night lighting rather than traffic noise affects the daily timing of dawn and dusk singing in common European songbirds. *Behavioural Ecology* **25**(5), pp1037-1047.

¹⁷ Dickerson, A.L., Hall, M.I. and Jones, T.M. (2022) The effect of natural and artificial light at night on nocturnal song in the diurnal willie wagtail. *Science of the Total Environment*, **808**, 151986.

¹⁸ Van Doren, B.M., Horton, K.G., Dokter, A.M., Klinck, H., Elbin, S.B., Farnsworth, A. (2017) High-intensity urban light installation dramatically alters nocturnal bird migration. *Proceedings of the National Academy of Science*, **114**, pp.11175–80.

¹⁹ <https://www.nytimes.com/2019/09/09/nyregion/911-tribute-birds.html> Accessed September 2023



still be relevant and checks for the presence of active nests at locations where key Event infrastructure is to be erected would be recommended (see below).

Invertebrates



- 4.31 Although many invertebrates found in the Botanic Gardens are not nocturnal, and are associated with soil habitats and vegetation, a large proportion of its known invertebrate assemblage would be expected to be night-flying, including moths and other insects. As with birds and bats, much of the available research into the effects of night lighting on this group is focussed on long-term trends associated with ALAN in urban or street-lit semi-rural areas. There is little information on whether or not significant impacts on survival or population numbers is affected by shorter periods of elevated lighting. Generally however, recent research has shown that moths in particular spend less time feeding in lit environments²⁰, although the effects are dependent on the intensity and signal colour of the lighting in question²¹.
- 4.32 The timing of the Event, in late October and early November, is not a key time for night flying invertebrates, when night time air temperatures are falling and the first ground frosts occur. Ground- and soil-dwelling species will be seeking safe locations in which to over-winter. Although some species will certainly still be active, it is unlikely that the Event will have any significant effects on these taxa if the sensitivities associated with other nocturnal species are given appropriate consideration.

²⁰ van Langevelde, F., van Grunsven, R. H. A., Veenendall, E. and Fijen, T. P. M (2017) Artificial night lighting inhibits feeding in moths. *Biol. Lett.* **13**: 20160874. <http://dx.doi.org/10.1098/rsbl.2016.0874>

²¹ Briolat, E.S., Gaston, K.J., Bennie, J., Rosenfeld, E.J & Troscianko, J. (2021) Artificial nighttime lighting impacts visual ecology links between flowers, pollinators and predators. *Nature Communications*, **12**, 4163, <https://doi.org/10.1038/s41467-021-24394-0> | www.nature.com/naturecommunications



General Areas of Ecological Sensitivity

-  Site boundary
-  Ecological sensitivity

- 1: Colony bat box.
- 2: Potential bat roost features (PRFs) in trees.
- 3: PRFs in trees.
- 4: Buildings of traditional construction including slate roofs that have PRFs.
- 5: Buildings of traditional construction including slate roofs that have PRFs.
- 6: Buildings of traditional construction including slate roofs that have PRFs.
- 7: Buildings of traditional construction including slate roofs that have PRFs.
- 8: Derelict buildings with PRFs.
- 9: PRFs in derelict station, including hibernation potential.
- 10: Less intensively managed grassland areas with higher species diversity e.g. common spotted orchid.
- 11: Compost heaps - shelter for hedgehog and common amphibian species.
- 12: Base of dense scrub habitats - suitability for hedgehog and birds, plus some plant species interest e.g. broad-leaved helleborine.
- 13: Species-rich grassland.
- 14: Compost heap and tree-mounted bird box.
- 15: PRFs in adjacent properties.

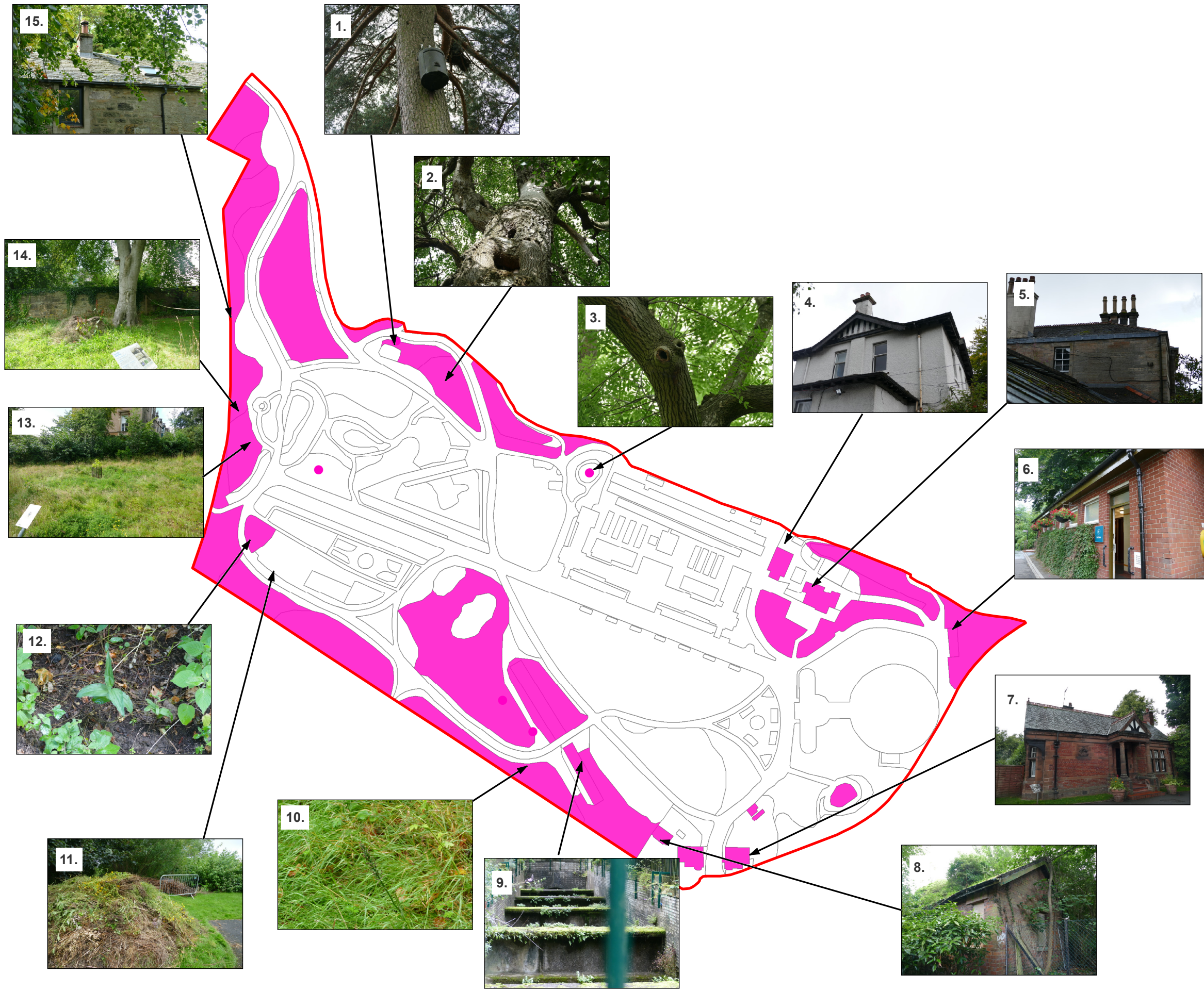



Figure 4.1

Map Scale @ A3: 1:2,000



Surveyed by: AEL	
Survey date: August 2023	
Drawn by: RAH	
Checked by: SH	
Status: Final	

Recommendations for key IEFs

Habitats and trees

Design phase

- 4.33 The following considerations relating to habitats and trees should be made during the design of the Event:
- the Event route must be planned so as to keep footfall within areas of hard standing. Where this is not possible, artificial surfaces should be utilised in key areas where soil compaction and/or erosion is likely;
 - sufficient provision must be made for fencing and/or barriers to prevent peripheral disturbance of habitats adjacent to the path network, including that arising from “short-cutting” or creating desire lines;
 - avoidance of Event infrastructure within habitats considered to be of greater biodiversity importance, including ground within the River Kelvin SINC, species-rich neutral grassland and under scrub habitats containing notable flora;
 - where Event features are proposed within longer grass (non-lawn) areas, formal marking of routes for installation and maintenance/operation should be pre-planned and marked on maps and on the ground, to ensure peripheral disturbance is minimised;
 - use of pyrotechnics in the north of the Site must be at sufficient distance from tree canopies so as to avoid scorching;
 - event infrastructure must be kept outwith the root protection zone of trees;
 - calculation of likely worst case scenario for habitat restoration, based on experience gained in previous years, to ensure that sufficient materials are pre-ordered and available for remediation works during close-out.

Event set up

- 4.34 During the setting out phase of the Event, the planned items described above from the Design Phase should be implemented in full. In particular, due attention must be paid to:
- **briefing Site personnel regarding the biodiversity protection measures which will be adopted for the Event, during set-up, operation and close-out;**
 - the need to keep tree root protection zones clear of plant and equipment, including the temporary storage of materials;
 - ensuring that the planned fencing off of non-hard standing habitats is implemented during set-up, so that personnel, vehicles and equipment are restricted to hard standing areas wherever practicable, to avoid peripheral disturbance of edge habitats;
 - ensuring cabling and other “hidden” Event infrastructure does not disturb undergrowth habitats with notable flora, brush or compost heaps;
 - discreet marking of maintenance/set up routes through longer grassland areas to prevent widespread disturbance.



Event operation

- 4.35 If the Design and Set-up phases of the Event have been executed as described above, there should be few, if any, habitat and tree concerns during the actual Event. The main actions to note would be:
- adhering to any set routes for maintenance or feature operation which have been determined in order to minimise peripheral disturbance of habitats;
 - prohibition of maintenance plant within root protection zones;
 - any notable issues involving habitats and trees should be noted in a Biodiversity Register. The Register should include details regarding issue location, date and time, personnel involved, likely cause(s) and adopted solution.

Event close-out

- 4.36 After the close of the Event, all cabling, staging, props and other infrastructure should be removed using the same precautionary measures as outlined above for set up.
- 4.37 All potential areas of habitat or tree sensitivity should be reinspected and the pre-agreed strategies for restoration implemented as planned.
- 4.38 The information contained within the Biodiversity Register should be reviewed and then filed with the Health and Safety documentation for the Event, for reference in future years.

Bats

Design phase

- 4.39 The majority of potential impacts on bats can be designed out during the Design Phase of the event. This would include:
- no new direct lighting of potential roost features, including the upper floors and roofs of traditionally constructed buildings on the Site, the underground railway station, the existing bat box and/or any trees identified by a Suitably Qualified Ecologist (SQE) as containing PRFs;
 - LED luminaires should be used where possible due to their sharp cut-off, lower intensity, good colour rendition and dimming capability (if relevant);
 - lights with blue components must not be used to light trees and/or key potential bat foraging or commuting features, using instead warm white sources (2700 Kelvin or lower) and peak wavelengths higher than 550nm. This is to avoid the component of light most disturbing to bats;
 - no direct sound at the location where the Event route crosses the railway tunnels;
 - no sound or lighting along the western boundary of the Site;
 - no sound or lighting at the pond in the east of the Site.

Event set up

- 4.40 During Event set-up, the above Design Phase actions will need to be implemented in full. In addition, the following measures will be required with respect to bats:



- where there is an intention to light trees contain PRFs or where the entirety of the tree cannot be viewed from ground level, PRFs should be inspected endoscopically at height by a Licensed Bat Worker (LBW) prior to the installation of the lighting. If evidence of bat occupancy is found during that inspection then it will not be possible to light that tree unless a licence is in place.

Event operation

- 4.41 If all measures described under the Design and Set-up stages are implemented in full, there should not be any additional measures required for bats during the actual operation of the Event.
- 4.42 However, any notable issues involving bats which occur during the Event should be noted in the Biodiversity Register (see above). The Register should include details regarding issue location, date and time, personnel involved, likely cause(s) and adopted solution.

Event close-out

- 4.43 There are no additional considerations for bats during the dismantling phase. However, any entries in the Biodiversity Register that relate to bats should be reviewed, to determine any actions needed in future years.

Hedgehog

Design phase

- 4.44 The majority of potential impacts on hedgehog can be designed out during the Design Phase of the event. This would include:
- planning of cable routes to avoid disturbing areas of scrub or brash;
 - no netting or other sources of entanglement to be placed within vegetation (trees or shrubs) which could be utilised by hedgehog for shelter.
- 4.45 It should be noted that these measures for hedgehog would also help to avoid impacts on **common amphibians**.

Event set up

- 4.46 During the setting out phase of the Event, the planned items described above from the Design Phase should be implemented in full.
- 4.47 If a hibernating hedgehog is discovered then the SSPCA should be contacted for advice.

Event operation

- 4.48 If all measures described under the Design and Set-up stages are implemented in full, there should not be any additional measures required for bats during the actual operation of the Event.
- 4.49 However, any notable issues involving hedgehogs which occur during the Event should be noted in the Biodiversity Register (see above). The Register should include details



regarding issue location, date and time, personnel involved, likely cause(s) and adopted solution.

Event close-out

- 4.50 There are no additional considerations for hedgehog during close-out. However, any entries in the Biodiversity Register that relate to birds should be reviewed, to determine any actions needed in future years.

Birds

Design phase

- 4.51 The majority of potential impacts on birds can be designed out during the Design Phase of the event. This would include:
- no sound or lighting along the western or northern boundaries of the Site;
 - use of mobile search beams (not static) and *potentially* the switching off of these for 10 min periods within each hour²²;
 - no netting or other sources of entanglement to be placed within vegetation (trees or shrubs) which could be utilised by birds for shelter.

Event set up

- 4.52 During the setting out phase of the Event, the planned items described above from the Design Phase should be implemented in full. In addition, locations where lighting will be installed within trees or shrubs will be checked in advance by a Suitable Qualified Ecologist to discount the presence of nesting woodpigeon.

Event operation

- 4.53 If all measures described under the Design and Set-up stages are implemented in full, there should not be any additional measures required for birds during the actual operation of the Event.
- 4.54 However, any notable issues involving birds which occur during the Event should be noted in the Biodiversity Register (see above). The Register should include details regarding issue location, date and time, personnel involved, likely cause(s) and adopted solution.

Event close-out

- 4.55 There are no additional considerations for birds during Event close-out. However, any entries in the Biodiversity Register that relate to birds should be reviewed, to determine any actions needed in future years.

²² A 20 min break technique is utilised at the September 11th monument in New York to “release” birds trapped by the light. It should be acknowledged however that the bird collision situation associated with the 9/11 monument is by no means transferable to the Event, and any such mitigation would be precautionary rather than essential.



Opportunities for biodiversity

- 4.56 The Site contains numerous opportunities for enhancing biodiversity despite its urban context. Such enhancements can be provided without creating new constraints for future users of the Site including event like GlasGLOW, through their careful siting and following consultation with other stakeholders. GCC has control of a wider area than that delimited by the Site boundary utilised for the Event, and therefore the potential area in which enhancement features could be deployed extends outwith the boundaries shown in this report.
- 4.57 Enhancement measures which may be appropriate could include:
- provision of dedicated hedgehog homes. These should be located along boundary features, in long grass and/or scrub²³;
 - provision of tree mounted bat boxes. These would need to be erected on trees where there is a low likelihood of arboricultural works being needed, in unlit areas and where there is clear flights accessed. A range of box types could be considered, including those suited to crevice roosting species such as pipistrelles²⁴, as well as cavity boxes suitable for *Myotis* species²⁵. The aim should be to erect boxes on a range of potential aspects to provide roosting options in all weathers/temperatures. There may be more suitable locations for such boxes outwith the Site boundary used for this report;
 - provision of bird boxes on trees²⁶ around the periphery of the Site and/or on appropriate features on the buildings²⁷ within the Site.
- 4.58 Consultation with stakeholders may reveal other activities which would assist with the conservation or management of biodiversity on the Site. This could include support for the formal monitoring of wildlife enhancement features, potentially in collaboration with personnel at the University of Glasgow.

²³ <https://www.hedgehoghighway.co.uk/shop/> Other similar products are available. Advice should be sought from an SQE.

²⁴ <https://www.greenwoodsecohabitats.co.uk/shop> Other similar products are available. Advice should be sought from an SQE.

²⁵ <https://www.nhbs.com/2f-schwegler-bat-box-with-double-front-panel> Other similar products are available. Advice should be sought from an SQE.

²⁶ <https://www.nhbs.com/1b-schwegler-nest-box> Other similar products are available. Advice should be sought from an SQE.

²⁷ <https://www.nhbs.com/vivara-pro-woodstone-house-martin-nest> Other similar products are available. Advice should be sought from an SQE.



5 Summary and Conclusions

- 5.1 In August 2023, a review was undertaken of the proposed content of a sound and light event to be held in the Glasgow Botanic Gardens, known as GlasGLOW. An appraisal was made of the likely ecological sensitivity in the context of the Event, and recommendations made for how these impacts and their resulting effects could first be avoided, and then mitigated or compensated. Measures to be implemented have been described for each of the design, set-up, operation and close-out phases of the Event, along with suggestions for opportunities for providing wildlife enhancements and biodiversity benefits within or close to the Gardens.
- 5.2 Although in the absence of complex before-and-after comparison studies it cannot be stated conclusively that these types of event will have zero effect on wildlife, adhering to the best practice measures outlined here will ensure compliance with both current best practice and legislation. A short review of the measures implemented will be carried out following the close-out of the 2023 Event, and this information will be used to inform approaches to be taken to similar events in future years.
- 5.3 The findings and recommendations made in this report will remain valid for a period of 18-24 months, after which time a review will be necessary.



Appendix A

List of Initialisms, Acronyms and Abbreviations Used in this Report



Short form	Full terminology
AEL	Applied Ecology Ltd
AWI	Ancient Woodland Inventory
BCT	Bat Conservation Trust
BoCC	Birds of Conservation Concern
BRS	Bat Roost Suitability
BRS	Biological Records Centre
CIEEM	Chartered Institute of Ecology and Environmental Management
DAFOR	Dominant, abundant, frequent, occasional or rare
EclA	Ecological Impact Assessment
EPS	European Protected Species
EUNIS	European Nature Information System
GIS	Geographical Information System
GMRC	Glasgow Museums Resource Centre
GPS	Global Positioning System
IEF	Important Ecological Feature
ILP	Institute of Lighting Professionals
INNS	Invasive Non-Native Species
LBAP	Local Biodiversity Action Plan
LDP	Local Development Plan
MMU	Minimum Mappable Unit
PEA	Preliminary Ecological Appraisal
PRF	Potential Roost Feature
RPZ	Roost Protection Zone
SBL	Scottish Biodiversity List
SINC	Site of Importance for Nature Conservation
SQE	Suitable Qualified Ecologist
SSSI	Site of Special Scientific Interest
SWT	Scottish Wildlife Trust
WANE Act	Wildlife and Natural Environment (Scotland) Act (2011)



Appendix B

Habitat Survey Target Notes



Target note	Description
1	Toilet block. Red brick construction with slate roof and timber soffits. Soffits appear to be entire, and fairly cobwebby, but access around the rear of the building was impeded for clear view of the roof. Precautionarily allocated bat roosting suitability to this structure, although front façade appears to be well lit, and cluttered environment on other aspects for clear flight access.
2	Small pond feature. Could not be accessed directly as fenced off and personnel were actively working in this area. Surrounded by a variety of ornamental beds and rock features.
3	Lodges at main entrance to gardens. Both of red sandstone construction with traditional slate roofs, clay ridge tiles and chimneys. Slipped and missing tiles, and wasps entering nest location on western lodge. Both buildings considered to have bat roosting suitability.
4	Planted mature lime trees, with abundant rhododendron in the shrub layer. Occasional holly. Single plant of Japanese knotweed seen.
5	Former Botanic Gardens train station, with associated tunnels. Bat roosting suitability. Potential for hibernation suitability further into tunnel system.
6	Area of taller neutral grassland as a result of relaxation of mowing. Dominated by Yorkshire fog, but with abundant perennial rye-grass and common bent. A number of herbs were occasional throughout this area, including common hogweed, creeping buttercup, meadow buttercup, ribwort plantain, common ragwort, common bird's-foot-trefoil, common hawkweed, perfoliate St John's-wort and a few spikes of common spotted orchid.
7	Unmown neutral grassland, with saplings of <i>Populus</i> sp.. Dominated by Yorkshire fog, with abundant red fescue. Common cat's-ear was abundant and fox-and-cubs occasional, along with common ragwort, white clover, common bistort and creeping buttercup. Small rowan trees also in this area.
8	Scrubby undergrowth, with frequent broad-leaved helleborine.
9	Strip of native scrub forming part of the Site boundary. Dominated by alder, ash, a species of <i>Ribes</i> , birches, <i>Prunus</i> sp., horse chestnut and great willowherb.
10	Species-rich neutral grassland, seemingly managed for wildlife. Did not cross the fenceline, but from perimeter estimated Yorkshire fog to be abundant, cock's-foot, crested dog's-tail and Timothy occasional, and common bent frequent. Wide range of herbs were conspicuous, including fox-and-cubs, common knapweed, yellow rattle, tufted vetch, white clover, common bird's-foot-trefoil, red clover, common cat's-ear, curled dock, ribwort plantain, meadow buttercup and germander speedwell. Birch seedlings also noted.
11	Pile of turfs (potential hibernacula) and bird box.
12	Relatively species-poor area of taller grass where mowing regime has been relaxed.
13	Schwegler large colony bat box in Scots pine.
14	Large poplar with numerous good PRFs, although grey squirrel seem to be occupying a number of these. Lower level PRFs inspectable – no droppings seen.
15	Large ash tree in centre of fern garden. PRFs present in knotholes.
16	Garden Manager office – traditional construction with slate roof and lead flashing, with numerous PRFs visible. Existing security lighting affixed to first floor level.
17	Tea room buildings, also of traditional construction and likely to represent PRFs.



Appendix C

Defining Important Ecological Features



Level of sensitivity or value	Examples (not exhaustive)
International (including European)	<p>An internationally designated site or candidate site (SPA²⁸, proposed SPA (pSPA)²⁹, Special Area of Conservation (SAC)³⁰, candidate SAC (cSAC)³¹, pSAC³², Ramsar site³³, Biogenetic Reserve³⁴) or an area which NatureScot has determined meets the published selection criteria for such designations, irrespective of whether or not it has yet been notified.</p> <p>A viable area of a habitat type listed in Annex 1 of the Habitats Directive, or smaller areas of such habitat which are essential to maintain the viability of that ecological resource.</p> <p>A regularly occurring population representing >1 % of the European resource of a species listed in Schedules 2 or 4 of the Habitat Regulations (as amended post-Brexit).</p>
National	<p>A nationally designated site (Site of Special Scientific Interest (SSSI)³⁵, National Nature Reserve (NNR)³⁶, Marine Nature Reserve) or a discrete area which NatureScot has determined meets the published selection criteria for national designation irrespective of whether or not it has yet been notified.</p> <p>A viable area of a priority habitat identified in the former UK BAP or Scottish Biodiversity List, or smaller areas of such habitat which are essential to maintain the viability of that ecological resource.</p> <p>A regularly occurring population representing >1 % of the national population of a nationally important species, i.e., a priority species listed in the former UK BAP or Scottish Biodiversity List and/or Schedules 1, 5 (S9 (1, 4a, 4b)) or 8 of the Wildlife and Countryside Act, or Schedules 2 or 4 of the Habitat Regulations (as amended post-Brexit).</p> <p>A regularly occurring and viable population of a UK Red Data Book species.</p>
Council/Regional	<p>Viable areas of key habitat identified in Council LBAP or Scottish Biodiversity List, or smaller areas of such habitats that are essential to maintain the viability of that ecological resource.</p> <p>Any regularly occurring, locally significant population of a species listed as being nationally scarce (occurring in 16-100 10 km squares in the UK) or in a relevant Council LBAP or Natural Heritage Zone profile on account of its rarity or localisation.</p> <p>Non-statutory designated wildlife sites including semi-natural ancient woodland greater than 0.25 ha.</p> <p>Networks of species-rich hedgerows.</p>
Local	<p>Locally important habitats or species such as:</p> <ul style="list-style-type: none"> - semi-natural ancient woodland smaller than 0.25 ha; - features that are scarce within the local area or which appreciably enrich the local habitat resource e.g. networks of hedgerow/ditches not considered to be species-rich; - small populations of notable species (e.g., SBL or LBAP species) regularly resident on or using the site.
Site	<p>Commonplace and widespread habitats or species which contribute to the functioning or value of the wider ecological landscape, such as:</p> <ul style="list-style-type: none"> - scrub, poor semi-improved grassland, coniferous plantation woodland, intensive arable farmland etc.; - common and widespread faunal species, or occasional individuals of more notable species such as SBL or LBAP species, either resident on or using the site.

²⁸ Special Protection Area classified under the EU Birds Directive for importance to birds.

²⁹ Potential Special Protection Area.

³⁰ Special Area of Conservation Area classified under the EU Habitats Directive for important habitat or non-bird species.

³¹ Candidate Special Area of Conservation.

³² Potential Special Area of Conservation.

³³ Wetland of international importance designated under the Ramsar Convention.

³⁴ Sites deemed representative examples of particular habitats in Europe.

³⁵ Site of Special Scientific Interest.

³⁶ National Nature Reserve.



Appendix D

Biodiversity Checklist for GlasGLOW



Checklist for biodiversity actions relevant to the Event

Feature to be considered	Design phase	Set-up	Operation	Close-out
Habitats				
Brief all personnel regarding biodiversity protection	●	●	●	●
Footfall in hard standing areas; provision of artificial surfaces	●	●	●	●
Provision of barriers	●	●	●	●
Exclusion of SINC/northern boundary	●	●	●	●
Exclusion of species-rich grassland areas	●	●	●	●
Exclusion of native scrub habitats	●	●	●	●
Plan/mark/use defined routes through taller grassland	●	●	●	●
Strategic placement of pyrotechnics	●	●		
Adhere to RPZs	●	●	●	●
Planning for/execution of habitat restoration				
Cabling must not disturb brush, compost heaps or undergrowth	●	●		●
Bats (and other nocturnal considerations)				
No new lighting of PRFs (structures and trees)	●	●		
Preferential use of LEDs	●			
No “white blue” lights in trees; < 2700 Kelvin; peak wavelengths > 500 nm	●			
No direct sound at railway tunnels	●	●	●	
No sound or new lighting along western and northern boundaries	●	●	●	
No sound or lighting at the pond	●	●	●	
LBW pre-check of PRFs in trees to be lit		●		
Hedgehog				
Cabling must not disturb brush, compost heaps or undergrowth	●	●		●
No netting or sources of entanglement	●			
Birds				
No sound or new lighting along western and northern boundaries	●	●	●	
Mobile search beams / 10 min rest breaks	●	●		
No netting or sources of entanglement	●			
Pre-checks for nesting woodpigeon		●		
General				
Biodiversity Register	●	●	●	●



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