

A417 Missing Link

Preliminary Environmental Information Report

Chapter 8 Biodiversity - Appendices

28 September 2020

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Preliminary Environmental Information Report

Appendix 8.1
Phase 1 Habitat Survey

28 September 2020

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1 Phase 1 habitat survey

1.1 Target notes

- 1.1.1 During the Phase 1 Habitat Survey between April and June 2017, features of potential significance regarding habitat and protected species were recorded as Target Notes as shown in the table below.

Target Notes

Target note number:	Notes
1.	<p>Calcareous grassland with scattered bramble scrub and scattered broadleaved trees; Lime <i>Tilia</i> species, Wild Cherry <i>Prunus Avuim</i>, Ash <i>Fraximus excelsior</i>, Hawthorn <i>Crataegus Monogyna</i>, Oak <i>Quercus robur</i>.</p> <p>Verge along the A417 – raised bank with semi-improved calcareous grassland Cowslip <i>Primula Veris</i>, Rock rose <i>Helianthemum nummularium</i>, Salad burnet <i>Sanguisorba minor</i>, Carnation Sedge <i>carex panicea</i>, Wooley thistle <i>circium eriophorum</i>, Common knapweed <i>Centtaurea nigra</i>, Common Spotted Orchid <i>Dactylorhiza fuchsia</i>.</p> <p>Excellent reptile habitat. Potential for notable botanical species.</p>
2.	<p>Plantation Broadleaved Woodland – semi mature planted trees and shrubs including Ash <i>Fraximus excelsior</i>, Hawthorn <i>Crataegus Monogyna</i>, Hazel <i>Corylus avellana</i> and Wild Cherry <i>Prunus Avuim</i>.</p> <p>Moderate dormouse potential. Moderate bat foraging habitat.</p>
3.	<p>Broadleaved woodland with mature Ash <i>Fraximus excelsior</i>, Birch <i>Betula pendula</i> and Grey Willow <i>Salix cinerea</i>, with an under story of Hawthorn <i>Crataegus Monogyna</i>, Hazel <i>Corylus avellana</i> and Sycamore <i>Acer pseudoplatanus</i>.</p> <p>Moderate dormouse potential and moderate bat foraging potential.</p>
4.	<p>Patches of Semi-improved Calcareous grassland along path with common knapweed, common spotted Orchid <i>Dactylorhiza fuchsia</i>, Perforate St Johns wort <i>Hypericum perforatum</i>, Cowslip <i>Primula Veris</i> and false morel <i>Gyromitre esculenta</i>.</p> <p>High potential reptile habitat.</p>
5.	<p>Semi Improved / rough Semi-improved calcareous grassland in field next to the Air Balloon pub including: Upright brome <i>Cytisus scoparius</i>, Cowslip <i>Primula Veris</i>, and Common knapweed <i>Centtaurea nigra</i>. The majority of the field is dominated by rough grasses, but areas are more diverse.</p> <p>Evidence of anthills found in the field suggests that the field is unmanaged.</p> <p>Small reed bed located in the northern end of the field with common reed <i>Phragmites australis</i> and common nettle <i>Urtica dioica</i>.</p> <p>The area has good reptile potential, along with good barn owl foraging habitat. Evidence of badger forging was also recorded.</p>
6.	<p>Air Balloon Pub</p> <p>The building consists of Cotswold stone wall with pitched roof with clay tiles. There are missing tiles on the roof and gaps in the mortar.</p> <p>Building has high bat potential.</p>
7.	<p>Mature Broadleaved woodland – secondary woodland</p> <p>Canopy with the following species present: Sycamore <i>Acer pseudoplatans</i>, Ash <i>Fraximus excelsior</i>, hornbeam <i>Carpinu betulus</i> and European larch <i>Larix europaea</i></p> <p>Understorey of Hawthorn <i>Crataegus Monogyna</i>, Elder <i>Sambucus nigra</i></p> <p>Field layer – wild garlic <i>Allium oleraceum</i>, Lords and ladies <i>Arum maculatum</i>, lesser Celandine <i>Ranunculus pencillatus</i>, moschatel <i>Adoxa moschatellina</i>, harts tongue</p>

	<p>fern <i>Asplenium scolopendrium</i>, male fern <i>Dryopteris filix-mas</i>, and dogs mercury <i>Mercurialis perennis</i>.</p> <p>Within woodland is a small glade of semi-improved calcareous grassland with common spotted orchid <i>Dactylorhiza fuchsia</i>, brome <i>Bromus hordeaceus</i>, salad burnet <i>Sanguisorba minor</i> at the base of an exposed limestone cliff face.</p> <p>Woodland includes trees with high bat roosting potential and provides high potential bat foraging habitat. Woodland has moderate dormouse potential.</p>
8.	<p>Unimproved Calcareous Grassland with upright brome <i>Bromopsis erecta</i>, common rock rose <i>Helianthemum nummularium</i>, sage <i>Salvia officinalis</i>, salad burnet <i>Sanguisorba minor</i>, carnation sedge <i>Carex Panicea</i>, common dog violet <i>Viola riviniana</i> and meadow vetchling <i>Lathyrus pratensis</i>.</p> <p>Scattered scrub and shrubs include: Hawthorn <i>Crataegus Monogyna</i>, holly <i>Ilex</i>, and honeysuckle <i>Lonicera periclymenum</i>. Frequent anthills indicate lack of improvement. Excellent reptile habitat. Potential to support notable invertebrates and notable botanical species.</p>
9.	<p>Two mature English Oaks <i>Quercus robur</i> with high bat potential with multiple splits, rot holes and branch drops.</p>
10.	<p>Semi-improved species poor grassland – locally diverse and species rich.</p> <p>Species of grass found here; sweet vernal <i>Anthoxanthum odoratum</i>, red fescue <i>festuca rubra</i>, Yorkshire fog <i>Holcus lanatus</i>, and cocks foot <i>Dactylis glomerata</i>.</p> <p>Other species of the plants include field wood rush <i>Luzula campestris</i>, common sorrel <i>Rumex acetosa</i>, cuckoo flower <i>Cardamine pratensis</i>, lesser celandine <i>Ficaria verna</i>, meadow vetchling <i>Lathyrus pratensis</i>, ribwort plantain <i>Plantago lanceolate</i>, selfheal <i>Prunella</i>, Barren strawberry <i>Potentilla sterilis</i>, Marsh thistle <i>Cirsium palustre</i>, and cowslip <i>Primula Veris</i>.</p>
11.	<p>Active Badger sett with 2 entrances, evidence suggests that it is well used with fresh spoil and entrance free of debris.</p>
12.	<p>Semi-improved calcareous grassland at the base of the steep slope up to the view point. The grassland is less diverse but still features interesting grasses with; upright brome, cowslip <i>Primula Veris</i>, common Knappweed <i>Centtaurea nigra</i>, carnation sedge <i>Carex glauca</i>, hawk bit <i>Leontodon</i> species, common spotted orchid <i>Dactylorhiza fuchsia</i>, salad burnett <i>Sanguisorba minor</i>, meadow vetch ling <i>Lathyrus pratensis</i> and cocks foot <i>Dactylis glomerata</i>, Yorkshire fog <i>Holcus lanatus</i>, and dandelion <i>Taraxacum</i>. There is also scattered bramble and hawthorn scrub present, with ant hills and solitary bees.</p> <p>Good terrestrial invertebrate potential. Moderate reptile potential.</p>
13.	<p>Unimproved Calcareous Grassland on steep slope within SSSI – see SSSI designation for detailed species list.</p>
14.	<p>Sheep grazed on Semi improved species poor / improved grassland. Shallow soils with exposed limestone rocks. Good potential for calcareous grassland creation.</p>
15.	<p>Broadleaved woodland with occasional planted coniferous trees. Canopy features Ash <i>Fraximus excelsior</i>, Beech <i>Fagus sylvatica</i>, Western red cedar <i>Thuja plicata</i>, Sycamore <i>Acer pseudoplatanus</i>, and silver birch <i>Betula pendula</i>. Sparse understorey of hazel <i>Corylus avellana</i>, Elder <i>Sambucus</i>, Hawthorn <i>Crataegus Monogyna</i>, Blackthorn <i>Prunus spinosa</i> and Yew <i>Taxus baccata</i>.</p>

	<p>e field layer feature species including dogs mercury <i>Mercurialis perennis</i>, Spurge laurel <i>Daphne laureola</i>, Woodruff <i>Galium odoratum</i>, Sanicle <i>Sanicula europaea</i>. There are steep slopes along the edge of the featuring scrub with Hawthorn <i>Crataegus Monogyna</i> and Ash <i>Fraxinus excelsior</i>. Some of the trees have high potential roosting features. The scrub margins offer good habitat for potential dormice.</p>
16.	<p>Broad-leaved Woodland – secondary woodland with a canopy of semi mature English Oak <i>Quercus robur</i> and Ash <i>Fraxinus excelsior</i>. The understorey consists of Hawthorn <i>Crataegus Monogyna</i> and Bramble <i>Rubus fruticosus</i> agg. with a poor understorey including dog's mercury <i>Mercurialis perennis</i>.</p>
17.	<p>Semi improved species-poor grassland and occasional scrub patches containing Hawthorn <i>Crataegus Monogyna</i> and bramble <i>Rubus</i>, with a stone wall to the east of track. Reptile potential here is moderate. Grassland species include cowslip <i>Primula Veris</i> common knapweed <i>Centaurea nigra</i>, creeping cinquefoil <i>Potentilla reptans</i>, sedge <i>Carex</i> species, tufted hair grass <i>Deschampsia cespitosa</i> and crosswort <i>Cruciata laevipes</i>. To the west of the track in the corner of the grassland there is an area of dense Blackthorn <i>Prunus spinosa</i>.</p>
18.	<p>Hedge banks along the access track to the kennels features the following species ; Brambles <i>Rubus</i>, Dog rose <i>Rosa canina</i>, Hawthorn <i>Crataegus Monogyna</i> and Ash <i>Fraxinus excelsior</i>. The rough semi improved poor grassland with scrub and trees with high suitability for reptiles.</p>
19.	<p>Dense scrub with semi mature native trees, featuring; Bramble <i>Rubus fruticosus</i> agg. Hawthorn <i>Crataegus Monogyna</i>, Elder <i>Sambucus nigra</i>, Travellers joy <i>Clematis vitalba</i>, Ash <i>Fraxinus excelsior</i>, Sycamore <i>Acer pseudoplatanus</i>. Moderate Dormouse potential.</p>
20.	<p>Set- aside in between managed arable land and hedgerow. Rough ground with ruderal and arable weeds. There is potential for good Barn owl foraging, and moderate reptile potential.</p>
21.	<p>Plantation mixed woodland, featuring the following species; Ash <i>Fraxinus excelsior</i>, Beech <i>Fagus</i>, Guelder Rose <i>Viburnum opulus</i>, Hawthorn <i>Crataegus Monogyna</i>, Blackthorn <i>Prunus spinose</i>, Lime <i>Tilia</i>, Wild Privet <i>Ligustrum vulgare</i>, Dogwood <i>Cornus</i>, Spruce <i>Picea</i>, Field Maple <i>Acer campestre</i>, Cedar <i>Cedrus</i>, Hazel <i>Corylus avellana</i> and Cherry <i>Prunus Avuim</i> . High potential for dormouse and reptiles.</p>
22.	<p>Semi Improved species poor grassland with a tussocky structure. Good Barn owl foraging along with high reptile potential. Species found in the grassland include; Yorkshire fog <i>Holcus lanatus</i>, false oat grass <i>Arrhenatherum elatius</i>, Creeping bent <i>Agrostis stolonifera</i>, common vetch <i>Vicia sativa</i>, and crosswort <i>Cruciata laevipes</i>. Evidence of badger snuffle holes present.</p>
23.	<p>Ash featuring numerous rot and wood pecker holes, high bat roost potential.</p>
24.	<p>Semi improved calcareous grassland featuring: upright Brome <i>Bromus erectus</i>, Burnett Saxiflage <i>Pimpinella saxifrage</i>, Crosswort <i>Cruciata laevipes</i>, Greater Knapweed <i>Centaurea scabiosa</i>, yellow wort <i>Blackstonia perfoliate</i>.</p>

	The south facing slope has good reptile potential. Dry stone wall at the bottom of the slope, featuring areas of Hawthorn <i>Crataegus Monogyna</i> , Bramble <i>Rubus</i> and travellers Joy <i>Clematis vitalba</i> .
25.	Pond - dry and in the process of scrubbing over.
26.	Native Broadleaved woodland featuring the following species; Mature Beech <i>Fagus</i> , Hawthorn <i>Crataegus Monogyna</i> , Dog rose <i>Rosa canina</i> and a Laurel hedgerow to one edge. Potential for bat roosting features in trees – not visible from footpath.
27.	Tall ruderal in arable set aside, dominated by nettle, which is bounded by a dry stone wall on one side. High reptile potential.
28.	Avenue of mature Lime trees adjacent to the road. A number of the trees have rot holes and other features with moderate to high bat potential.
29.	Spring – dry no signs of standing water.
30.	Marshy grassland featuring the following species: cuckoo flower <i>Cardamine pratensis</i> , soft rush <i>Juncus effusus</i> , common spotted orchid <i>Dactylor fuchsii</i> , Willow herb <i>Epilobium</i> , Marsh thistle <i>Cirsium palustre</i> , and Lesser celandine <i>Ficaria verna</i> .
31.	The buildings here are made out of old Cotswold stone with roosting potential for both bat and barn owls.
32.	Poor Semi improved grassland and scrub offering good reptile habitat
33.	Semi improved cancerous grassland offers good reptile habitat with the following species present; upright brome <i>Bromus</i> , Cowslip <i>Primula veris</i> , knapweed <i>Centaurea nigra</i> , Ladies Bedstraw <i>Galium verum</i> and Forget-me-not <i>Myosotis arvensis</i>
34.	Marshy grassland featuring hard rush <i>Juncus inflexus</i> , soft rush <i>Juncus effuses</i> , and bulrush <i>Typha latifolia</i> .
35.	Broad leaved Woodland featuring; Hawthorn <i>Crataegus Monogyna</i> , Blackthorn <i>Prunus spinose</i> , Hazel <i>Corylus avellana</i> , Bramble <i>Rubus fruticosus</i> , Elder <i>Sambucus</i> , Lesser celandine <i>Ficaria verna</i> , Bluebells <i>Hyacinthoids non -scripta</i> , Dogs mercury <i>Mercurialis pernnis</i> , Lords and Ladies <i>Arum maculatum</i> , Dog rose <i>Rosa canina</i> , Guelder Rose <i>Viburnum opulus</i> . High dormouse potential. High bat roosting potential. High foraging potential.
36.	Breeding Skylark.
37.	Broadleaved woodland containing; Beech <i>Fagus sylvatica</i> , wild garlic <i>Allium ursinum</i> , Bluebell <i>Hyacinthoids non -scripta</i> , Hawthorn <i>Crataegus Monogyna</i> , Elder <i>Sambucus</i> , Rowan <i>Sorbus aucuparia</i> . Some of the trees in the wood have high bat potential. Green wood pecker seen in the woodland during the survey.
38.	Broadleaved woodland - Beech <i>Fagus sylvatica</i> , Hawthorn <i>Crataegus Monogyna</i> , Ash <i>Fraximus excelsior</i> , Oak Bluebell <i>Hyacinthoids non -scripta</i> , Dogs mercury <i>Mercurialis pernnis</i> , Lords and Ladies <i>Arum maculatum</i> , Enchanters nightshade, Dog violet <i>Violia riviniana</i> , Wayfaring <i>Viburnum lantana</i> , Horse Chesnutt <i>Aesculus hippocastanum</i> and Hornbeam <i>Carpinus betulus</i> . There is also evidence of a pond that is now dried up.
39.	Avenue of mature trees along the road some of them have bat roosting potential. High bat commuting potential, Beech <i>Fagus sylvatica</i> , Elm <i>Ulmus</i> species and Sycamore <i>Acer pseudoplatanus</i> . Rough semi improved grass verge and dry stone wall provides good reptile and invertebrate habitat.

	Small plantation broadleaved woodland including; Ash <i>Fraxinus excelsior</i> , Lime <i>Tilia</i> , Sycamore <i>Acer pseudoplatanus</i> Cow parsley <i>Anthriscus sylvestris</i> , Nettle <i>Urtica dioica</i> , Elder <i>Sambucus nigra</i> , and Blackthorn <i>Prunus spinosa</i> .
41.	Hedgerow featuring Blackthorn <i>Prunus spinosa</i> , Hawthorn <i>Crataegus Monogyna</i> , Ash <i>Fraxinus excelsior</i> , Bramble <i>Rubus</i> , Holly <i>Ilex aquifolium</i> , Field Maple, Apple <i>Malus domestica</i> , Beech <i>Fagus sylvatica</i> , Elder <i>Sambucus nigra</i> , Hazel <i>Corylus avellana</i> . This is a potentially important hedgerow as it is displaying evidence of a dry-stone wall. There is evidence of heaving grazing from sheep.
42.	Old veteran Beech <i>Fagus sylvatica</i> , with large cavities and dense Ivy <i>Hedera helix</i> 1.5 DBH with bat potential.
43.	Rough Grassland along the field margin that has reptile potential. Species featured ; Red canary grass , Cocks foot <i>Dactylis glomerate</i> , Red fescue <i>Festuca rubra</i> , Barren brome <i>Anisantha sterilis</i> , Common Vetch , Creeping thistle <i>Cirsium spp</i> , cowslip <i>Primula veris</i> , dock <i>Rumex obtusifolius</i> , nettle <i>Urtica dioica</i>
44.	Mixed Plantation containing species including: Alder <i>Alnus glutinosa</i> , Lime <i>Tilia sp.</i> Field Maple, Apple <i>Malus domestica</i> , Privet <i>Ligustrum ovalifolium</i> , Hawthorn <i>Crataegus Monogyna</i> , Oak <i>Quercus robur</i> , Sycamore <i>Acer pseudoplatanus</i> , Spruce Norway <i>Picea abies</i> , Ash <i>Fraxinus excelsior</i>
45.	A dry-stone wall with scrub and rough grassland round the verge that is suitable habitat for reptiles. With species present including; bramble <i>Rubus</i> , nettle <i>Urtica dioica</i> , Red fescue <i>Festuca rubra</i> , Cocks foot <i>Dactylis glomerate</i> , creeping buttercup <i>Ranunculus repens</i> , dandelion <i>Taraxacum spp</i> , hedge woodwort , creeping thistle , hogweed, cow parsley , tufted vetch <i>Vicia cracca</i> , cross wort , knapweed <i>Centaurea nigra</i> , sedge, meadow vetchling <i>Lathyrus pratensis</i> , cinquefoil , tufted hair grass <i>Deschampsia cespitosa</i> , rib wort plantain <i>Plantago lanceolate</i> , dog rose <i>Rosa canina</i> , Agrimony <i>Agrimonia eupatoria</i> , White dead nettle <i>Lamium album</i> , Salade burnette <i>Sanguisorba minor</i> , Brome <i>Bromus</i> , Red champion <i>Silene dioica</i> , Rough hawkbit <i>Leontodon hispidus</i>
46.	Small corpse with species including; Forget me not <i>Myosotis arvensis</i> , Dogs mercury <i>Mercurialis</i> , Ivy <i>Hedera helix</i> , Lords and ladies <i>Arum maculatum</i> , nettle, hart tongue fern <i>Asplenium scolopendrium</i> , male fern <i>Dryopteris filix-mas</i> , Ground ivy <i>Glechoma hederacea</i> , Wood speedwell <i>Veronica montana</i> , Willow herb <i>Chamerion angustifolium</i> and Orchid. The broad-leaved woodland found at the quarry contains the following species; Elder <i>Sambucus nigra</i> , Ash <i>Fraxinus excelsior</i> , Hawthorn <i>Crataegus Monogyna</i> , Sycamore <i>Acer pseudoplatanus</i> and Hazel <i>Corylus avellana</i> .
47.	Keepers Cottage appears to be from distance (viewed from footpath) to be of high bat roost potential.
48.	Mature Ash that has multiple deep holes with high bat potential.
49.	Semi improved grassland that features soft rush, creeping buttercup, Ox Eye Daisy, Vetch, Red fescue, meadow foxtail. The area has reptile potential and barn owl foraging and badger snuffle holes.
50.	2 old Ash <i>Fraxinus excelsior</i> that features large rot holes with high bat potential.
51.	Old Quarry with a bike track, leading on to a semi improved grassland with scattered scrub, containing species such as; crosswort <i>Cruciata laevipes</i> , Sedge <i>Cyperaceae</i> , Rib wort plantain <i>Plantago lanceolate</i> , Common vetch <i>Vicia sativa</i> , Nettle <i>Urtica</i>

	<p><i>dioica</i>, Bramble <i>Rubus fruticosus</i>, Cow parsley <i>Anthriscus sylvestris</i>. There is potential for good reptile habitat and barn owl foraging. It is possible species rich but due to lack of access could not survey further.</p>
52.	Rough grassland with abundant Reed canary grass, sedges with makes good potential habitat for reptiles and foraging habitat for barn owls.
53.	Broad leafed woodland with mature Beech trees <i>Fagus sylvatica</i> with high bat potential.
54.	Old Ash <i>Fraximus excelsior</i> with bat roost potential surrounded by tall ruderal, scattered scrub and improved grassland with potential for reptiles.
55.	Old bank with exposed rock suitable for reptiles.
56.	Farm with extensive various barns and farm buildings suitable for bats and barn owls.
57.	Hedgerow with semi improved grassland strips either side, species found; Ash <i>Fraximus excelsior</i> , Hawthorn <i>Crataegus Monogyna</i> , Field Maple, Apple <i>Malus domestica</i> , Hazel <i>Corylus avellana</i> , Blackthorn <i>Prunus spinose</i> .
58.	Strip of rough grassland that extends round the field margin adjacent to the woodland and hedgerows between the dry-stone wall. Species found here are; nettle <i>Urtica dioica</i> , Meadow foxtail <i>Alopecurus pratensis</i> , Cow parsley, Nettle, Hedge wound wort, Herb robert <i>Geranium robertianum</i> , Creeping buttercup <i>Ranunculus repens</i> , Cocks foot <i>Dactylis glomerate</i> , Chick weed <i>Stellaria media</i> , Creeping thistle <i>Cirsium arvense</i> .
59.	<p>Pond recently enhanced with shading tree removed and log piles/ wood chip created. Species found here include; silver grass, Creeping buttercup <i>Ranunculus repens</i>, aquatic mint <i>Mentha citrate</i>. Line of grassland glade in woodland and dried up stream.</p> <p>The pond has GCN potential, the woodland has potential of dormice and bats roosting potential in the large oak with rot holes.</p>
60.	Old Ash <i>Fraximus excelsior</i> with high bat potential in hedgerow, species include Hawthorn <i>Crataegus Monogyna</i> , Field Maple, Apple <i>Malus domestica</i> , Blackthorn <i>Prunus spinose</i> , Ash <i>Fraximus excelsior</i>
61.	Rough Grassland semi improved featuring; Meadow Thistle <i>Cirsium dissectum</i> , Dock <i>Rumex</i> , Brome <i>Bromus erectus</i> , Cocks foot <i>Dactylis glomerate</i> , Common Sorrel <i>Rumex acetosa</i> , Common Vetch <i>Vicia sativa</i> , Red fescue <i>Festuca rubra</i> . The grassland has reptile good potential.
62.	Mixed woodland surrounds a small dried up stream that steams from the pond.
63.	Farm house that supports high potential roosting features for bats.
64.	Old Ash <i>Fraximus excelsior</i> with large split that has high roosting potential for bats.
65.	Semi improved grassland with the following species; Cocks foot <i>Dactylis glomerate</i> , Creeping buttercup <i>Ranunculus repens</i> , False oat grass <i>Arrhenatherum elatius</i> , Hogweed <i>Heracleum sphondylium</i> , White clover <i>Trifolium repens</i> , Dandelion <i>Taraxacum</i> , Creeping Cinquefoil <i>Potentilla reptans</i> , Yorkshire fog <i>Holcus lanatus</i> , Rib wort plantain <i>Plantago lanceolate</i> , Red clover <i>Trifolium pratense</i> , and Common vetch <i>Vicia sativa</i> .
66.	Large Sycamore <i>Acer pseudoplatanus</i> with bat potential covered in dense Ivy <i>Hedera</i> and rot holes.

	Species poor hedgerow featuring Sycamore <i>Acer pseudoplatanus</i> , Hawthorn <i>Crataegus Monogyna</i> , Ash <i>Fraximus excelsior</i> , Ivy, and wild privet
68.	Free standing Sycamore <i>Acer pseudoplatanus</i> with callas rolls that has high bat potential.
69.	Line of trees free standing Sycamore <i>Acer pseudoplatanus</i> , Elder <i>Sambucus nigr</i> , Ash <i>Fraximus excelsior</i>
70.	Around the field margin species include Forget me not, Dove foot, Cranes Bill , Speedwell , Brome and Red clover <i>Trifolium pratense</i> and White clover <i>Trifolium repens</i>
71.	Hedgerow with trees, species including Hazel <i>Corylus avellana</i> , Spindle <i>Euonymus europaeus</i> , Sycamore <i>Acer pseudoplatanus</i>
72.	Corrugated barn which has features for Barn owl <i>Tyto alba</i> nesting potential.
73.	Hawthorn <i>Crataegus Monogyna</i> and Field Maple <i>Malus domestica</i> are evident here.
74.	Barn building that has barn owl and roosting bat potential as well as nesting birds.
75.	Neutral grassland containing species such as false oat grass <i>Arrhenatherum elatius</i> , cleaver <i>Galium aparine</i> , Hog weed <i>Heracleum sphondylium</i> , Nettle <i>Urtica dioica</i> , Cocksfoot <i>Dactylis glomerate</i> , Cranesbill, False brome <i>Anisantha sterlis</i> , Speedwell Veronica, Forget me not <i>Myosotis arvensis</i> , Red fescue <i>Festuca rubra</i> , Yorkshire fog <i>Holcus lanatus</i> , Shepard purses <i>Capsella bursa-pastoris</i> , Bed straw <i>Galium aparine</i> and Redshank. There is reptile habitat potential in this area.
76.	A plastic lined pond surrounded by tall ruderal, scrub and rubble. The area has good reptile and amphibian potential.
77.	Hedgerow featuring Damson, Bramble <i>Rubus</i> , Field Maple, <i>Malus domestica</i> , Hawthorn <i>Crataegus Monogyna</i> , Dog rose <i>Rosa canina</i>
78.	Cricket Clubhouse which has moderate potential for bats – cracks and holes in fascias and brickwork.
79.	Pond surrounded by amenity grassland with good amphibian potential.
80.	Hedgerow featuring Dogwood Cornus, Hawthorn <i>Crataegus Monogyna</i> , Field Maple <i>Malus domestica</i> , Beech <i>Fagus sylvatica</i> , Guelder Rose <i>Viburnum opulus</i> , Blackthorn <i>Prunus spinose</i> , Hazel <i>Corylus avellana</i> , Apple <i>Malus domestica</i>
81.	Semi-improved grassland with potential for reptiles at the edges, containing the following species: Annual Meadow Grass <i>poa annua</i> , Yorkshire Fog <i>Holcus lanatus</i> , Perennial, White Clover <i>Trifolium repens</i> , Dovesfoot Cranesbill <i>Geranium molle</i> , Creeping Buttercup <i>Ranunculus repens</i> , Dock <i>Rumex obtusifolius</i> , Nettle <i>Urtica dioica</i> , Red Fescue <i>festuca rubra</i> , Hedge Woundwort <i>Stachys sylvatica</i> , Cock's foot <i>Dactylis glomerate</i> , Hair grass <i>Deschampsia cespitosa</i> .
82.	Mixed Woodland
83.	Ash <i>Fraximus excelsior</i> with dense ivy coverage that has bat roost potential.
84.	Hedgerow with potential for dormice containing Elder <i>Sambucus nigra</i> , Blackthorn <i>Prunus spinose</i> , Bramble <i>Rubus</i> , Hazel <i>Corylus avellana</i> , Dog rose <i>Rosa canina</i> , Hawthorn <i>Crataegus Monogyna</i> and Clematis <i>Clematis</i>
85.	Semi-improved neutral grassland with reptile potential, featuring the following species: Dock <i>Rumex obtusifolius</i> , Creeping buttercup <i>Ranunculus repens</i> , Red Clover <i>Trifolium pratense</i> , Chickweed <i>Stellaria media</i> , White Clover <i>Trifolium repens</i> , Greater Plantain <i>Plantago Major</i> , Daisy <i>Bellis perennis</i> , Creeping Thistle <i>Circium spp</i> , Annual Meadow Grass <i>Poa Annus</i> , Perennial Rye Grass <i>Lolium perenne</i> ,

	Cock's-foot <i>Dactylis glomerate</i> , Yorkshire Fog <i>Holcus lanatus</i> , Black Medick <i>Medicago lupulina</i> , Crested Dogstail <i>Cynosurus cristatus</i> , Spear Thistle <i>Cirsium vulgare</i> , Yellow Rattle <i>Rhianthus Minor</i> , Dovesfoot Cranesbill <i>Geranium molle</i> , Meadowsweet <i>Filipedula ulmaria</i> , Mint <i>Mentha</i> , Meadow Foxtail <i>Alopecurus pratensis</i> , Ribwort Plantain <i>Plantago lanceolate</i> , Sheep Sorrel <i>Rumex acetosella</i> and Horsetail <i>Equisetum</i> .
86.	Ash <i>Fraximus excelsior</i> with bat potential in the hedgerow.
87.	Broad leaved woodland containing Ash <i>Fraximus excelsior</i> , Field Maple <i>Acer Campestre</i> , Hawthorn <i>Crataegus Monogyna</i> , Blackthorn <i>Prunus spinose</i> , Hazel <i>Corylus avellana</i> and Crack Willow <i>Salix fragilis</i> , some of which have bat potential. On the Forest floor are species such as Wood Melick <i>Melica uniflora</i> , Dog's Mercury <i>Mercurialis perennis</i> , Red Campion <i>Silene dioica</i> , Ground Ivy <i>Glechoma hederacea</i> , Hedge Woundwort <i>Stachys sylvatica</i> , Nettle <i>Urtica dioica</i> , Cleaver <i>Galium aparine</i> , Lords and Ladies <i>Arum maculatum</i> and Bluebell <i>Hyacinthoides non -scripta</i> .
88.	Pond with potential for reptiles and amphibians surrounded by species such as Mint <i>Mentha</i> , Soft Rush <i>Juncus effusus</i> , Meadow Vetch <i>Lathyrus pratensis</i> , Floating Sweetgrass <i>Glyceria fluitans</i> , Dock <i>Rumex obtusifolius</i> , Meadowsweet <i>Filipedula ulmaria</i> , Red Campion <i>Silene dioica</i> , Common Vetch <i>Vicia sativa</i> , Enchanter's Nightshade <i>Circaea lutetiana</i> , Greater Willowherb <i>Epilobium hirsutum</i> , Crack Willow <i>Salix fragilis</i> , Goat Willow <i>Salix caprea</i> and Cock's-foot <i>Dactylis glomerate</i> .
89.	Semi-improved grassland with scattered scrub featuring Yarrow <i>Achillea millefolium</i> , Creeping Buttercup <i>Ranunculus repens</i> , Perrenial Rye Grass <i>Lolium perenne</i> , Daisy <i>Bellis perennis</i> , Cock's-foot <i>Dactylis glomerate</i> , Spear Thistle <i>Cirsium vulgare</i> , Greater Plantain <i>Plantago Major</i> , Annual Meadow Grass <i>Poa Annus</i> , Ribwort Plantain <i>Plantago lanceolate</i> , Dock <i>Rumex obtusifolius</i> , Meadow Thistle <i>Cirsium dissectum</i> , White Clover <i>Trifolium repens</i> , Red Clover <i>Trifolium pratense</i> , Crested Dogstail <i>Cynosurus cristatus</i> , Birdsfoot Trefoil <i>Lotus corniculatus</i> , Germander Speedwell <i>Veronica chamaedrys</i> , Sweet Vernal Grass <i>Anthoxanthum odoratum</i> , Chickweed <i>Stellaria media</i> , Dovesfoot Cranesbill <i>Geranium molle</i> , Creeping Thistle <i>Cirsium spp</i> , Meadow Foxtail <i>Alopecurus pratensis</i> , Woolly Thistle <i>Cirsium eriophorum</i> , Hard Rush <i>Juncus inflexus</i> and Silverweed <i>Argentina anserine</i> .
90.	Pond with a concrete base.
91.	Conifer Plantation
92.	Broadleaved plantation, mainly consisting of Poplar <i>Populus tremula</i> trees.
93.	Mixed Woodland on banks featuring Ash trees <i>Fraximus excelsior</i> with rot holes suitable for bats.
94.	Hedgerow containing Hazel <i>Corylus avellana</i> and Hawthorn <i>Crataegus Monogyna</i> , suitable for dormice.
95.	Hedgerow with trees and a ditch, featuring Dogrose <i>Rosa canina</i> , Blackthorn <i>Prunus spinose</i> , Hawthorn <i>Crataegus Monogyna</i> , Field Maple <i>Acer Campestre</i> , Hazel <i>Corylus avellana</i> , Bramble <i>Rubus</i> and Ash <i>Fraximus excelsior</i> . There is potential for dormice here.
96.	Barn with bat and barn owl potential. The barn is directly adjacent to a veteran sycamore <i>Acer pseudoplatanus</i> with rot holes and callus rolls. Tall ruderals and rough grassland also surround the barn, suitable for reptiles.

97.	Verge suitable for reptiles with semi-improved tussocky grassland, scattered scrub and tall ruderals. Species include: Red Fescue <i>festuca rubra</i> , Cow Parsley <i>Anthriscus sylvestris</i> , Nettle <i>Urtica dioica</i> , Hawthorn <i>Crataegus Monogyna</i> , False Oatgrass <i>Arrhenatherum elatius</i> , Grasses <i>Poa spp</i> , Common Vetch <i>Vicia sativa</i> , Bramble <i>Rubus</i> , Clover <i>Trifolium spp</i> , Blackthorn <i>Prunus spinose</i> , Creeping Buttercup <i>Ranunculus repens</i> , Dovesfoot Cranesbill <i>Geranium molle</i> , False Brome <i>Anisantha sterilis</i> , Forget-me-not <i>Myosotis arvensis</i> , Chickweed <i>Stellaria media</i> , Yorkshire Fog <i>Holcus lanatus</i> and Ragwort <i>Jacobea vulgaris</i> .
98.	SR semi-improved grassland containing species such as Yorkshire Fog <i>Holcus lanatus</i> , Crested Dogstail <i>Cynosurus cristatus</i> , Red Fescue <i>festuca rubra</i> , Selfheal <i>Prunella</i> , Spear Thistle <i>Cirsium vulgare</i> , White Clover <i>Trifolium repens</i> , Red Clover <i>Trifolium pratense</i> , Ribwort Plantain <i>Plantago lanceolate</i> , Creeping Buttercup <i>Ranunculus repens</i> , Chickweed <i>Stellaria media</i> , Yellow Rattle Rhianthus Minor, Dandelion <i>Taraxacum</i> , False Oatgrass <i>Arrhenatherum elatius</i> , Smooth Hawksbeard <i>Crepis capillaris</i> , Catsear <i>Hypochaeris radica</i> , Common Vetch <i>Vicia sativa</i> , Chickweed <i>Stellaria media</i> , Pyramidal Orchid <i>Anacamptis pyramidalis</i> , Creeping thistle <i>Cirsium arvense</i> , Greater Plantain <i>Plantago Major</i> and Ragwort <i>Jacobea vulgaris</i> .
99.	Hedgerow containing Elder <i>Sambucus nigra</i> , Ivy <i>Hedera helix</i> , Hawthorn <i>Crataegus Monogyna</i> , Hazel <i>Corylus avellana</i> , Field Maple <i>Acer Campestre</i> , Elm <i>Ulmus rubra</i> and Blackthorn <i>Prunus spinose</i> .
100.	Buildings with low bat potential
101.	Broadleaved woodland containing Beech <i>Fagus sylvatica</i> , Wych Elm <i>Ulmus glabra</i> , Ash <i>Fraximus excelsior</i> , Lime <i>Tilia sp.</i> , Pedunculate Oak <i>Quercus robur</i> , Hazel <i>Corylus avellana</i> and Holly <i>Ilex aquifolium</i> . Also contains Wood Melick <i>Melica uniflora</i> , Woodruff <i>Galium odoratum</i> , Wood False Brome <i>Brachypodium sylvaticum</i> , Harts tongue fern <i>Asplenium scolopendrium</i> , Wild garlic <i>Allium oleraceum</i> , Tufted hair grass <i>Deschampsia cespitosa</i> and Hard Shield Fern <i>Polystichum aculeatum</i> . A mature broadleaved woodland on a steep slope with limestone outcrops. A number of trees have high bat potential and excellent foraging and also good for dormice and nesting birds.
102.	Parkland type landscape of semi-improved grassland and scattered broadleaved woodland. The grassland is poor semi-improved with patches of Common Nettle <i>Urtica dioica</i> and Bracken as well as Soft Rush <i>Juncus effusus</i> and Marsh Thistle <i>Cirsium palustre</i> , which indicate damp grassland. There are a number of scattered trees including Pedunculate Oak <i>Quercus robur</i> and Ash <i>Fraximus excelsior</i> and a number of mature species with high bat potential and moderate bid nesting potential.
103.	Viewed from the woodland edge, possible semi-calcareous grassland with a diverse mix of grasses and herbs including Quaking Grass <i>Briza media</i> , Crested Dogstail <i>Cynosurus cristatus</i> , Cock's-foot <i>Dactylis glomerate</i> , Annual Meadow Grass <i>Poa Annu</i> , Sedge <i>Carex sp.</i> , Marsh thistle <i>Cirsium palustre</i> , Ladies Bedstraw <i>Galium verum</i> , Meadow Buttercup <i>Ranunculus acris</i> , Common Spotted Orchid <i>Dactylorhiza fuchsii</i> , Birdsfoot Trefoil <i>Lotus corniculatus</i> , Pyramidal Orchid <i>Anacamptis pyramidalis</i> , Crosswort <i>Cruciata laevipes</i> , Yellow wort <i>Blackstonia perfoliate</i> and

	Milkwort <i>Polygala vulgaris</i> . There is moderate potential for reptile habitat in the margins.
104.	Exposed soil from a slump has left excellent habitat for invertebrates, particularly solitary bees and wasps.
105.	Mature Willow <i>Salix spp</i> with high potential for bats as there are a number of cavities and a hollow base. There is a tree bumblebee nest in the tree.
106.	Spring but no standing water.
107.	A mature Oak <i>Quercus spp.</i> with several cavities and high bat and barn owl potential.
108.	Dead Oak with flaky bark and rot holes and a high bat and invertebrate potential.
109.	Plantation Broadleaved Woodland featuring Ash <i>Fraxinus excelsior</i> , Wild Cherry <i>Prunus Avuim</i> , Pedunculate Oak <i>Quercus robur</i> , Field Maple <i>Acer Campestre</i> and Lime <i>Tilia sp.</i> . The trees are mainly semi-mature planted trees with remnant mature and over-mature standards, some with high bat potential. The understory is generally sparse, except amid the margins. Species present include Wood Dock <i>Rumex sanguineus</i> , Wood speedwell <i>Veronica montan</i> , Wood Avens <i>Geum urbanum</i> . There is moderate dormouse potential although there is a poor understory.
110.	No access although likely a pond a distance from the path with bulrushes <i>Typha gracilis</i> visible. A Semi-improved poor grassland field with moderate reptile potential.
111.	Species rich hedge along the track containing the following species: Wild Privet <i>Ligustrum vulgare</i> , Hazel <i>Corylus avellana</i> , Field Maple <i>Acer Campestre</i> , Hawthorn <i>Crataegus Monogyna</i> , Holly <i>Ilex aquifolium</i> , Wych Elm <i>Ulmus glabra</i> , Dog rose <i>Rosa canina</i> , Bush Vetch <i>Vicia sepium</i> , Wood Dock <i>Rumex sanguineus</i> , Herb robert <i>Geranuim robertianum</i> , Black Bryony <i>Dioscorea communis</i> , Horse Chestnut <i>Aesculus hippocastanum</i> and Sycamore <i>Acer pseudoplatanus</i> .
112.	An oval pond with an island, viewed from footpath. It has good water quality, no ducks or fish, 10% shading and 60% vegetation cover. There is excellent terrestrial habitat and a high potential for great crested newts.
113.	One mature and three smaller pollarded black poplars on hedge.
114.	A dry ditch next to a hedge with trees featuring Crack Willow <i>Salix fragilis</i> , Ash <i>Fraxinus excelsior</i> , Bramble <i>Rubus</i> , Elder <i>Sambucus nigra</i> , Hawthorn <i>Crataegus Monogyna</i> , Elm <i>Ulmus rubra</i> and Common Nettle <i>Urtica dioica</i> .
115.	Verge of the A417, planted with trees and shrubs including Aspen <i>Populus tremula</i> , Dog rose <i>Rosa canina</i> , Dogwood <i>Cornus sanguinea</i> , Wayfaring <i>Viburnum lantana</i> , Damson <i>Prunus domestica</i> and Ash <i>Fraxinus excelsior</i> and Pyramidal Orchid <i>Anacamptis pyramidalis</i> . There are patches of good reptile habitat on the grassy verges and good dormouse habitat, although there is some loss of connectivity.
116.	Small broadleaved woodland containing actively managed hazel coppice with mature Hazel <i>Corylus avellana</i> . There is good dormouse potential with good connectivity to the hedgerow network.
117.	A network of fields which appear to be semi-improved poor with areas of tall ruderals. There is no access and two inaccessible footpaths. It is used as a mountain bike park and looks to have moderate reptile potential.
118.	Rough semi-improved poor grassland featuring Cock's-foot <i>Dactylis glomerate</i> , Yorkshire fog <i>Holcus lanatus</i> , False oat grass <i>Arrhenatherum elatius</i> , Nettle <i>Urtica dioica</i> , Wood Dock <i>Rumex sanguineus</i> , Creeping Thistle <i>Circium arvense</i> and

	Broad-leaved Dock <i>Rumex obtusifolius</i> . There is moderate reptile potential and good Barn Owl foraging potential.
119.	Pedunculate Oak <i>Quercus robur</i> with numerous deep rot hole and fissures, creating a high bat potential.
120.	Mature Ash <i>Fraxinus excelsior</i> with a high bat potential. There is a large split down the stem at the base with multiple deep rot holes.
121.	Semi-improved/semi-calcareous grassland. The area is mostly semi-improved but is locally herb rich in all three fields. Species include: Yellow Rattle <i>Rhianthus Minor</i> , Crosswort <i>Cruciata laevipes</i> , Ribwort plantain <i>Plantago lanceolate</i> , Meadow Buttercup <i>Ranunculus acris</i> , Cock's-foot <i>Dactylis glomerate</i> , False oat grass <i>Arrhenatherum elatius</i> , Red fescue <i>festuca rubra</i> , Crested Dogstail <i>Cynosurus cristatus</i> , Cranesbill <i>Geranium maculatum</i> , Pyramidal Orchid <i>Anacamptis pyramidalis</i> , Common vetch <i>Vicia sativa</i> , Ladies Bedstraw <i>Galium verum</i> , Red clover <i>Trifolium pratense</i> and Germander Speedwell <i>Veronica chamaedrys</i> . There is moderate reptile potential around the margins.
122.	A 3m x 2m pond with no shade, ducks or fish. There is 10% aquatic vegetation coverage of Floating Sweetgrass <i>Glyceria fluitans</i> . There is moderate potential for great crested newts, but perhaps a bit small. Only 10 bottle traps needed.

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.2
Hedgerow Technical Report

28 September 2020

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Executive Summary

The proposed A417 Missing Link scheme (hereafter referred to as 'the scheme') aims to provide a dual carriageway to a stretch of single carriageway between the Cowley roundabout and Crickley Hill in Gloucestershire; the 5.5km section is the only remaining section of single carriageway. The scheme would increase capacity by creating a free-flowing link between the Brockworth Bypass and Cowley roundabout and remove the at-grade junction with the A436, resulting in a continuous flow between the M4 Junction 15 (Swindon) and the M5 Junction 11a (Gloucester/Cheltenham).

A total of 34 hedgerows were recorded within the survey area and were subject to further assessment due to likely impacts from the scheme. Twelve hedgerows were found to be species-rich, 10 species-poor intact, 9 were species-poor defunct and 3 hedgerows were not fully surveyed, due to access restrictions. Of the 31 hedgerows surveyed in this study, 13 were deemed to be important under the Hedgerow Regulations 1997.

Hedgerow composition was dominated by hawthorn throughout the survey area, abundant shrub species included blackthorn, field maple, rose species and hazel. Standard trees were largely ash and English oak.

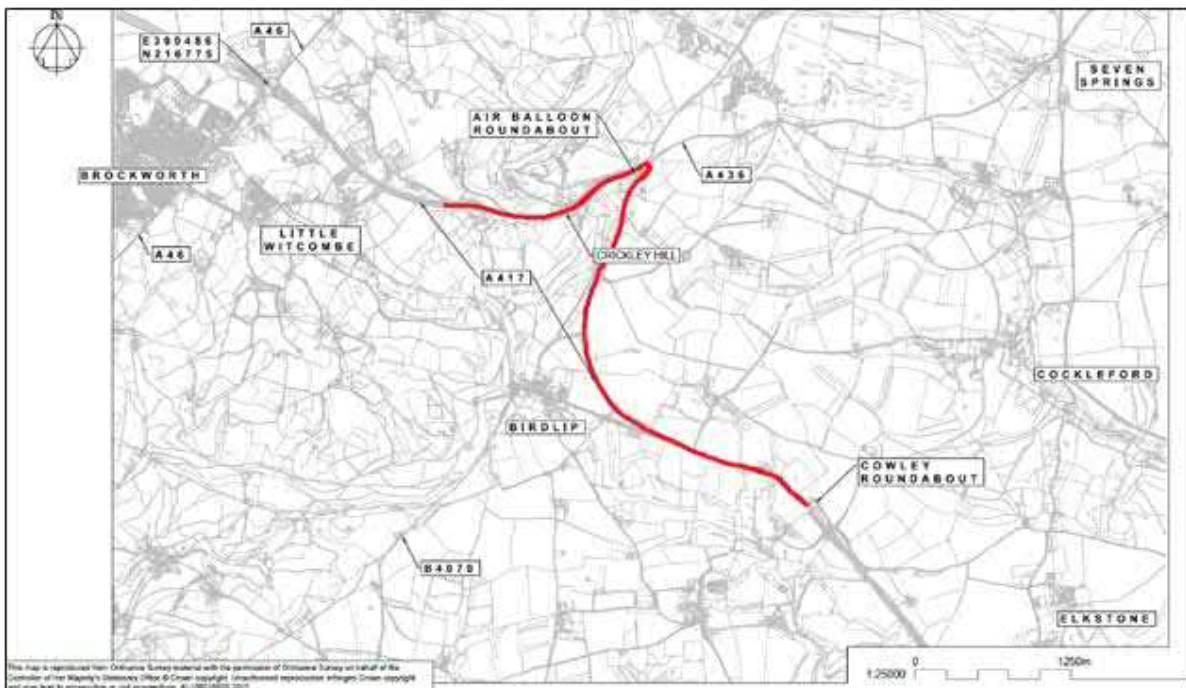
Hedgerows providing important linkages to streams and woodland were numerous throughout the survey area, suggesting that hedgerows within the study area are likely to contribute significantly to the landscape connectivity for wildlife movements and dispersal. Future impact assessment of these hedgerows should take into account this aspect of their distribution in relation to the scheme proposals.

1. Introduction

1.1. Background

1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and as an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'missing link', forms the only section of single carriageway along the route, with an at-grade junction located at the 'Air Balloon' public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5km stretch shown on Figure 1.1 below.

Figure 1.1: A417 Missing Link Scheme Location Plan



Source: GiGi GIS Portal. Crown Copyright 2016 100030649

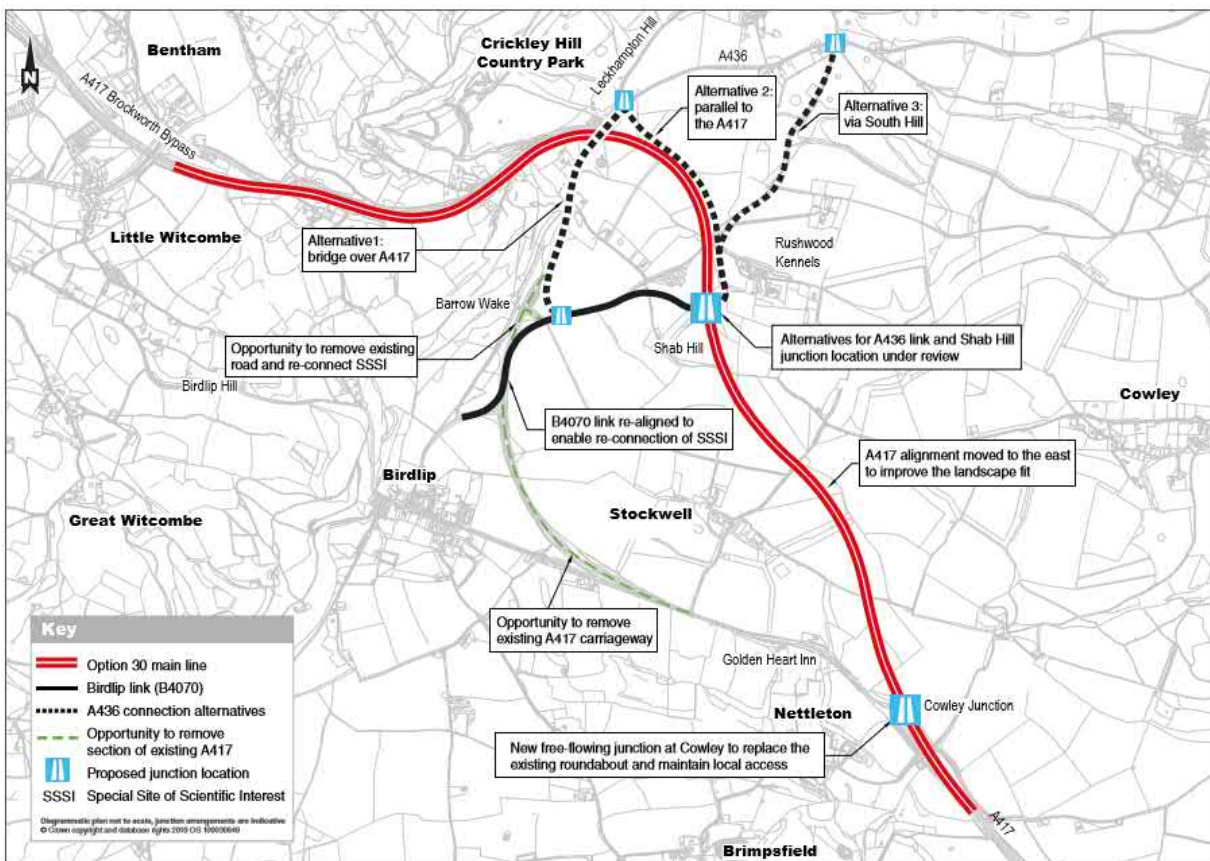
1.2. Scheme Proposal

- 1.2.1 The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill.
- 1.2.2 Any proposed scheme would aim to increase capacity by creating a free-flowing link between the Brockworth Bypass and the Cowley roundabout and remove the at-grade junction with the A436 (Air Balloon roundabout). This Missing Link will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester / Cheltenham (M5 Junction 11).

1.2.3 The preferred route for the Scheme was confirmed as Option 30 by the Secretary of State in March 2019 (see Figure 2.1 below). The Scheme comprises the construction of a new dual carriageway to replace the existing single carriageway section between Brockworth bypass and Cowley Roundabout. It is predominately an “offline” Scheme but approximately a third of the route follows the existing A417 route corridor at Crickley Hill.

1.2.4 A new link road would be built between the slip road junction at Shab Hill and the existing A417 to connect traffic to and from Birdlip and the A436 with the new A417. This new link road would end in a new roundabout near Barrow Wake.

Figure 1.2: A417 Preferred Route Announcement



1.2.5 Figure 1.2 above shows how there are three A436 link road alternative connections. Alternative 2, parallel to the A417, is the selected route proceeded with for assessment in the Environmental Statement.

1.3. Scope of Report

1.3.1. The objectives of the report are:

- to collect and review the Phase 1 habitat survey to identify potential species rich hedgerows, and those connected to other notable features, for example ponds, woodland, other hedgerows
- to present the methods, constraints and results of the hedgerow assessments, including the notable herb layer species for those hedgerows thought to be species rich
- to assess the importance of the hedgerows, specifically whether hedgerows are considered 'important' under the Hedgerow Regulations (1997) and whether they are species rich

1.4. Study Area

1.4.1. Guidance on ecological assessments recommends that all ecological features that occur within a zone of influence (Zoi) for a proposed scheme are investigated (CIEEM, 2016)¹. The potential Zoi includes:

- areas to be directly within the land take for the proposed scheme
- areas that would be temporarily affected during construction

1.5. Legislation

1.5.1. The Hedgerow Regulations 1997 protect important hedgerows from damage or destruction. The key principle of the hedgerow regulations is that those in the countryside are often ancient features that have been part of the landscape for many centuries. Their age, combined with the fact that they are valuable assets in ecological terms, means that important hedgerows merit a degree of protection.

1.5.2. The removal of countryside hedgerows (excluding garden hedges) is prohibited without first submitting a hedgerow removal notice to the local planning authority (LPA). In considering the removal notice, the LPA can order the retention of 'important' hedgerows. The regulations set out the criteria under which hedgerows are considered important.

1.5.3. A hedgerow is defined within the Hedgerow Survey Handbook² as 'any boundary line of trees or shrubs over 20 metres long and less than 5 metres wide at the base, provided that at 1 time the trees and shrubs were more or less continuous'. This includes shrubby hedgerows; lines of trees and very gappy

¹ Chartered Institute of Ecology and Environmental Management (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal

² Defra (2007) *Hedgerow Survey Handbook: A standard procedure for local surveys in the UK*. Defra, London

hedgerows, where each section may be less than 20 metres long, but the gaps are less than 20 metres.

- 1.5.4. For the purposes of the Hedgerow Regulations 1997, a hedgerow is classified as 'important' if it, or the hedgerow of which it is a stretch:
- has existed for 30 years or more
 - satisfies at least 1 of the criteria listed in Part II of Schedule 1. This criterion is presented in Appendix A
- 1.5.5. All native hedgerows (including species-poor ones) are listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 and are considered to be of high conservation value.
- 1.5.6. Species-rich hedgerows are defined as those containing an average of 5 or more native woody species (or at least 4 in northern and eastern England, upland Wales and Scotland) per 30 metres length.

1.6. Status of hedgerows at the national level

- 1.6.1. Historically, hedgerows were listed as a UK Biodiversity Action Plan (BAP) habitat and are now listed as a habitat of 'principal importance for the conservation of biodiversity in England' under Sections 41 and 42 of the NERC Act 2006.
- 1.6.2. Hedgerows over 20 metres in length that are composed of at least 80% of 1 or more UK native species are classed as a UK habitat of principal importance. Hedgerows fulfilling this criteria will also be less than 5 metres wide and have gaps of less than 20 metres between tree or scrub species³.

1.7. Status of hedgerows at the county level

- 1.7.1. Although the UK BAP has been superseded, BAPs are still widely used at county level to support Biodiversity 2020⁴. Species rich hedgerows and ancient hedgerows are listed as an "Action Plan Habitat" within the Biodiversity action plan for Gloucester as produced by the Gloucester Local Nature Partnership which describes BAP actions to halt the net loss of biodiversity⁵.

³ Bickmore, C.J. (2002) Hedgerow survey handbook: a standard procedure for local surveys in the UK. London, DEFRA.

⁴ Defra (2011) *Biodiversity 2020: A strategy for England's wildlife and ecosystem services* [online] available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69446/pb13583-biodiversity-strategy-2020-111111.pdf

⁵ Biodiversity Plan for Gloucestershire. Gloucester Local Nature Partnership 2000.

2. Methodology

2.1. Desk study

2.1.1. The aims of the desk study with specific regard to hedgerows, was to identify all hedgerows directly impacted by the scheme. Therefore, all hedgerows within the present red line boundary were identified using the Phase 1 habitat maps, online databases and aerial images. The following databases were used to extract the required information outlined above:

- Google Maps⁵
- Multi-Agency Geographic Information for the Countryside (MAGIC) website⁶

2.1.2. All hedgerows were then individually numbered using a sequential numerical referencing system to identify them for surveying. Hedgerows less than 20 metres in length or with gaps of more than 20 metres in length, were not classed as hedgerows and were not highlighted for surveying. Appendix B displays the locations of all hedgerows.

2.1.3. The historic importance of hedgerows within 50 metres of the scheme was reviewed using maps indicating pre-1850s parish boundaries. Hedgerows which form historic field patterns are discussed in Section 3.1 of this report.

2.2. Hedgerow assessment

2.2.1. All hedgerows that fall or partly fall within the scheme and a surrounding 50 metre buffer from the red line scheme boundary were surveyed to comply with the requirements of the 'Wildlife and Landscape Criteria' in the Hedgerow Regulations 1997. Areas considered as 'within the scheme' are as follows:

- areas to be directly within the land take for the scheme and access
- areas that would be temporarily affected during construction
- areas likely to be impacted by hydrological disruption
- areas where there is a risk of pollution and noise disturbance during construction or operation

⁵ Biodiversity Plan for Gloucestershire. Gloucester Local Nature Partnership 2000. co.uk/" <https://maps.google.co.uk/> (last accessed April 2018)

⁶ Defra (2018) Multi-Agency Geographic Information for the Countryside [online] available at: <http://magic.defra.gov.uk/> (last accessed April 2018)

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- 2.2.2. Each survey was completed by 2 experienced ecologists with experience of undertaking botanical and hedgerow surveys. As part of this survey, the hedgerows were identified and mapped in accordance with the Hedgerow Regulations 1997. Species lists were compiled and any signs of fauna noted. An 8-digit grid reference was taken at the start and end points of each hedgerow using the British National Grid Ordnance System.
- 2.2.3. To ensure quantifiable lengths of hedgerow were surveyed; end points were defined as stated in the Hedgerow Survey Handbook. These were identified as where there was a connection to another feature (for example, hedge, road, wall or fence), a gap of 20 metres or more, or a link to woodland or other semi-natural habitat.
- 2.2.4. Hedgerow surveys were undertaken on each hedgerow within the area of the scheme and within a 50 metre buffer. Thirty-one hedgerows were surveyed in June 2019 to assess their quality and determine the importance of hedgerows present within the survey area. Optimal timing for hedgerow surveys is between May- July, when the woody vegetation is fully in leaf and woodland ground flora can be easily identified.
- 2.2.5. The hedgerows within the survey are shown in Appendix B.1. With results maps contained in Appendix B.2. Photographs of surveyed hedgerows are shown in Appendix C.
- 2.2.6. The primary and most important criteria for determining whether a hedgerow is covered by the regulations is the number of woody species within the surveyed section. Woody species are defined as those listed in Schedule 3 of the Hedgerow Regulations 1997 and are essentially those tree and shrub species that are indicative of an ancient hedgerow.
- 2.2.7. For the purposes of this assessment, each hedgerow was sampled in typical 30 metre sections in accordance with the guidance outlined within Schedule 1 Part II of the Hedgerow Regulations 2007:
- length of the hedgerow does not exceed 30 metres, whole hedgerow surveyed
 - hedgerow exceeds 30 metres, but not exceeding 100 metres, central stretch of 30 metres surveyed
 - hedgerow exceeding 100 metres, but not exceeding 200 metres, central 30 metres stretch within each half of the hedgerow surveyed
 - hedgerow exceeding 200 metres, central 30 metres stretch within each third of the hedgerow surveyed
-

- 2.2.8. The woody species relevant to the Hedgerow Regulations 1997 present in each section were recorded, along with any additional woody species. This included both those not in any of the 30 metre sections but present in the rest of the length and additional woody species that are not relevant to the hedgerow regulations assessment, for example sycamore *Acer pseudoplatanus* and cherry laurel *Prunus laurocerasus*.
- 2.2.9. An estimation of individual woody species was assessed using the DAFOR scale (a simple qualitative plant abundance cover classification system) from, as follows:
- D: Dominant- comprises most of the community
 - A: Abundant -very frequent in the community but not dominant
 - F: Frequent- frequently seen in the community
 - O: Occasional- seen but not frequently occurring
 - R: Rare- hardly ever found
- 2.2.10. The secondary set of criteria that are assessed relate to the whole hedgerow, not just the 30 metre section surveyed. Ground flora within the whole hedge and within 1 metre of the outermost edges of the hedge was recorded. The number of woodland species relevant to the Hedgerow Regulations 1997 was counted as 3 or more constitute an associated feature. Woodland species are listed in Schedule 2 of the Hedgerow Regulations 1997, and are plant species that, because of the conditions that they grow in, indicate an ancient hedgerow. Additional features such as ditches, walls, banks, parallel hedges, connections and standard and rare trees were also recorded.

2.3. Survey Constraints

- 2.3.1. It was not possible to survey some areas within the survey extent; this is largely due to limited or irregular land access. This includes hedgerows 7,8 and 10 which were not surveyed due to denied land access. Hedgerow 9 was partially surveyed from accessible land and all other remaining hedgerows with granted land access have had surveys carried out.
- 2.3.2. Field surveys were restricted to locations where landowners granted permission, and therefore it was not possible in all instances to survey the hedgerows from both sides in accordance with best practice. In addition, in some areas, vegetation prevented surveyors from accessing both sides of a hedgerow. Nevertheless, it is considered that sufficient data has been collected for hedgerow evaluation and an accurate representation of the species was

obtained, and therefore this is unlikely to have detracted from the reliability of results.

- 2.3.3. This report is based on the scheme information obtained at the time of the appraisal. If the design is subject to significant change then an updated report with associated surveys may be required.

3. Results

3.1. Desk study

3.1.1. Multiple hedgerows within 50 metres of the scheme are recorded within historic mapping, dating back to 1882. This includes ancient hedgerows bordering fields, tracks, and roads. Hedgerows H28 and H30 border a historic parish boundary at the site of the route of the Roman Road. The route of the present day A417 is congruous with this historic settlement boundary, it is therefore likely that hedgerows lying adjacent to the A417 route will be historic in nature. Similarly, historic by-ways through the Shab Hill and Stockwell are well documented on historic mapping, indicating their long-established presence within the landscape, hedgerows H12, H16a, H16, H17, H21, H22, H23, H24 and H29 fall at these historic boundaries.

3.2. Field assessment

- 3.2.1. A total of 34 hedgerows were recorded within the survey area and were subject to further assessment. Twelve hedgerows were found to be species-rich, 10 species-poor intact, 9 were species-poor defunct and 3 hedgerows were not fully surveyed, due to access restrictions. Of the 31 hedgerows surveyed in this study, 13 were deemed to be important under the Hedgerow Regulations (Table 3.1).
- 3.2.2. To be classified as important, a hedgerow must be at least 30 years old and meet at least 1 of the 8 criteria set out in Schedule 1 of the Hedgerow Regulations 1997, summarised in appendix B.
- 3.2.3. Of the 12 species-rich hedgerows identified within the study area, 10 qualified as 'important' under the Hedgerow Regulations 1997 due to their wildlife and landscape value. An additional 3 hedgerows which were comprised of 4 woody species (species-poor intact) also qualified as important hedgerows due to their position adjacent to a "by-way open to all traffic" and additional features of biodiversity importance.
- 3.2.4. All hedgerows surveyed fall within the current design option, the hedgerow classifications and their locations regarding the current central route option are shown in Map 2 in Appendix B. All 'important' hedgerows and their reason for classification are detailed in Table 3.1 and the findings of all hedgerows surveyed are detailed in Table 3.2.

Table 3.1 Description of hedgerows qualifying as “important” under the Hedgerow Regulations 1997

Hedgerow Number	Land Parcel	Length	Species Rich	Important	Qualifying features
1	GR382246	136	Yes	Yes	At least 7 woody species listed through the length of the hedgerow, numerous woodland indicator flora
2	GR382246	220	Yes	Yes	Cross bill records within this hedgerow as identified
9	U00049	100	Yes	Yes	Hedge is older than 30 years, contains at least 6 woody species
12a	U00049	63	Yes	Yes	Hedge adjacent to a bridleway, foot path/road used by public, path/byway open to all traffic
17	GR159309	180	Yes	Yes	7 woody species and species rich woodland ground flora. Historic land boundary (pre1900). Hedge adjacent to a bridleway, foot path/road used by public, path/byway open to all traffic
17a	GR159309	100	No	Yes	Hedge adjacent to a bridleway, foot path/road used by public, path/byway open to all traffic + at least 4 woody species (from Schedule 3) + at least 2 of the features described in (a) to (g) above
22	GR159309	345	Yes	Yes	7 woody species present on a by-way open to all traffic
23	GR159309	225	Yes	Yes	6 woody species 3 features and Hedge adjacent to a bridleway, foot path/road used by public, path/byway open to all traffic
24	GR159309	675	No	Yes	4 species, 2 features and Hedge adjacent to a bridleway, foot path/road used by public, path/byway open to all traffic
27	U00120	130	Yes	Yes	Contains 6 woody species and 4 qualifying features
28	U00120	285	Yes	Yes	Demarks historic parish boundary, identified from 1882. 6 woody species with 3 features
29	GR159309	300	Yes	Yes	7 woody species but not technically a hedge as it forms part of the woodland
30	GR298558	308	Yes	Yes	7 woody Species

3.2.5. Of the 13 important hedgerows identified, 5 qualified as important due to their high species diversity (H1,H17,H22, H29 and H30) in which 7 woody species listed in Schedule 2 of the hedgerow regulations were present within the

hedgerow. A further hedgerow (H9) was identified due to its species richness in combination with landscape and wildlife features; particularly as the hedgerow contained a high proportion of standard trees and a diverse woodland ground flora.

- 3.2.6. Five of the important hedgerows were situated adjacent to a bridleway or by-way open to all traffic. Of these hedgerows, 3 (H17a, H24 and H23) would not have qualified as important hedgerows under additional criteria.
- 3.2.7. In addition, 1 hedgerow (H2) qualified as important due to records of common crossbill *Loxia curvirostra* at this location, all crossbill species are listed in Schedule 1 of the WCA 1981, fulfilling one criteria of an important hedgerow under the 1997 regulations. This hedgerow would not have qualified as important owing to any additional criteria.
- 3.2.8. Hedgerows form an important part of the character of a rural landscape. The landscape character within the study area is not homogenous and can roughly be categorised between the landscape to the west of the existing A417 route and those hedgerows lying to the east of the existing road. To the west and south of the existing road, remnants of ash dominated woodland are linked by relatively short hedgerows on steep foot slopes. Typically, the demarcation of these fields divide historic and presently used pastoral areas. To the east of the existing A417 the hedgerow configuration trends towards a more open landscape, set on more expansive fields at a markedly higher elevation to those in the west, with woodland linkages scant; traditional scrub hedgerows are often absent or defunct, replaced by ruderal banks, defunct stonewalls and post and wire fencing laced with bramble and hedge bindweed.
- 3.2.9. Mature standards trees (over 20 centimetres diameter at chest height) were heavily associated with the hedgerows to the west of the scheme, notably hedgerows H1, H2, H12a, H27, H28, H29 and H30. Mature and over-mature English oak *Quercus robur*, and ash *Fraxinus excelsior* standards were of biodiversity value were present, the scrub bulk of these hedgerows tended to be hawthorn *Crataegus monogyna* dominant with abundant field maple *Acer campestre*, hazel *Corylus avellana* and blackthorn *Prunus spinosa*.
- 3.2.10. Hedgerows, which defined the boundary extents of Stockwell Farm tended to be distinct in character (H16a, 22 and 24), bearing the hallmark of historic agricultural boundaries. These hedgerows lacked a well-defined scrub layer and were dominated by standard tree planting; the species composition comprised mature and often well maintained standards of singular or few dominant species. In H16a, this comprised exclusively beech *Fagus sylvatica*, in H22 English Oak with ash and horse-chestnut *Aesculus hippocastanum* and at H24 mature poplar hybrids were planted alternately with semi-mature small leaved lime *Tilia*

cordata. Though the age and condition of the trees indicate their present arrangement and planting is likely to be post-war, historic maps dating from the 1880's indicate the presence of historic boundary demarking vegetation, increasing the cultural and aesthetic value of these hedgerows.

- 3.2.11. Among the traditional scrub dominated hedgerows present within the study area the dominant species were hawthorn and blackthorn. However, these species were rarely a monoculture and were frequently associated with stands of field maple, rose species *Rosa* sp. hazel, wild privet *Ligustrum vulgare* and crab apple *Malus sylvestris*. Guelder rose *Viburnum opulus*, dogwood *Cornus* sp., holly *Ilex aquifolium*, Swedish whitebeam *Sorbus intermedia* and wild service *Sorbus torminalis* were rare within the hedgerows themselves but well distributed throughout the study area. Within hedgerows which qualified as important due to particularly high species richness, hazel, rose species, field maple and dominant hawthorn or blackthorn were noted to be growing within the shrub layer at varying heights at one given location, resulting in a dense appearance to the hedgerow body, with layers of species contributing to a well-defined structure.
- 3.2.12. The ground flora present fell into 2 broad categories; hedgerow with woodland ground flora (often more frequent to the west of the existing road) and species poor grassland fragments adjacent to intense arable agriculture. Hedgerows H1, H2, H9, H17, H17a, H27 and H28 comprised well distributed woodland species; lords and ladies *Arum maculatum*, lesser stitchwort *Stellaria graminea*, wood avens *Geum urbanum*, hedgerow cranesbill *Geranium pyrenaicum*, enchanter's nightshade *Circaea lutetiana*, dog's mercury *Mercurialis perennis*, herb Robert *Geranium robertianum*, primrose *Primula vulgaris* and native bluebell *Hyacinthoides non-scripta* were noted. In areas of frequent water pooling within H1 and H2, pendulous sedge *Carex pendula* was locally abundant. Lining the other hedgerows, ground flora tended to be poor and indicative of an enriched sward; narrow grassland strips dominated by cocks-foot *Dactylus glomerata*, hedge bindweed *Calystegia sepium*, false oat grass *arrhenatherum elatius* with stands of common nettle *Urtica dioica* and common ragwort *Senecio jacobaea* were present. An exception was H12a and H18-20, where crested dog's tail *Cynosurus cristatus*, and sweet vernal grass *Anthoxanthum odoratum* dominated, denoting the base-rich nature of the underlying soils.
- 3.2.13. Hedgerows can form important connections to wildlife landscape features; for example, rivers, streams, ponds and woodland. Within the studied area 2 hedgerows (H1 and H2) bordered streams, no hedgerows within the study area were directly (or within 20 metres of) a pond or wetland. Ten hedgerows linked with woodland habitat; H1, H2, H3, H4, H12a, H22, H27, H28, H29 and H30.

3.2.14. During the hedgerow surveys observations of notable fauna or signs of fauna were noted by surveyors. A stoat *Mustela erminea* was observed on the roadside bank adjacent to Hedgerow 16. Bird species such as yellowhammer *Emberiza citrinella* and goldfinch *Carduelis carduelis* were observed within the hedgerow 17. Hedgerow 18 is congruous to a reptile survey site where adder *Vipera berus* presence has been confirmed during 2019 surveys.

Table 3.2 Surveyed Hedgerows

	Species Rich	Important	(a) A bank or wall which supports the hedgerow along at least half of its length	(b) Gaps which aggregate do not exceed 10% of length of hedgerow	(c) Where the length of the hedgerow does not exceed 50m, at least one standard tree	(d) Where the length of the hedgerow exceeds 50m but does not exceed 100m, at least 2 standard trees	(e) Where the length of the hedgerow exceeds 100m, such number of standard trees (within a part of its length) as would be averaged over its total length amount at least one for each 50m	(f) At least 3 woodland species (Schedule 2) within one metre, in any direction, of the outermost edges of the hedgerow	(g) A ditch along at least one half of the length of the hedgerow	(h) Connections scoring 4 points or more in accordance with sub-paragraph (5)	(i) A parallel hedge within 15m of the hedgerow	Hedge older than 30 years?	Does hedge currently support or have desk study records of spp protected in Schedules 1, 5 or 8 of the WACA, or red data book species for 2007 to date.	Does the hedge include at least 7 woody species (from Schedule 3)	Does the hedge include at least 6 woody species (from Schedule 3) + 3 features listed overleaf?	Does the hedge include at least 6 woody species (from Schedule 3), including native black poplar, small or large lvd lime or service tree?	Does the hedge include at least 5 woody species (from Schedule 3) + four features listed overleaf?	Hedge adjacent to a bridelway, foot path/road used by public, path/byway open to all traffic + at least 4 woody species (from Schedule 3) + at least 2 of the features described in (a) to (g) above.
1	1	1					1	1	1	1		1		1			1	
2	1	1					1	1	1	1		1		1				
3			1		1					1	1		1					
4				1	1					1								
5			1				1	1										
6					1						1							
7																		
8																		
9	1	1		1		1			1			1			1			
10																		
11																		
12																		
12a	1	1		1			1					1						1
13							1					1						
13a			1									1						
14																		
15																		
16											1	1						
16a							1	1			1	1						
17	1	1						1			1	1		1				1
17a		1	1								1	1						1
18																		
19																		
20	1			1		1						1						
21	1		1	1	1													
22	1	1								1		1		1				
23		1		1						1	1	1						1
24		1					1				1	1						1
25																		
26																		
27	1	1			1				1	1		1			1			
28	1	1					1			1		1			1			
29	1	1		1								1						
30	1	1										1		1				
Total	12	13	5	7	5	2	8	5	3	8	8	20	1	5	4	0	1	5

4. Conclusion

- 4.1.1. Field surveys were undertaken in July 2019, 34 hedgerows were identified within 50m of the red line boundary of the scheme. Thirty-one of these hedgerows were subject to field survey at this time.
- 4.1.2. Hedgerows were assessed against their species diversity, and the criteria as set out within the Hedgerow regulations.
- 4.1.3. Of the 34 hedgerows identified 31 were surveyed in the field, 3 could not be assessed due to access permissions. It is recommended that future surveys are undertaken to complete these surveys, when access permission is granted.
- 4.1.4. Of the 31 hedgerows surveyed, 9 were found to be defunct, comprising either post-or wire fencing or fallen stonewalls which had been colonised by ruderal plants such as bramble, nettle and bindweed species.
- 4.1.5. The surveys identified 13 important hedgerows within the study area, 10 of these hedgerows qualified as important, predominantly due to their species-rich composition. A further 3 hedgerows qualified due to a moderate species richness combined with their prominent landscape position, adjacent to bridle ways and by-ways open to all traffic.
- 4.1.6. Species rich (containing over 5 species/30 metres) hedgerows were also mapped. A total of 12 species rich hedgerows were identified within the study area. Hedgerows providing important linkages to streams and woodland were numerous throughout the survey area, suggesting that hedgerows within the study area are likely to contribute significantly to the landscape connectivity for wildlife movements and dispersal. Future impact assessment of these hedgerows should take into account this aspect of their distribution in relation to the scheme proposals.
- 4.1.7. Hedgerow composition was dominated by hawthorn throughout the survey area, abundant shrub species included blackthorn, field maple, rose species and hazel. Standard trees were largely ash and English oak.
- 4.1.8. The survey area encompasses a historic rural landscape, with historic parish boundaries and agricultural estates evident on historic mapping resources. Hedgerows within the study area form part of these historic boundaries and would also be afforded protection as important hedgerows due to their cultural and aesthetic importance.

Appendix A: Criteria for Important Hedgerow

Accompanying notes for Hedgerows Regulations 1997 record sheet

A hedgerow may be classified as ‘important’ for archaeological/historical reasons, or according to Wildlife and Landscape criteria. To be classified as ‘important’ under the Wildlife and Landscape criteria, the hedgerow must be over 30 years old and should comprise 1 of the following:

- *at least 7 woody species/30m
- *at least 6 woody species/30m and at least 3 features
- *at least 6 woody spp/30m including any one of Pn/Sot/Tic/Tip (see below)
- *at least 5 woody species and at least 4 features
- or if adjacent to a bridleway/footpath, at least 4 woody species and at least 2 features

*If the hedgerow is situated wholly or partly in 1 of the counties listed in Criteria 7 sub-paragraph (2) of the Regulations, the number of woody species should be reduced by 1.

Note that a hedgerow may also be classified as ‘important’ due to the presence or recorded presence of particular animal and plant species (see Criteria 6 sub-paragraphs (1)-(4) of the Regulations for details).

Table A.1: The woody species ‘recognised’ by the Hedgerows Regulations 1997 are listed below, along with the species codes to be used on the record sheet

Spp	Scientific name	English name	Spp	Scientific name	English code
Ac	<i>Acer campestre</i>	Field Maple	Pa	<i>Prunus avium</i>	Wild Cherry
Ag	<i>Alnus glutinosa</i>	Alder	Pp	<i>Prunus padus</i>	Bird Cherry
Bpe	<i>Betula pendula</i>	Silver Birch	Ps	<i>Prunus spinosa</i>	Blackthorn
Bpu	<i>Betula pubescens</i>	Downy Birch	Pyc	<i>Pyrus communis</i>	Pear
Bxs	<i>Buxus sempervirens</i>	Box	Qp	<i>Quercus petraea</i>	Sessile Oak
Cb	<i>Carpinus betulus</i>	Hornbeam	Qr	<i>Quercus robur</i>	Pedunculate Oak
Cos	<i>Cornus sanguinea</i>	Dogwood	Rc	<i>Rhamnus cathartica</i>	Buckthorn
Ca	<i>Corylus avellana</i>	Hazel	Ruv	<i>Ribes uva-crispa</i>	Gooseberry
Cla	<i>Crataegus laevigata</i>	Midland Hawthorn	Ros	<i>Rosa sp(p)</i>	Rose
Cm	<i>Crataegus monogyna</i>	Hawthorn	Rac	<i>Ruscus aculeatus</i>	Butcher’s-broom
Cys	<i>Cytisus scoparius</i>	Broom	Sx	<i>Salix sp(p)</i>	Willow
DI	<i>Daphne laureola</i>	Spurge-laurel	Sxv	<i>Salix viminalis</i>	Osier
Ee	<i>Euonymus europaeus</i>	Spindle	Sn	<i>Sambucus nigra</i>	Elder
Fs	<i>Fagus sylvatica</i>	Beech	Sac	<i>Sorbus aucuparia</i>	Rowan
Fa	<i>Frangula alnus</i>	Alder Buckthorn	Sor	<i>Sorbus sp(p)</i>	Whitebeam
Fe	<i>Fraxinus excelsior</i>	Ash	Sot	<i>Sorbus torminalis</i>	Wild Service-tree
Hr	<i>Hippophae rhamnoides</i>	Sea-buckthorn	Tb	<i>Taxus baccata</i>	Yew
la	<i>Ilex aquifolium</i>	Holly	Tic	<i>Tilia cordata</i>	Small-leaved Lime

Spp	Scientific name	English name	Spp	Scientific name	English code
Jr	<i>Juglans regia</i>	Walnut	Tip	<i>Tilia platyphyllos</i>	Large-leaved Lime
Jc	<i>Juniperus communis</i>	Common Juniper	Ue	<i>Ulex europaeus</i>	Gorse
Liv	<i>Ligustrum vulgare</i>	Wild Privet	Ug	<i>Ulex gallii</i>	Western Gorse
Ms	<i>Malus sylvestris</i>	Crab Apple	Umi	<i>Ulex minor</i>	Dwarf Gorse
Pal	<i>Populus alba</i>	White Poplar	Um	<i>Ulmus sp(p)</i>	Elm
Pn	<i>Populus nigra sub-species betulifolia</i>	Black-poplar	VI	<i>Viburnum lantana</i>	Wayfaring-tree
Pot	<i>Populus tremula</i>	Aspen	Vop	<i>Viburnum opulus</i>	Guelder Rose
Pcan	<i>Populus x canescens</i>	Grey Poplar			

Table A.2: Woody species recorded in hedgerows but not recognised as such by Hedgerows Regulations 1997

Spp code	Scientific name	English name
Ah	<i>Aesculus hippocastanum</i>	Horse-chestnut
Ap	<i>Acer pseudoplatanus</i>	Sycamore
Cs	<i>Castanea sativa</i>	Sweet Chestnut
Pd	<i>Prunus domestica</i>	Wild Plum
	<i>Prunus laurocerasus</i>	Cherry Laurel
Tie	<i>Tilia x europaea</i>	Lime

The presence of a number of features along a hedgerow influences the classification under the Regulations. The terms used on the record sheet are explained in Table A.3 below, and their presence is indicated by a '✓'.

Table A.3: Terms used on the record sheet

Term	Description
Bank/wall	The hedgerow is supported along at least half of its length by a bank/wall.
Intact	The hedgerow contains less than 10% gaps along its length.
Trees	The hedgerow supports at least 1 standard tree per 50m length (standard trees are defined as those which when measured at 1.3m above ground level have a diameter of at least 20 cm, or 15 cm for multi-stemmed trees).
3 flora spp	The hedgerow supports at least 3 of the valuable ground flora species defined by the Regulations. The hedgerow is considered to support a plant if it is rooted within 1m (in any direction) of the hedgerow.
Ditch	There is a ditch along at least half of the length of the hedgerow.
Connections ≥ 4 points	A hedgerow must score 4 or more 'connections points'. Connections with an adjoining hedgerow(s) score 1 point each and a connection with a pond or woodland (in which the majority of the trees are broad-leaved) scores 2 points each. A hedgerow is considered to be connected if it meets the feature or if it has a point within 10m of it and would meet it if the line of the hedgerow continued.
Parallel hedge	A parallel hedgerow is present within 15m.

An explanation of additional terms used on the Hedgerow Regulations record sheet are contained in Table A.4.

Table A.4: Additional terms used on the Hedgerow Regulations record sheet

Term	Description
Hedge No.	Hedgerow Number (within survey area/ site)
Important	Is the hedgerow classified as 'important' under the Hedgerows Regulations?
Bridleway/path	The hedgerow runs parallel to a designated bridleway/footpath.
Pn/Sot/Tic/Tip	The presence of these trees within the hedgerow influences the classification. An explanation of the species codes is shown above.
Woody species	A list of the woody species found along the hedgerow (this is likely to list more species than are present along 30 m length(s)).
Ground flora spp	Any dominant and/or notable ground flora species recorded along the hedgerow.

Table A.5: Valuable ground flora species with regard to the Hedgerows Regulations 1997

Spp code	Scientific name	English name
Amos	<i>Adoxa moschatellina</i>	Moschatel
Ajr*	<i>Ajuga reptans</i>	Bugle
Alu*	<i>Allium ursinum</i>	Ramsons
An*	<i>Anemone nemorosa</i>	Wood Anemone
Amac	<i>Arum maculatum</i>	Lord's-and-Ladies
Aff*	<i>Athyrium filix-femina</i>	Lady-fern
Bsp*	<i>Blechnum spicant</i>	Hard-fern
Bs*	<i>Brachypodium sylvaticum</i>	False Brome
Bram	<i>Bromopsis ramosa</i>	Hairy Brome
Clat	<i>Campanula latifolia</i>	Giant Bellflower
Ctra	<i>Campanula trachelium</i>	Nettle-leaved Bellflower
Cxsy	<i>Carex sylvatica</i>	Wood Sedge
Cl*	<i>Circaea lutetiana</i>	Enchanter's Nightshade
Cmaj	<i>Conopodium majus</i>	Pignut
Daff	<i>Dryopteris affinis</i>	Scaly Male-fern
Dcar	<i>Dryopteris carthusiana</i>	Narrow Buckler-fern
Dfm	<i>Dryopteris filix-mas</i>	Male-fern
Ehel	<i>Epipactis helleborine</i>	Broad-leaved Helleborine
Esyl	<i>Equisetum sylvaticum</i>	Wood Horsetail
Eamy	<i>Euphorbia amygdaloides</i>	Wood Spurge
Fgig	<i>Festuca gigantea</i>	Giant Fescue
Fv*	<i>Fragaria vesca</i>	Wild Strawberry
Godo	<i>Galium odoratum</i>	Woodruff
Gsx*	<i>Galium saxatile</i>	Heath Bedstraw
Gro*	<i>Geranium robertianum</i>	Herb-Robert
Gu*	<i>Geum urbanum</i>	Wood Avens
Hn*	<i>Hyacinthoides non-scripta</i>	Bluebell
Lgal	<i>Lamiastrum galeobdolon</i>	Yellow Archangel
Lsqu	<i>Lathraea squamaria</i>	Toothwort
Ls*	<i>Luzula sylvatica</i>	Greater Wood-rush
Lnem	<i>Lysimachia nemorum</i>	Yellow Pimpernel
Mpra	<i>Melampyrum pratense</i>	Common Cow-wheat
Msyl	<i>Melampyrum sylvaticum</i>	Small Cow-wheat
Muni	<i>Melica uniflora</i>	Wood Melick

Spp code	Scientific name	English name
Mp*	<i>Mercurialis perennis</i>	Dog's Mercury
Meff	<i>Milium effusum</i>	Wood Millet
Omas	<i>Orchis mascula</i>	Early –purple Orchid
Oxa*	<i>Oxalis acetosella</i>	Wood Sorrel
Pqua	<i>Paris quadrifolia</i>	Herb Paris
Psco	<i>Phyllitis scolopendrium</i>	Hart's-tongue
Pnem	<i>Poa nemoralis</i>	Wood Meadow-grass
Pvul	<i>Polypodium vulgare</i>	Polypody
Pacu	<i>Polystichum aculeatum</i>	Hard Shield-fern
Pset	<i>Polystichum setiferum</i>	Soft Shield-fern
Pere	<i>Potentilla erecta</i>	Tormentil
Pste	<i>Potentilla sterilis</i>	Barren Strawberry
Pela	<i>Primula elatior</i>	Oxlip
Pvul	<i>Primula vulgaris</i>	Primrose
Raur	<i>Ranunculus auricomus</i>	Goldilocks Buttercup
Sne*	<i>Sanicula europaea</i>	Sanicle
Tsn*	<i>Teucrium scorodonia</i>	Wood Sage
Vmon	<i>Veronica montana</i>	Wood Speedwell
Vodo	<i>Viola odorata</i>	Sweet Violet
Vrei	<i>Viola reichenbachiana</i>	Early Dog-violet
Vriv	<i>Viola riviniana</i>	Common Dog-violet

* Denotes code taken from Phase 1 handbook.

The remaining species have not been given a code under Phase 1. To make up a code, use the first letter of the genus and first 3 letters of the specific epithet (for sedges use 'Cx').

Below are species codes for other species often found in hedgerows, with their codes as stated in Phase 1 handbook. The table suggests some of the possible dominant species for the recording table above, but is not exclusive. If any Ancient Woodland Indicators (AWI) are encountered (some are included below and marked 'AWI') which are not dominant and not listed as valuable under the Hedgerow Regulations, they should be included in the 'notes' section, not in the 'notables' section.

Table A.6: Ground flora recorded in hedgerows but not recognised as such by Hedgerows Regulations 1997

Spp code	Scientific name	English name
`	<i>Arrhenatherum elatius</i>	False Oat-grass
Apet	<i>Alliaria petiolata</i>	Garlic Mustard
Aste	<i>Anisantha sterilis</i>	Barren Brome
Asy*	<i>Anthriscus sylvestris</i>	Cow Parsley
Car*	<i>Cirsium arvense</i>	Creeping Thistle
Cxrm AWI	<i>Carex remota</i>	Remote Sedge
Ddl*	<i>Dryopteris dilatata</i>	Broad Buckler-fern
Dp*	<i>Digitalis purpurea</i>	Foxglove
Fu*	<i>Filipendula ulmaria</i>	Meadowsweet
Gap*	<i>Galium aparine</i>	Cleavers
Gh*	<i>Glechoma hederacea</i>	Ground-ivy
Gmol	<i>Galium mollugo</i>	Hedge Bedstraw
Hh*	<i>Hedera helix</i>	Ivy
Hl*	<i>Holcus lanatus</i>	Yorkshire-fog
Hlup	<i>Humulus lupulus</i>	Hop

Spp code	Scientific name	English name
Ig*	<i>Impatiens glandulifera</i>	Indian Balsam
Lped	<i>Lotus pedunculatus</i>	Greater Bird's-foot-trefoil
Lpc*	<i>Lonicera periclymenum</i>	Honeysuckle
Ocro	<i>Oenanthe crocata</i>	Hemlock Water-dropwort
Cop* AWI	<i>Chrysosplenium oppositifolium</i>	Opposite-leaved Golden-saxifrage
Pt*	<i>Pteridium aquilinum</i>	Bracken
Pver	<i>Primula veris</i>	Cowslip
Rf*	<i>Rubus fruticosus agg.</i>	Bramble
Shol	<i>Stellaria holostea</i>	Greater Stitchwort
Ssyl	<i>Stachys sylvatica</i>	Hedge Woundwort
Hand AWI	<i>Hypericum androsaemum</i>	Tutsan
Ud*	<i>Urtica dioica</i>	Common Nettle
Vio	<i>Viola sp</i>	Violet species

Appendix B Survey Maps



Key to symbols

Legend

- Option 30 Scheme Extent (at time of survey)
- Hedgerow importance**
- Defunct
- No
- Unknown - couldn't be surveyed
- Yes

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	November 2019	Minor Revision of key	TJ	EA	SM
P01	July 2019	1st Issue	TJ	EA	SM

Mott MacDonald Sweco



Drawing Status	Suitability
For Information	S2


Project Title
A417 - Missing Link

Drawing Title
Hedgerow survey results 2019

Scale	Designed	Drawn	Checked	Approved	
Original Size A1	CD	TJ	EA	SM	
Date	JULY 2019	Date	JULY 2019	Date	JULY 2019

Drawing Number	Originator	Volume	Project Ref. No.
551505 - MMSJV	EBD	-	551505
000	DR	LB	00053
Location	Type	Role	Number
			P02

Appendix C Photographs


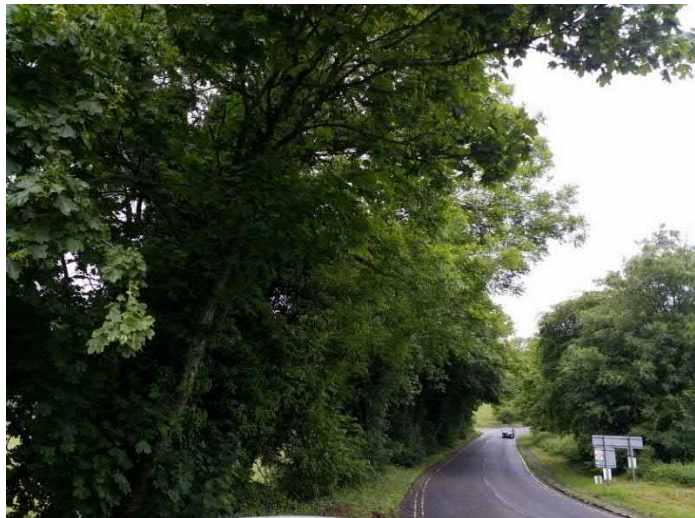

Hedgerow	Photograph
1	


2



3



4	
5	
6	




7	No access- survey not undertaken
8	No access- survey not undertaken
9	 <p>The first photograph shows a white flower with five petals and a yellow center, surrounded by lush green ferns and foliage. The second photograph shows a large, dense green bush with many leaves, some showing signs of insect damage or disease, set against a background of trees and a hillside.</p>
10	No access- survey not undertaken




11 and 12









12a








<p>13 Bund</p>	
<p>13</p>	
<p>14</p>	

<p>15</p>	
<p>16- Hedge not Present</p>	
<p>16- Windrow</p>	

17a	
17	
18	No photograph
19	

20	
21	 
22	No photograph

23	
24	
25	

26	
27	
28	No photographs

29	
30	No photographs

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.3
NVC Woodland Survey Report

28 September 2020

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Executive Summary

The proposed A417 Missing Link scheme (hereafter referred to as ‘the scheme’) aims to provide a dual carriageway to a stretch of single carriageway between the Cowley roundabout and Crickley Hill in Gloucestershire; the 5.5km section is the only remaining section of single carriageway. The scheme would increase capacity by creating a free-flowing link between the Brockworth Bypass and Cowley roundabout and remove the at-grade junction with the A436, resulting in a continuous flow between the M4 Junction 15 (Swindon) and the M5 Junction 11a (Gloucester/Cheltenham).

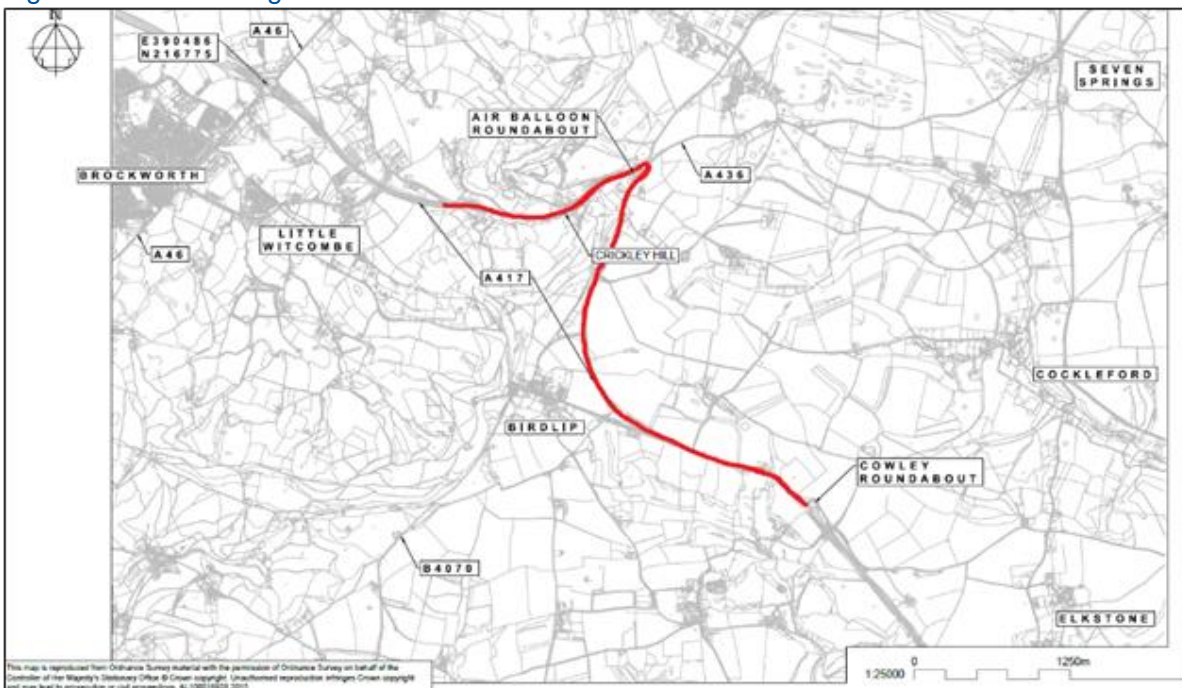
National Vegetation Classification (NVC) field surveys to identify woodland plant communities were undertaken by Mott MacDonald in 2019. The field surveys assigned a total of 8 separate plant communities for the 24 land parcels surveyed.

1. Introduction

1.1. Background

1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and as an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'missing link', forms the only section of single carriageway along the route, with an at-grade junction located at the 'Air Balloon' public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5km stretch shown on Figure 1 below.

Figure 1: A417 Missing Link Scheme Location Plan



Source: GiGi GIS Portal. Crown Copyright 2016 100030649

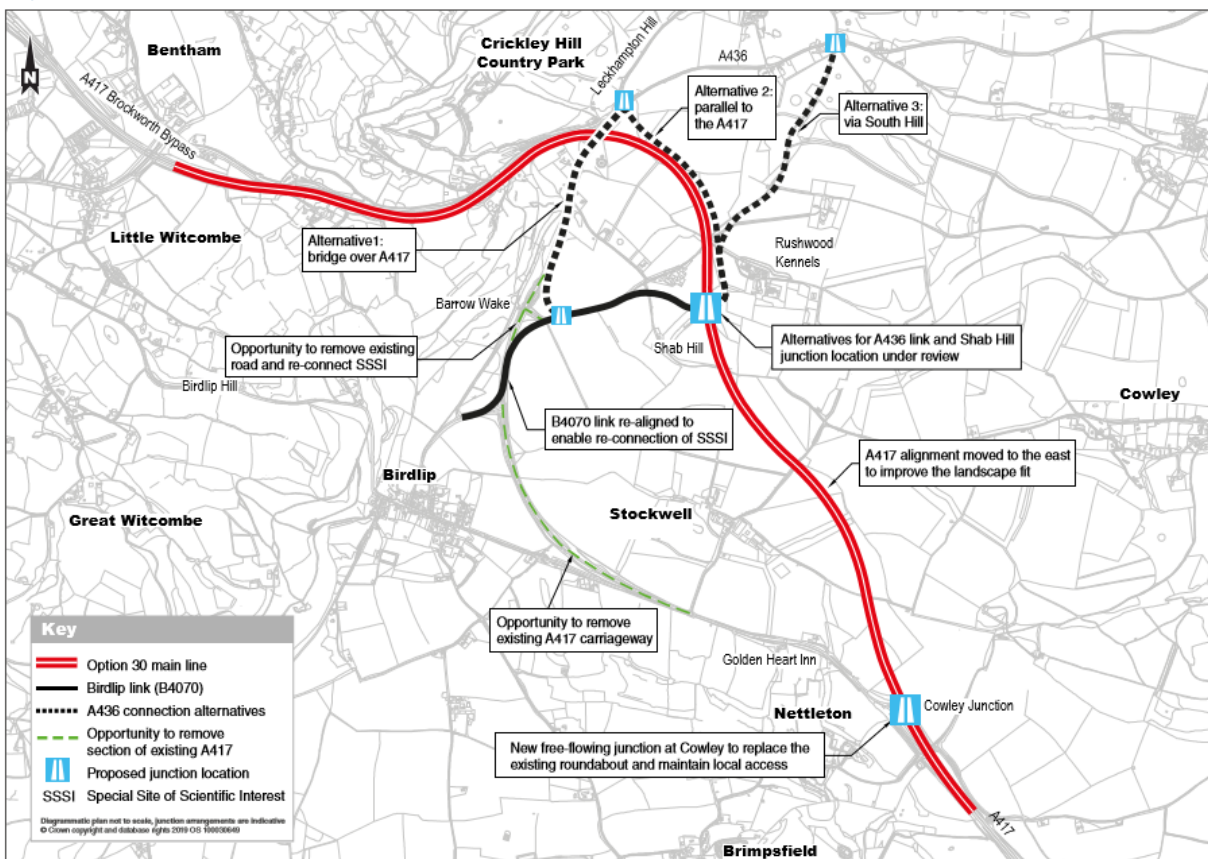
1.2. Scheme Proposal

1.2.1. The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill.

1.2.2. Any proposed scheme would aim to increase capacity by creating a free-flowing link between the Brockworth Bypass and the Cowley roundabout and remove the at-grade junction with the A436 (Air Balloon roundabout). This Missing Link will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester / Cheltenham (M5 Junction 11).

- 1.2.3. The preferred route for the scheme was confirmed as Option 30 by the Secretary of State in March 2019 (see Figure 2 below). The scheme comprises the construction of a new dual carriageway to replace the existing single carriageway section between Brockworth bypass and Cowley Roundabout. It is predominately an "offline" scheme but approximately a third of the route follows the existing A417 route corridor at Crickley Hill.
- 1.2.4. A new link road would be built between the slip road junction at Shab Hill and the existing A417 to connect traffic to and from Birdlip and the A436 with the new A417. This new link road would end in a new roundabout near Barrow Wake.

Figure 2: A417 Preferred Route Announcement



- 1.2.5. Figure 1.2 above shows how there were three A436 link road alternative connections. Alternative 2 is the option taken forward for assessment in the Environmental Statement.

1.3. Objectives and Scope of the Report

- 1.3.1. The objectives and scope of the report are:

- to identify areas of notable woodland with potential to be directly or indirectly impacted by the scheme and carry out a NVC survey of those areas;
- to assess the composition and structure of the plant communities identified, and assign an NVC plant community category;
- to present the methods, results and constraints of the National Vegetation Classification (NVC) survey;

1.4. Study Area

- 1.4.1. This area is within the Cotswolds Area of Outstanding Natural Beauty (AONB). The Cotswolds are nationally important for their rare limestone grassland habitat and for ancient beechwoods with rich flora. Some Cotswolds plants are so rare that they have specific legal protection under the Wildlife and Countryside Act 1981.
- 1.4.2. Motorways, together with a central location, make the Cotswolds accessible to a huge urban visitor area including Bristol, London and the West Midlands. The AONB, with 'honey pot' villages such as Bourton-on-the-Water, Bibury and Castle Combe, is a national and international tourist destination as well as an important local recreation area¹.

1.5. Zone of Influence

- 1.5.1. Guidance on ecological assessments recommends that all ecological features that occur within a zone of influence (Zoi) for a proposed scheme are investigated (CIEEM, 2016). The potential Zoi includes:
- areas to be directly within the land take for the proposed scheme and access that could cause loss of woodland or severance of woodland habitat;
 - areas that would be temporarily affected during construction that cause loss or disturbance to woodland habitats, and;

¹ Landscapes for Life. Cotswolds AONB. Available from <https://landscapesforlife.org.uk/about-aonbs/aonbs/cotswolds>

- areas where there is a risk of noise and light disturbance during construction and/or operation.

1.5.2. For the NVC woodland survey, the zone of influence considered land up to 200m from the schemes construction footprint, to account for potential air quality impacts which have potential to have adverse impacts within 200m of the air pollution source.

1.6. Legislative and Policy Framework

1.6.1. The construction and operational activities for the proposed works must comply with International, European and UK nature conservation legislation, and with national and local biodiversity policies. The two main pieces of legislation on nature conservation are the Wildlife and Countryside Act 1981 (WCA 1981) and, the Conservation of Habitats and Species Regulations 2017 which transposes Council Directive 92/43/EEC, on the conservation of natural habitats and of wild fauna and flora (EC Habitats Directive), into national law.

1.6.2. Other key national policies which influence the ecology and nature conservation assessments are the:

- National Policy Statement for National Networks (2014);
- The Natural Environment and Rural Communities (NERC) Act 2006;
- UK Post-2010 Biodiversity Framework (2012); and
- Biodiversity 2020: A strategy for England's wildlife and ecosystem service (2011).

1.6.3. The relevant local biodiversity policy is the Gloucestershire Local Nature Partnership (GLNP), GNLP Strategy; The Future For Nature 2019-2022.

1.6.4. **Gloucestershire Local Nature Partnership (GLNP), GNLP Strategy; The Future For Nature 2019-2022.** The three year strategy for the GLNP is designed to provide a top-level set of priorities for the group to promote and, with its constituent partners, to take action to deliver in order to conserve and enhance the county's biodiversity². No specific NVC communities have been described within this strategy.

1.6.5. **Ancient Woodland Inventory.** The Ancient Woodland Inventory identifies woodlands that have had continuous woodland cover for some centuries. The

² Gloucestershire Local Nature Partnership (2019). The Future For Nature 2019-2022. Available from <https://www.gloucestershirenature.org.uk/our-strategy>

Ancient Woodland Inventory has become an important tool for policy makers and planners. Although ancient woodland may be a feature of statutorily designated sites, it is not in itself a statutory designation. However, ancient woodland is given considerable protection through the planning process.

2. Methodology

2.1. Field Survey

- 2.1.1. The survey was undertaken by experienced Mott MacDonald Ecologists (Phil Newberry, Jonathan Dye and Bethany Gray) between 14 and 17 May 2019, as well as, between 21 and 24 May 2019.
- 2.1.2. The survey was undertaken using the standard methodology from NVC Woodlands.³
- 2.1.3. Full NVC surveys (where safe) were conducted on all woodland land parcels within the Study Area. Each woodland parcel was given an initial walkover, to assess the number of homogenous stands present within each parcel. 50m x 50m plots were placed within each stand. The canopy and sub-canopy layers can be surveyed at this point, identifying the tree and shrub species within each stand. Domin values were then used to deduce the abundance of each canopy - layer species. The Domin scale is a classification of plant cover used to measure abundance within a specific quadrat. An approximation of the canopy layers' cover percentage and mean height was then undertaken.
- 2.1.4. 4m x 4m quadrats were then undertaken within each plot, to assess the diversity of the ground flora, and a photo was taken for each quadrat. If the ground flora vegetation was sparse, then 10m x 10m quadrats were undertaken. Every species within each quadrat was positively identified and assigned a Domin value. Also, for each quadrat, the average height of the ground flora layer was undertaken. At this point, plant communities were assigned for each stand. Domin values were also assigned for the amount of bare ground in each quadrat.
- 2.1.5. Other aspects of the NVC survey included; describing the management of each of layer or particular species (i.e. lapsed coppiced hazel, active pollard oak), the structure of the woodland habitat, plus noting any noticeable faunal damage (usually caused by browsing deer or squirrels).
- 2.1.6. Professional judgement was then undertaken by keying out grouped quadrats using the NVC community key to woodland, whilst also comparing floristic tables of NVC communities to the grouped quadrats.³
- 2.1.7. For each species identified, Domin values were assigned (Table 1).

³ Rodwell, J.S. (Ed.) (1990) British Plant Communities. Volume 1. Woodland and scrub. Cambridge University Press. Cambridge.

Table 1: “Domin” and percentage abundance values used

Domin Value	Percentage abundance
10	91-100%
9	76-90%
8	51-75%
7	34-50%
6	26-33%
5	11-25%
4	4-10%
3	< 4% many
2	< 4% several
1	< 4% few

Source; Rodwell et al. 1990.

- 2.1.8. The nomenclature for the vascular plants in this report follows Stace⁴ for both scientific and English names. Scientific names are only mentioned the first time each species is named in the report unless heading a table or figure.
- 2.1.9. Constancy values (see Table 2) were assigned for each species surveyed. These values give a good indication of the frequency of a particular species within a specific community. A constancy value of IV or V denotes a frequency of more than 60% i.e. a species that is present in four or more quadrats, out of a total of six quadrats within a community. Such species are described as constant.
- 2.1.10. A software package, Modular Analysis of Vegetation Information System (MAVIS), was used as a guidance to determine plant communities for each area. The community tables for all stands are shown in Appendix D.

Table 2: Constancy values

Cover Value	Frequency class
1-20%	I
21-40%	II
41-60%	III
61-80%	IV
81-100%	V

Source; Rodwell et al. 1990.

2.2. Survey Constraints

- 2.2.1. The survey was undertaken within the optimum survey period for NVC Woodland surveys (April to June).
- 2.2.2. There were some woodland parcels that were unsafe to survey under full NVC woodland surveying protocols. These were due to the conditions underfoot, which were either very steep slopes or boggy terrain. Where safe, the canopy,

⁴ Stace, C.S. (2019). New Flora of the British Isles. 4th Edition. Cambridge University Press, Cambridge.

sub-canopy and ground flora layer species were noted and assigned DAFOR (Dominant, Abundant, Frequent, Occasional and Rare) abundance values.

- 2.2.3. One woodland (close to Emma's Grove) could not be surveyed as land access was not granted at the time of survey. It is recommended that this woodland is surveyed in spring 2020 to assess the communities present and in-particular the presence of ancient woodland indicators, if access is possible.

3. Results

3.1. Woodland NVC Survey Results

- 3.1.1. A total of 24 separate woodland stands were surveyed, of which, 20 of these stands were surveyed under standard NVC woodland protocols. Four separate woodland stands were identified at the Barrow Wake site (GR354675). In four stands, where the terrain was very steep and therefore unsafe to undertake ground flora quadrats, DAFOR (Dominant, Abundant, Frequent, Occasional and Rare) values were given. Using binoculars, the ground flora within these stands, could be safely identified.
- 3.1.2. Following analysis, eight plant communities and sub-communities were identified within the survey areas. These are described in further detail below and their locations shown in Appendix A. Photographs of each survey quadrat are provided in Appendix B, species tables are provided in Appendix C and community lists are provided in Appendix D.
- 3.1.3. The following land parcels resembled the **W8e *Fraxinus excelsior* – *Acer campestre* – *Mercurialis perennis* woodland – *Geranium robertianum* sub-community**; Woodland at Fly Up Project (GR112176); Barrow Wake woodland Stands 1, 2 and 4 (GR354675); Woodland at Rushwood Kennels (GR138283); Woodland at Birdlip Radio Station (GR252644); Highways England woodland north of A417 (GR323231); Woodland north east of Grove Farm (GR320093); Woodland south of Dog Lane (no land registry title given); and, Highways England woodland south of A417 (GR326339, GR325786, GR19275, GR21956, GR21586).
- 3.1.4. The following land parcels resembled the **W8a *Fraxinus excelsior* – *Acer campestre* – *Mercurialis perennis* woodland – *Primula vulgaris* – *Glechoma hederacea* sub-community**; Barrow Wake woodland Stand 3 (GR354675); Shab Hill woodland Stand 3 (GR97761); and, Woodland north of Dog Lane (GR95689).
- 3.1.5. The following land parcel resembled the **W8d *Fraxinus excelsior* – *Acer campestre* – *Mercurialis perennis* woodland - *Hedera helix* sub-community**; Woodland at Cukoopen Barn Farm (GR136598).
- 3.1.6. The following land parcels resembled the **W8f *Fraxinus excelsior* – *Acer campestre* – *Mercurialis perennis* woodland – *Allium ursinum* sub-community**; Crickley Hill woodland Stand 2 (GR32911); and, Ullen Wood parcels (GR346313), (GR352384) and (GR354154).

- 3.1.7. The following land parcels resembled the **W12a *Fagus sylvatica* - *Mercurialis perennis* woodland – *Mercurialis perennis* sub-community**; Shab Hill woodland Stand 1 (GR97761); Woodland at Birdlip Quarry (GR353298); and, Woodland at The Scrubbs (GR32911).
- 3.1.8. The following land parcel resembled the **W12b *Fagus sylvatica* - *Mercurialis perennis* woodland – *Sanicula europaea* sub-community**; Crickley Hill woodland Stand 1 (GR32911).
- 3.1.9. The following land parcel resembled the **W21b *Crataegus monogyna* – *Hedera helix* scrub community - *Mercurialis perennis* sub-community**; Shab Hill woodland Stand 2 (GR97761).
- 3.1.10. The following land parcel resembled the **MG1a *Arrhenatherum elatius* grassland – *Festuca rubra* sub-community**; Land north west of Grove Farm (GR320093).

3.2. Surveyed Land Parcels

- 3.2.1. **Woodland at Fly Up Project (GR112176)**. This is linear woodland adjacent directly to the south of the A417. This is likely to be historically planted canopy (as a screen to the A417) and is currently exhibiting no signs of recent management. The ground layer throughout is very soft, uneven and undulating underfoot, therefore it was unsafe to survey the ground flora within the entire extent of the woodland. As such, DAFOR values were given for ground flora species present where terrain underfoot was considered safe. Both the canopy and sub-canopy layers are open and there are waterbodies present within the woodland. Oak species *Quercus* sp. are noticeably absent from the canopy layer and therefore all oak woodland communities can be discounted. Although ash *Fraxinus excelsior* is the most prominent canopy species, W9 can also be discounted due to the absence of rowan *Sorbus aucuparia* and downy birch *Betula pubescens*. This woodland can be ascribed as W8 *Fraxinus excelsior*-*Acer campestre*-*Mercurialis perennis* woodland due to presence of hawthorn *Crataegus monogyna*. There are a few crack willow *Salix fragilis* and alder *Alnus glutinosa* trees present, though are scattered. This would suggest that there are pockets of damper habitat within this woodland. Due to the local abundance of common nettle *Urtica dioica* and the presence of elder *Sambucus nigra* within the sub-canopy layer, the habitat has the strongest affinities with the W8e *Geranium robertianum* sub-community. This area has been classified as Priority Deciduous Woodland. MAVIS analysis could not be implemented, as it was considered unsafe to undertake ground flora quadrats.
- 3.2.2. **Barrow Wake woodland Stand 1 (GR354675)**. This stand is a pocket of young woodland located on undulating terrain, which is sloping downwards from the

road. The canopy is open with beech and ash. Within the sub-canopy layer there is coppiced hazel *Corylus avellana* present thus indicating past management, but only within a small concentration towards the northern extent. Other than that, there are no signs of recent management. The area is freely accessible with public paths situated throughout the woodland stand. The ground flora is sparse where beech *Fagus sylvatica* is present, though this ground layer is locally abundant in places. There is young ash in the south western corner of the stand with several semi mature and mature beech trees present. Oak species are rarely abundant in the canopy layer, as well as, being absent from the canopy quadrat and therefore oak woodland communities can be discounted. Although ash is the most prominent canopy species, W9 can be ruled out due to the absence of rowan and downy birch. The woodland can be ascribed as W8e *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland *Geranium robertianum* sub-community, due to the presence of prominent ash in the canopy layer and hawthorn plus elder within the sub-canopy layer. The W8e sub-canopy is strongly associated with the ground flora composition of; constant dog's mercury *Mercurialis perennis*, frequent bramble *Rubus fruticosus* agg., plus rarely abundant common nettle and ivy *Hedera helix*. This area has been classified as Priority Deciduous Woodland. MAVIS analysis has identified the stand as either W8, W12 or W13 communities. Neither beech or Yew *Taxus baccata* dominate the canopy layer and therefore the W12 and W13 communities can be discounted.

- 3.2.3. **Barrow Wake woodland Stand 2 (GR354675).** This small stand is a woodland comprised of a canopy of semi mature grey willow *Salix cinerea*. The southern extent divided by stock fencing and undulating terrain within the eastern extent with abundant deadwood. The ground layer flattens out after sloping down from the A417. The canopy layer is very open with occasional grey willow and sycamore *Acer pseudoplatanus* and a more extensive sub-canopy with coppiced hazel with scattered and occasional elder, as well as, hawthorn. The structure of this layer suggests some previous coppicing management with some canopy clearance though it appears that this woodland parcel is currently unmanaged. The woodland most strongly resembles the W8e *Fraxinus excelsior-Acer campestre-Mercurialis perennis-Geranium robertianum* sub-community due to the presence of hazel and hawthorn within the sub-canopy. The constancy of common nettle and herb-robert *Geranium robertianum*, plus the locally abundant presence of dog's mercury and frequency of bramble suggests that the woodland is a W8e sub-community. MAVIS has identified this stand as either W6, W8, W21, W24 or W25. The W6, W21, W24 and W25 woodland communities can be discounted as the canopy is not dominated by willow species or alder. Also, the habitat is not a scrub community.

- 3.2.4. **Barrow Wake woodland Stand 3 (GR354675).** This is a small woodland stand directly easterly and north-easterly adjacent to Barrow Wake car park is comprised of an open and prominent ash canopy with coppiced hazel. The ground undulates greatly and is open to the public. There is no apparent recent management. Rowan and downy birch are absent whilst ash and hazel predominantly make up the canopy and sub-canopy layers. Sycamore and elm species *Ulmus* spp. are also absent from these layers. The woodland shows the strongest affinities with the *W8a Fraxinus excelsior-Acer campestre-Mercurialis perennis woodland-Primula vulgaris-Glechoma hederacea* sub-community. Ivy is absent throughout the woodland and therefore sub-communities W8d and W8e can be discounted. Known W8a associate species are present, these are constant ground ivy *Glechoma hederacea* and frequent common dog-violet *Viola riviniana* which are present within the quadrats, whilst bugle occurs within the woodland stand. Other species present within the open ground flora layer are constant bramble, frequent cleavers *Galium aparine*, occasional smooth meadow-grass *Poa pratensis*, as well as, rarely frequent burdock *Arctium* spp., common twayblade *Listera ovata*, dandelion *Taraxacum officinale* agg., germander speedwell *Veronica chamaedrys*, bush vetch *Vicia sepium*, traveller's-joy *Clematis vitalba* and creeping thistle *Cirsium arvense*. The bryophyte layer consists of frequent rough feather-moss *Brachythecium rutabulum*, occasional common feather-moss *Kindbergia praelonga* and hypnum moss *Hypnum cupressiforme*. This area has been classified as Priority Deciduous Woodland. MAVIS has identified this stand as either W6, W8, W12, W24 or W25. This woodland is neither dominated by willow, beech or alder and cannot be considered a scrub habitat. Therefore, all woodland communities bar the W8 community, can be discounted.
- 3.2.5. **Barrow Wake woodland Stand 4 (GR354675).** This stand is a woodland comprised of predominantly semi-mature oak canopy layer with a sub-canopy layer. The northern and western extent is comprised of a very steep slope and therefore too difficult and unsafe to survey. This comprised mainly of coppiced hazel and scattered ash trees. This is an area open to the public and is likely to undergo management periodically. As ash is frequent within the canopy, the W10 community can be ruled out. Rowan and downy birch are absent and therefore the W9 community can also be discounted. This woodland stand can be ascribed as the *W8e Fraxinus excelsior-Acer campestre-Mercurialis perennis woodland Geranium robertianum* sub-community. This is due to the presence of occasional herb robert and cleavers plus rarely abundant common nettle. Wild garlic is also a rare species within the ground layer. Known W8e associate dog's mercury is frequent and achieves cover where present. Other species present within the ground flora layer are constant wood avens *Geum urbanum*, frequent smooth meadow-grass, occasional woodruff *Galium odoratum*, false brome *Brachypodium sylvaticum*, cleavers and dandelion plus rarely abundant woody

nightshade *Solanum dulcamara*, barren strawberry *Potentilla sterilis*, male fern *Dryopteris filix-mas* and germander speedwell. The bryophyte layer is comprised of infrequent rough feather-moss and rarely abundant common feather-moss. This area has been partially classified as Priority Deciduous Woodland. MAVIS has identified this stand as either W6, W8, W12 or W24. This woodland is not dominated by willow, beech or alder within the canopy layer and is also not a scrub habitat. Therefore, all woodland communities bar the W8 community, can be discounted.

3.2.6. **Shab Hill woodland Stand 1 (GR97761).** This linear stand, adjacent to a public rights-of-way, is a semi-mature to mature beech woodland with cavities in trunks and very sparse ground flora with leaf litter. There was an understorey layer of hawthorn, elder and holly on the fringes of the woodland. The canopy layer was closed with sparse vegetation within the ground layer. This may be due to the distinct lack of sunlight reaching the ground layer. This woodland can be ascribed as W12a *Fagus sylvatica-Mercurialis perennis* woodland *Mercurialis perennis* sub-community as the field layer has constant and locally abundant dog's mercury. The sub-canopy layer was very sparse and is characteristic of a W12 community. The ground layer was very species-poor and sparse due to the heavy shade from the closed beech canopy. Occasional lords-and-ladies *Arum maculatum* (a known W12a associate species), infrequent hawthorn seedlings and rarely abundant common nettle comprised the rest of the ground layer though all were of low abundance. The bryophyte layer was comprised of constant rough feather-moss and infrequent common feather-moss. MAVIS identified this stand as either W8, W12, W13 or W21. Ash and yew are absent whilst this habitat is not scrub. Therefore, the latter three communities can be ruled out.

3.2.7. **Shab Hill woodland Stand 2 (GR97761).** This area is comprised of scattered shrub species without a canopy layer present. This area can be described as scrubby habitat with scattered elder and hawthorn trees present within the sub-canopy. The woodland is likely to be a hawthorn community with scattered trees forming an open sub-canopy. There is scattered hawthorn on fringes of woodland and likely to be unmanaged with hypnum moss growing on trunks of elder trees. The woodland is on a steep embankment adjacent to the grassy footpath. It is likely that this area has been unmanaged for a considerable amount of time. This habitat can be ascribed as W21b *Crataegus monogyna-Hedera helix* scrub-*Mercurialis perennis* sub-community. This is due to hawthorn and elder *Sambucus nigra* present within the sub-canopy layer, plus constant dog's mercury, ground ivy, common nettle and occasional rough-meadow grass *Poa trivialis* within the ground flora layer. This area has been classified as Priority Deciduous Woodland. MAVIS analysis suggests the woodland is either W6, W21, W24, OV21, OV24 or SD18. The habitat is comprised of an

established understorey layer, therefore the latter three communities can be ruled out. Bracken *Pteridium aquilinum* is absent and the W24 community can also be ruled out.

- 3.2.8. **Shab Hill woodland Stand 3 (GR97761).** This is a young to semi mature woodland, mainly comprised with ash within the canopy young ash canopy, goat willow and elder sub-canopy. The ash canopy is scattered and open, which is predominantly within the northern extent of woodland. The margins of the wood are dense with vegetation and are on a steep south facing slope. There are no signs of recent management. The ground flora distribution was patchy with several areas of bare ground. Due to the frequency of ash and hawthorn, as well as, the absence of rowan, downy birch and elm species the community can be attributed to W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland. The woodland most closely resembles the W8a *Primula vulgaris-Glechoma hederacea* sub-community due to the presence of ground ivy. Bugle *Ajuga reptans*, another W8a species, is also present though not within the quadrat samples. Dog's mercury, although not a constant species, is locally dominant within the ground flora. Other species present are; infrequent sycamore and elder within the sub canopy, as well as, constant common nettle and occasional enchanter's nightshade. The bryophyte layer consists of constant and locally abundant common feather-moss and infrequent rough feather-moss. This area has been classified as Priority Deciduous Woodland. MAVIS analysis has identified that this woodland is either W6, W8, W12, W21, W25 or SD18. Beech and alder are absent from the canopy layer. Grey willow *Salix cinerea* does not dominate, whilst the habitat is neither scrub or sand dune habitat. Therefore, all communities, except W8, can be discounted.
- 3.2.9. **Woodland at Rushwood Kennels (GR138283).** There has been a recent tree clearance on the far south-eastern extent of the site, though no apparent recent management to the rest of the woodland. This woodland is located on a south facing slope with a predominantly ash and sycamore canopy with a hawthorn sub-canopy with patches of dog's mercury on the northern aspect of the woodland. The woodland has a central track with damp areas next to the track indicated by soft rush *Juncus effusus* and great willowherb *Epilobium hirsutum*. The woodland contains several young to semi-mature beech trees within the canopy, though this does not largely form the canopy layer. There are several patches of extensive and thick ruderal vegetation present within the central section of the woodland. There was no ground flora around a cluster of young sycamore trees on the southern extent of the woodland. An inlet was present running north to south through the woodland and starting at a small pond on the eastern extent of the woodland with dense algae, *Juncus* spp and great willowherb. The open woodland most closely resembles W8e *Fraxinus excelsior-Acer campestre-Mercurialis perennis-Geranium robertianum* sub-community.

This is due to ash predominantly forming the canopy and the very sparse sub-canopy layer comprised partially of hawthorn. Many ground flora species are present close to the northern track though are not present throughout all other areas of the woodland. Species present within the quadrats that are indicative of a W8e sub-community are constant and locally abundant bramble, as well as, constant and sparse cleavers. This area has been classified as Priority Deciduous Woodland. MAVIS analysis has identified the woodland as either W6, W8, W12 or W24. Willow and alder are absent from the canopy and although beech is present, does not dominate this layer. The woodland cannot be considered a scrub habitat therefore all of these woodland communities, except for W8, can be ruled out.

3.2.10. **Crickley Hill woodland Stand 1 (GR32911).** This is young to semi mature beech woodland managed by the Gloucestershire Wildlife Trust and is boarded by wooded fencing. The woodland is open to the public with trails and paths throughout the woodland. There are several brush piles in woodland, suggesting there has been recent management. The canopy is fairly open in some areas suggesting that beech has been historically felled and that ash has likely grown in 'regeneration gaps' within the canopy layer. This woodland can be ascribed as W12 *Fagus sylvatica-Mercurialis perennis* woodland as hazel and ash occur within the canopy and sub-canopy layers. The woodland shows the strongest affinities to the W12b *Mercurialis perennis* sub-community due to the presence of abundant ash within the canopy layer. Further evidence of a W12a sub-community is the presence of false brome *Brachypodium sylvaticum*, enchanter's nightshade, wild garlic, lesser celandine *Ficaria verna* and bramble, though none of these species occur within the quadrat sampling. The ground flora is comprised of constant and locally abundant wood avens, occasional cleavers and smooth meadow-grass, as well as, the presence of numerous tree saplings (beech, ash, hazel, pedunculate oak *Quercus robur*, field maple *Acer campestre* and hawthorn). This area has been classified as Priority Deciduous Woodland. MAVIS analysis has classified this woodland as either W8, W10, W12, W24, OV24 or MG1. As oak is absent and ash is only a small component of the woodland, the W8 and W10 communities can be ruled out. As this woodland is neither scrub, grassland or open vegetation all other communities, except W12 can be discounted.

3.2.11. **Crickley Hill woodland Stand 2 (GR32911).** This is a mature ash and hazel dominated woodland though some ash saplings are present. There is abundant coppiced hazel, therefore indicating past management. The ground flora is dominated by wild garlic with some tree saplings present (field maple, ash, hawthorn and hazel). The woodland is enclosed and not open to the public and is surrounded by a stock proof fence. There are two mature beech trees with callus rolls, as well as, small quantities of fallen deadwood in situ. The woodland

slopes at a constant angle towards the north west. Due to the absence of rowan and downy birch, the W9 woodland community can be discounted and because ash forms the prominent canopy layer, the woodland can be ascribed as W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland. Due to the dominance of constant wild garlic within the ground flora layer, the woodland has the strongest affinities with the W8f *Allium ursinum* sub-community. Dog's mercury is locally abundant within the ground flora and may be more prominent later in the year when wild garlic has died back. Other species present within the ground flora are infrequent lords-and-ladies, bluebell, wood anemone and herb-paris. The bryophyte layer is comprised of frequent common feather-moss, occasional rough feather-moss and rarely abundant common smoothcap. This area has been classified as Priority Deciduous Woodland. MAVIS analysis suggests that the woodland is either W8, W10, W12, W13 or W21. Oak and yew are absent whilst beech, although present, is not a dominant species. This woodland cannot be considered scrub habitat and therefore all communities, except W8 can be excluded.

- 3.2.12. **Woodland at Birdlip Radio Station (GR252644).** This stand of woodland was directly northerly adjacent to Birdlip Radio Station and is enclosed by stock fencing. The canopy layer is very open with planted young to semi-mature ash and sycamore, whilst the sub-canopy is very sparse and is comprised of hawthorn. The ground flora layer is patchy in abundance though more species-rich than the adjacent stand. This layer was grassy in areas where the canopy is open. Due to the absence of rowan, sessile oak and elm species within the canopy, the W9 community can be discounted. Oak species are also absent and therefore any associated oak woodland communities can also be discounted. The woodland can be ascribed as W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland as ash is the prominent species within the open canopy with some associated sycamore also present though far less abundant. Due to the young age of the woodland, the ground flora, although present and abundant in places, has yet to develop fully. However, the woodland shows the strongest affinities with the W8e *Geranium robertianum* sub-community. This is due to the presence of common nettle and bramble. Cleavers is also present though not within the quadrat samples. Wood speedwell *Veronica montana* is frequent within the ground flora and is locally abundant. The bryophyte layer is very sparse with only rough feather-moss present. The woodland is enclosed by stock fencing and there was no obvious evidence of recent management. This area has been classified as Priority Deciduous Woodland. MAVIS analysis suggests that the woodland is either W8, W10, W12, W13 or W21. As oak and yew is absent and beech only forms a minor component of the canopy, the W10, W12 and W13 communities can be ruled out. This habitat is also not scrub and therefore the W21 community can also be discounted.

- 3.2.13. **Highways England woodland north of A417 (GR323231).** This is an area of steep woodland adjacent to A417. The ground flora quadrats were undertaken in an area adjacent to the A417 where the ground was less steep and undulating. The canopy and sub-canopy layers were open whilst the ground flora was patchy. There were no signs of recent management. The canopy comprised of young to semi-mature trees with mainly ash with some sycamore and wych-elm present. The sub-canopy was very sparse with occasional elder shrubs present with rarely abundant hazel. This woodland can be ascribed as *W8e Fraxinus excelsior-Acer campestre-Mercurialis perennis Geranium robertianum* sub-community as sycamore achieves cover within the canopy layer. Ivy is a constant and abundant species within the ground flora along with occasional herb-robert plus rarely frequent hart's-tongue *Asplenium scolopendrium* and common nettle (the latter present though not in the sample quadrats). All of these species are known *W8e* associates. Other species present within the ground flora quadrats are numerous tree seedlings (ash, field maple, hazel, sycamore, beech, hawthorn and wych-elm), as well as, rarely abundant lords-and-ladies, wood avens and male fern. Bryophytes were absent within these quadrats. This area has been classified as Priority Deciduous Woodland. MAVIS analysis suggests that the woodland is either *W8*, *W10*, *W12* or *W21*. Oak and beech are absent whilst the habitat cannot be considered to be a *W21* community. Therefore, all communities, except *W8*, can be discounted.
- 3.2.14. **Woodland at Birdlip Quarry (GR353298).** This is a linear semi-natural broad-leaved woodland on the southern extent of Hanson quarry adjacent to the A417. There is a steep slope throughout the woodland (towards the A417) that is utilised by a social group of badgers. The canopy is largely beech (semi-mature to mature) with a very sparse sub-canopy layer. The canopy is closed with very little sunlight reaching ground level. There appears to be no recent management. The beech communities *W14* and *W15* can be discounted as although holly is present within the sub-canopy layer, it is neither frequent nor abundant, whilst silver birch (trees or saplings), sessile oak, pedunculate oak and beech saplings are all absent. This woodland can be ascribed as *W12a Fagus sylvatica-Mercurialis perennis* woodland-*Mercurialis perennis* sub-community due to the presence of constant ivy and bluebell, as well as, frequent lords-and-ladies. Other species present within the ground flora layer are infrequent redcurrant *Ribes rubrum*, rarely abundant wood avens, wall lettuce *Mycelis muralis*, violet species *Viola* spp., common nettle and common chickweed *Stellaria media*. The bryophyte layer was also sparse with occasional (though not abundant) hypnum moss. This area has been classified as Priority Deciduous Woodland. MAVIS analysis has classified this woodland as either *W8*, *W10*, *W12* or *W21*. Ash and beech are both absent from the canopy layer, whilst the habitat cannot be considered as scrub. Therefore, all communities, except the *W12*, can be discounted.

- 3.2.15. **Woodland north east of Grove Farm (GR320093).** This stand was a very steep young to semi mature mixed woodland with vertical bare earth drops either facing west or south. Larch was present within the canopy but was rare in abundance. The slope is too steep to survey ground flora under NVC woodland protocols and DAFOR values were given for the ground flora present. This woodland stand can be ascribed as W8 due to the abundance of ash within the canopy. Sessile oak and rowan are both absent and therefore the W9 community can be discounted. The rest of the canopy layer are comprised of frequent sycamore and wych-elm, plus rarely abundant field maple (all known W8 associate species). The sub-canopy is very sparse and contains only hazel. The woodland most strongly resembles the W8e *Geranium robertianum* sub-community as sycamore is prevalent within the canopy layer and also due to the presence of locally frequent dog's mercury, plus occasional ivy, false brome and cleavers, as well as, rarely abundant herb-robert, bramble and hart's tongue. The woodland is privately owned and there were no signs of management present. This area has been partially classified as Priority Deciduous Woodland. MAVIS analysis could not be implemented, as it was considered unsafe to undertake ground flora quadrats.
- 3.2.16. **Highways England woodland south of A417 (GR326339, GR325786, GR19275, GR21956, GR21586).** This is a linear stretch of woodland on steep banks adjacent to A417 surrounded by pasture to the east. The canopy is likely to be historically planted when the A417 was constructed as landscape screening. The woodland is unlikely to be recently managed. The canopy layer is predominantly comprised of ash with small numbers of field maple, pedunculate oak, horse-chestnut, female Lombardy-poplar, hazel, wych-elm, elder and alder. There is also a stream running through middle of woodland, from west to east, where there were large areas of damp and muddy ground. Away from the stream, the ground level was unstable and uneven with steep slopes towards the northern extent adjacent to the A417. This woodland most strongly resembles the W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland due to the prominence of ash within the canopy and the absence of sessile oak and rowan. The woodland can be ascribed as a W8e *Geranium robertianum* sub-community due to the presence of constant cleavers, frequent common nettle, locally abundant dog's mercury and infrequent herb-robert. Other species present within the ground flora are hart's-tongue (a known W8a associate species), constant and locally dominant comfrey, as well as, rarely abundant smooth meadow-grass, bluebell and lords-and-ladies. Pendulous sedge is present within the damper areas of the woodland close to the stream. The bryophyte layer is comprised of infrequent common feather-moss, as well as, rarely abundant rough feather-moss and common smoothcap. This area has been partially classified as Priority Deciduous Woodland, mainly to the eastern extent. MAVIS analysis has classified this habitat as either W6, W8, W21, W22

or W25. Willow and alder are absent from the canopy, whilst the habitat cannot be considered as scrub. Therefore, all communities, except W8, can be discounted.

- 3.2.17. **Land north west of Grove Farm (GR320093).** This is a small, young planted woodland, mostly of ash, which is enclosed by security fencing and has a track running through the centre. There is mechanical plant equipment scattered throughout the stand and vehicles passing through the woodland. The canopy is open with no sub-canopy present which means the ground flora isn't truly representative of a woodland habitat and has the appearance of a species-poor semi improved grassland. As the habitat is young unestablished woodland, it is unsuitable to assign a woodland community. The habitat more strongly resembles a MG1 *Arrhenatherum elatius* grassland. This can currently be ascribed to the MG1a *Festuca rubra* sub-community, due to the presence of red fescue and other known MG1a associate species. These are; frequent creeping thistle, infrequent hogweed, dandelion, cleavers and common nettle plus rarely abundant creeping bent, white dead-nettle *Lamium album*, common sorrel *Rumex acetosa*, common mouse-ear *Cerastium fontanum* and creeping buttercup. There appears to be no current management. This area has been classified as Priority Deciduous Woodland. MAVIS analysis has classified this habitat as either MG1, OV24, OV26 or W24. This habitat is neither open vegetation or scrub therefore all communities can be ruled out except for MG1.
- 3.2.18. **Woodland south of Dog Lane (no land registry title given).** This stand is a linear belt of young woodland adjacent to Dog Lane. Field maple and sycamore are abundant within the canopy layer. There is an earth bank which is parallel to Dog Lane towards the northern extent. The woodland was situated between the A417 and Dog Lane. There were no fencing surrounding this woodland and no obvious signs of recent management. Due to the presence of sycamore and field maple plus the absence of oak and downy birch, the woodland shows the strongest affinities with the W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland. Wild garlic, although present outside of the quadrats, never achieves dominance. The woodland can be ascribed as W8e *Geranium robertianum* sub-community due to the constant presence of herb-robert, cleavers and locally dominant ivy, plus an under scrub of bramble. Other species present within the ground flora quadrats include numerous tree seedlings (field maple, hawthorn, dogwood, ash and sycamore), occasional ground ivy, plus rarely abundant gooseberry *Ribes uva-crispa* and common nettle. The bryophyte layer is comprised of frequent common feather-moss and occasional rough feather-moss. This area has been classified as Priority Deciduous Woodland. MAVIS analysis has suggested that the woodland is either W6, W8, W12, W21 or W25. As willow, beech and alder are all absent from the canopy and that the

habitat cannot be considered as scrub, all communities, except for W8, can be ruled out.

- 3.2.19. **Woodland north of Dog Lane (GR95689).** This is a very steep (south east facing) woodland northerly adjacent to Dog Lane. This habitat was too steep to undertake ground flora quadrats safely (DAFOR only). The woodland consisted of mature to semi mature ash dominant steep banks with a thick undergrowth, suggesting that there is infrequent management. The woodland shows closest affinities with the W8a *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland. Sycamore and field maple also occur within the canopy but are rare in abundance. the woodland can be ascribed to the W8a *Primula vulgaris - Glechoma hederacea* sub-community to the presence of W8a associate species dog's mercury, ground-ivy and violet species. This area has been classified as Priority Deciduous Woodland. MAVIS analysis could not be implemented, as it was considered unsafe to undertake ground flora quadrats.
- 3.2.20. **Woodland at The Scrubbs (GR32911).** This is a woodland with a mature beech canopy and coppice hazel, sparse holly, hawthorn, oak and ash. There are also several dead standing trees within the woodland and a steady slope from A417 road to Crickley Hill. It is likely there has been recent management due to coppiced hazel trees present and new fencing. There is abundant dead wood on the woodland floor. The ground flora is dense in some patches though mainly sparse with large areas of bare ground, therefore 10x10m ground flora quadrats were undertaken. There is also evidence of squirrel activity. The woodland is in a public area and is used frequently by dog walkers and other users. The canopy is closed in some areas with an open under-storey layer present throughout the woodland. The woodland can be ascribed as W12 *Fagus sylvatica-Mercurialis perennis* woodland due to the presence of hazel and constant dog's mercury within the ground flora layer. The W12a *Mercurialis perennis* sub-community has the strongest affinities to the woodland due to the presence of constant dog's mercury, lords-and-ladies and wood anemone *nemorosa*, as well as, occasional bluebell. Yellow archangel *Lamiastrum galeobdolon*, sanicle *Sanicula euopaea* and male fern, known W12a associate species, are present within the woodland but were not found within the quadrat samples. This area has been classified as Priority Deciduous Woodland. MAVIS analysis suggests the woodland is either W8, W10 or W12. Ash is constant, though only as a seedling within the ground flora layer and in low abundance. Oak is absent and therefore the W8 and W10 communities can be ruled out.
- 3.2.21. **Woodland at Cukoopen Barn Farm (GR136598).** This is a broad-leaved woodland with an open canopy and sub-canopy layer with some evidence of fly tipping. There are young to semi mature trees and no obvious signs of recent management. There are patches of bare ground within the ground flora layer and a consistent slope away from the road-side. The woodland is enclosed with

a stock-proof fence and a dry stone wall. There are a number of planted ornamental trees (including Swedish whitebeam *Sorbus x intermedia*) within a separate fragment towards the southern extent comprised of young wild cherry, Swedish whitebeam *Sorbus torminalis* and lime species *Tilia* spp. This area has been classified as Priority Deciduous Woodland and Ancient Replanted Woodland (excluding the southern ornamental fragment.) The canopy is comprised of semi-mature ash with rarely abundant semi-mature beech. Due to the canopy composition and the presence of hazel and hawthorn within the canopy this woodland can be ascribed as a W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland community. The sub-community that has the strongest affinities with this woodland is the W8d *Hedera helix* sub-community. Although Ivy is not present within the quadrats, it is present within the woodland as a frequent species. Other ground flora species show matched abundance and frequency values with the W8d sub-community, these are; constant and locally dominant dog's mercury, infrequent enchanter's nightshade plus rarely abundant wild garlic, tufted hair-grass *Deschampsia cespitosa*, wood sedge *Carex sylvatica* and woodruff *Galium odoratum*. The bryophyte layer is comprised of occasional rough-stalked feather-moss, infrequent common feather-moss and rare fox-tail feather-moss. MAVIS analysis has classified this woodland as either W8, W10 or W12. Oak is absent whilst beech only forms a minor component of the canopy, therefore the W10 and W12 communities can be discounted.

3.2.22. **Ullen Wood (GR346313)**. This is young to semi-mature semi-natural broad-leaved woodland with beech, sycamore, ash and coppiced hazel *Corylus* within the canopy and subcanopy layers. These layers are open. The beech trees present are more mature with callus rolls with decaying and scarring bark on branches. The woodland has a five degrees continuous slope downwards to the north and has a shallow trench bisecting the woodland from south to north. Beech is not a prominent species within the canopy layers and therefore the beech woodland communities can be discounted. As hazel is the only sub-canopy species and wild garlic forms a carpet throughout the ground flora layer, as well as, being a constant species, the woodland can be ascribed as a W8f *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland, *Allium ursinum* sub-community. Further evidence of a W8f community is the patchy abundance of bluebell and the presence of wood avens and wood anemone. This area has been classified as Priority Deciduous Woodland and Ancient Semi-natural Woodland. MAVIS analysis has classified this woodland as either W8, W10 or W12. Beech is of a low abundance within the canopy and oak is absent throughout. Therefore, the W10 and W12 communities can be ruled out.

3.2.23. **Ullen Wood (GR352384)**. This is an established broad-leaved woodland with young and semi-mature trees within canopy. This parcel has a very similar

woodland structure to GR354154 with open canopy and sub-canopy layers. The ground flora is dense and is currently being actively managed. There is one dead standing tree within the canopy. The woodland can be ascribed as a W8f *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland-*Allium ursinum* sub-community due to the prominence of ash within the canopy, the presence of hazel within the sub-canopy layer and the constant dominance of wild garlic. Within the ground flora layer and further evidence of a W8f sub-community is constant (though not abundant) wood anemone, bluebell and the local abundance of dog's mercury. There are several tree seedlings within ground flora, these include; constant and locally abundant ash, plus rarely abundant hazel, sycamore and hawthorn. This area has been classified as Priority Deciduous Woodland and Ancient Semi-natural Woodland. MAVIS analysis has classified this woodland as either W8, W10 or W12. Oak and beech are both absent from this woodland and therefore the W10 and W12 communities can be discounted.

- 3.2.24. **Ullen Wood (GR354154).** This is an established mixed woodland with young to semi-mature trees within canopy and sub-canopy. The canopy and sub-canopy layers are open with abundant dead wood on the woodland floor. Coppiced hazel present suggests recent management. The slope is constant throughout woodland and slopes downwards towards the northern extent. There is bare ground underneath some leyland cypress although generally the ground flora layer is dense with vegetation. Wood sedge is only present on paths within the land parcel. This woodland can be ascribed as W8f *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland *Allium ursinum* sub-community. The W9 community can be discounted due to the lack of rowan within the sub canopy. As wild garlic is a constant and a local dominant throughout the ground flora layer, the woodland show strong affinities to the W8f sub-community. Ash is the most prominent species amongst the open canopy layer, with infrequent wych-elm and sessile oak. Hazel is frequent within the species-poor sub-canopy layer. There are numerous W8f associate species within the ground flora layer. These are; constant dog's mercury, wood anemone and bluebell, as well as, infrequent wood-sorrel and rarely abundant pignut and wood spurge. The bryophyte layer is extensive and is comprised of constant common feather-moss, locally abundant rough-stalked feather moss and rarely abundant common smoothcap. This area has been classified as Priority Deciduous Woodland and Ancient Semi-natural Woodland. MAVIS analysis has classified this woodland as either W8, W10 or W12. Both oak and ash are absent throughout the woodland and therefore the W10 and W12 communities can be ruled out.

4. Potential Impacts

- 4.1.1. The impact assessment will be covered within the Biodiversity chapter of the Environmental Statement for the project. At the time of writing, the scheme is still being designed and firm conclusions on impacts will be detailed in the aforementioned document.

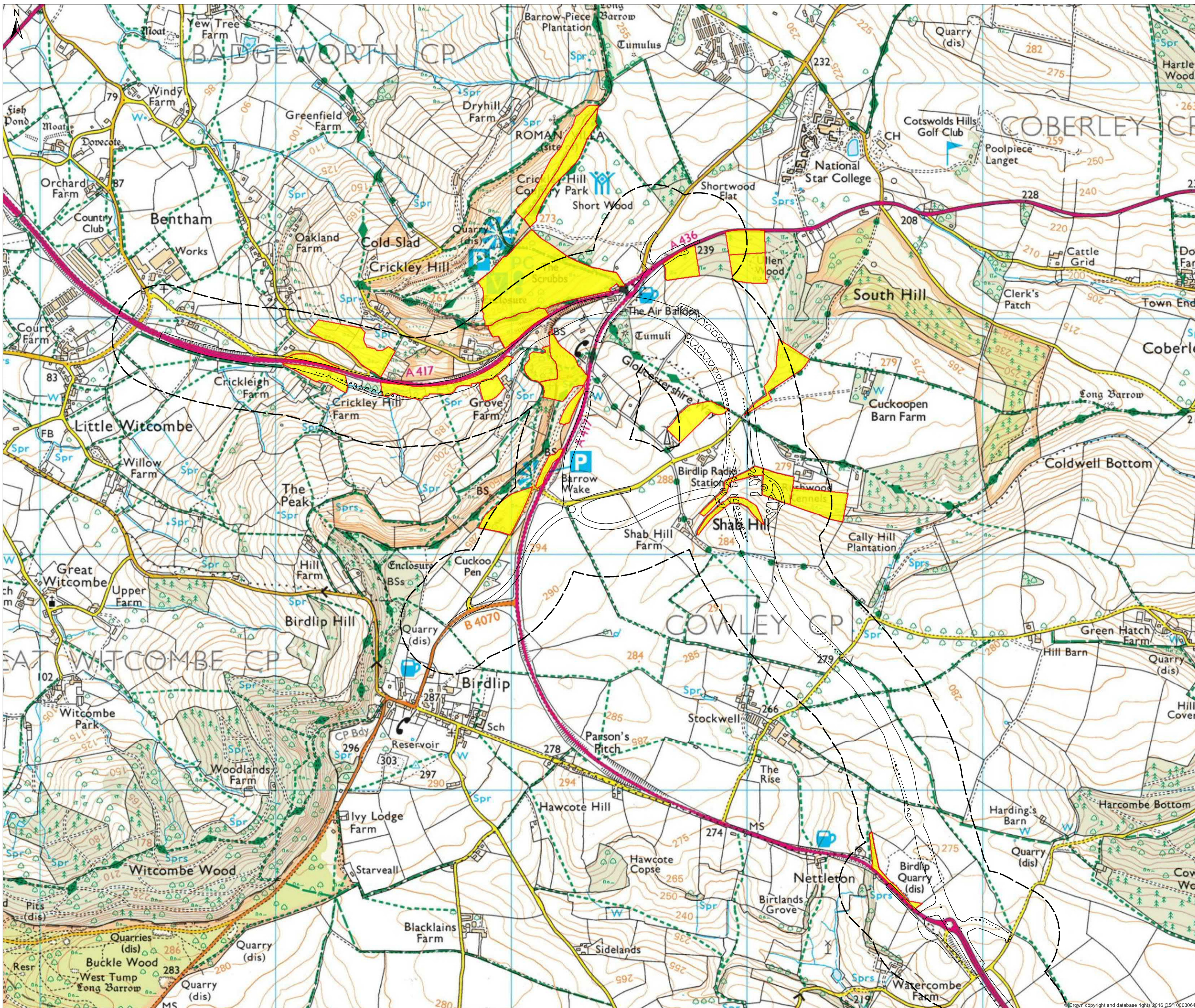
5. Mitigation and enhancement recommendations

- 5.1.1. Full details of ecological mitigation and enhancement measures will be included within the Biodiversity chapter of the Environmental Statement for the project.

6. Conclusion

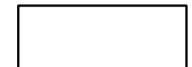
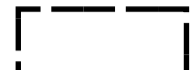

- 6.1.1. Field surveys, undertaken in 2019, identified plant communities for all 24 woodland parcels considered to be potentially directly or indirectly impacted by the scheme.
- 6.1.2. A number of these woodland parcels may be directly impacted by the scheme including habitat loss and fragmentation. This includes an area of potential ancient semi-natural woodland at Emma's Grove. Retained woodland habitats may also be potentially adversely impacted by decreased air quality including emissions and dust during construction, and during the operations life of the scheme by increased emissions including increased NO^x deposition.
- 6.1.3. The impact assessment and subsequent mitigation and enhancement strategy will be covered within the ecology and nature conservation chapter of the Environmental Statement for the project. At the time of writing, the scheme is still being designed and firm conclusions on impacts and mitigation will be detailed in the aforementioned document.

Appendix A NVC Survey Drawings



Notes

Legend

-  Option 30 Scheme Route
-  Option 30 200m Buffer
-  Woodland Locations

P01	10/07/2019	First Revision	TW	VH	SM
Rev	Date	Amendment Details	Drawn	Chk'd	App'd

Mott MacDonald Sweco

highways england

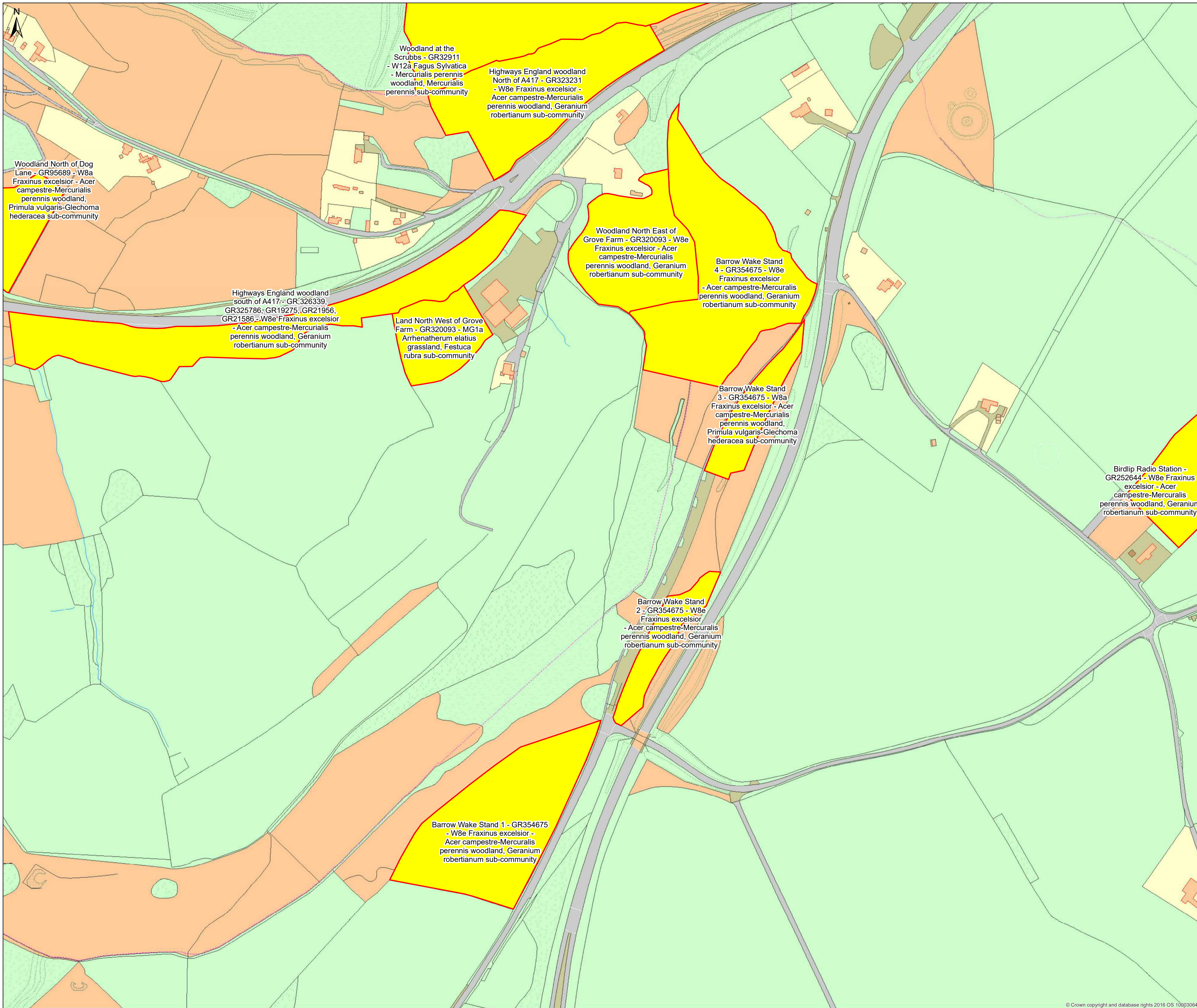
Client	FOR INFORMATION	Suitability	S2
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Project Title
A417 Missing Link

Drawing Title
NVC WOODLAND SURVEYS
Page 1 of 18

Scale	1:10	Designed	TW	Drawn	TW	Checked	VH	Approved	SM
Original Size	A1	Date	10/07/2019	Date	10/07/2019	Date	10/07/2019	Date	10/07/2019

Drawing Number	HE PNU	Originator	Volume	Project Ref. No.
551505 - MMSJV - EBD -				551505
000 - DR - LB -			00051	Revision
				P01



Notes

Legend

Woodland Locations

P01	12/07/2019	First Revision	TW	VH	SM
Rev	Date	Amendment Details	Drawn	Chk'd	App'd

**Mott MacDonald
Sweco**



Client	FOR INFORMATION	Suitability	S2
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Project Title	A417 Missing Link
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Drawing Title	NVC WOODLAND SURVEYS Page 8 of 18
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Scale	1:0	Designed	TW	Drawn	TW	Checked	VH	Approved	SM
Original Size	A1	Date	12/07/2019	Date	12/07/2019	Date	12/07/2019	Date	12/07/2019

Drawing Number	HE PIN	Originator	Volume	Project Ref. No.
551505 - MMSJV	-	EBD	-	551505
000	-	DR	-	00051
		LB		Revision
				P01

Appendix B Photographs of Survey Quadrats

Land Parcel	Photo
Ullen Wood (GR354154) Canopy Quadrat	
Ullen Wood (GR354154) Ground flora Quadrat 1	
Ullen Wood (GR354154) Ground flora Quadrat 2	

Ullen Wood
(GR354154)
Ground flora
Quadrat 3



Ullen Wood
(GR354154)
Ground flora
Quadrat 4



Ullen Wood
(GR354154)
Ground flora
Quadrat 5



Ullen Wood
(GR352384)
Canopy
Quadrat



Ullen Wood
(GR352384)
Ground flora
Quadrat 1



Ullen Wood
(GR352384)
Ground flora
Quadrat 2



Ullen Wood
(GR352384)
Ground flora
Quadrat 3



Ullen Wood
(GR352384)
Ground flora
Quadrat 4



Ullen Wood
(GR352384)
Ground flora
Quadrat 5



Ullen Wood
(GR346313)
Canopy
Quadrat



Ullen Wood
(GR346313)
Ground flora
Quadrat 1



Ullen Wood
(GR346313)
Ground flora
Quadrat 2



Ullen Wood
(GR346313)
Ground flora
Quadrat 3



Ullen Wood
(GR346313)
Ground flora
Quadrat 4



Ullen Wood
(GR346313)
Ground flora
Quadrat 5



The Scrubbs
Canopy
Quadrat



The Scrubbs
Ground flora
Quadrat 1



The Scrubbs
Ground flora
Quadrat 2



The Scrubbs
Ground flora
Quadrat 3



The Scrubbs
Ground flora
Quadrat 4



The Scrubbs
Ground flora
Quadrat 5



Crickley Hill
Stand 1
Canopy
Quadrat



Crickley Hill
Stand 1
Ground flora
Quadrat 1



Crickley Hill
Stand 1
Ground flora
Quadrat 2



Crickley Hill
Stand 1
Ground flora
Quadrat 3



Crickley Hill
Stand 1
Ground flora
Quadrat 4



Crickley Hill
Stand 1
Ground flora
Quadrat 5



Crickley Hill
Stand 2
Canopy
Quadrat



Crickley Hill
Stand 2
Ground flora
Quadrat 1



Crickley Hill
Stand 2
Ground flora
Quadrat 2



Crickley Hill
Stand 2
Ground flora
Quadrat 3



Crickley Hill
Stand 2
Ground flora
Quadrat 4



Crickley Hill
Stand 2
Ground flora
Quadrat 5



Barrow Wake
Stand 1
Canopy
Quadrat



Barrow Wake
Stand 1
Ground flora
Quadrat 1



Barrow Wake
Stand 1
Ground flora
Quadrat 2



Barrow Wake
Stand 1
Ground flora
Quadrat 3



Barrow Wake
Stand 1
Ground flora
Quadrat 4



Barrow Wake
Stand 1
Ground flora
Quadrat 5



Barrow Wake
Stand 2
Canopy
Quadrat



Barrow Wake
Stand 2
Ground flora
Quadrat 1



Barrow Wake
Stand 2
Ground flora
Quadrat 2



Barrow Wake
Stand 2
Ground flora
Quadrat 3



Barrow Wake
Stand 2
Ground flora
Quadrat 4



Barrow Wake
Stand 2
Ground flora
Quadrat 5



Barrow Wake
Stand 3
Canopy
Quadrat



Barrow Wake
Stand 3
Ground flora
Quadrat 1



Barrow Wake
Stand 3
Ground flora
Quadrat 2



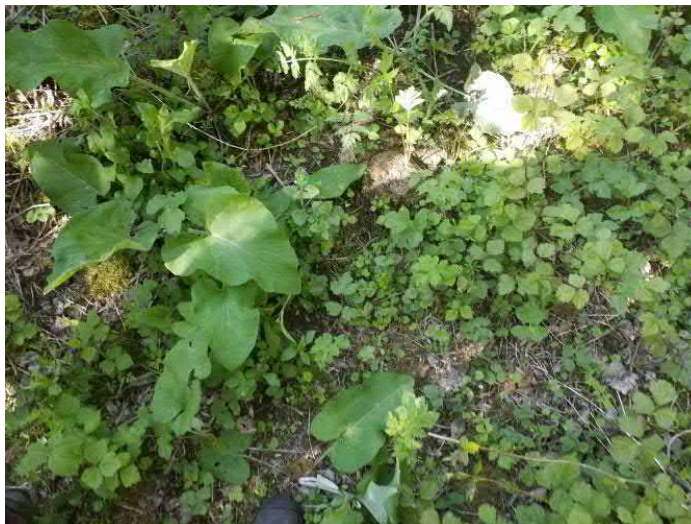
Barrow Wake
Stand 3
Ground flora
Quadrat 3



Barrow Wake
Stand 3
Ground flora
Quadrat 4



Barrow Wake
Stand 3
Ground flora
Quadrat 5



Barrow Wake
Stand 4
Canopy
Quadrat



Barrow Wake
Stand 4
Ground flora
Quadrat 1



Barrow Wake
Stand 4
Ground flora
Quadrat 2



Barrow Wake
Stand 4
Ground flora
Quadrat 3



Barrow Wake
Stand 4
Ground flora
Quadrat 4



Barrow Wake
Stand 4
Ground flora
Quadrat 5



Shab Hill
Stand 1
Canopy
Quadrat



Shab Hill
Stand 1
Ground flora
Quadrat 1



Shab Hill
Stand 1
Ground flora
Quadrat 2



Shab Hill
Stand 1
Ground flora
Quadrat 3



Shab Hill
Stand 1
Ground flora
Quadrat 4



Shab Hill
Stand 1
Ground flora
Quadrat 5



Shab Hill
Stand 2
Canopy
Quadrat



Shab Hill
Stand 2
Ground flora
Quadrat 1



Shab Hill
Stand 2
Ground flora
Quadrat 2



Shab Hill
Stand 2
Ground flora
Quadrat 3



Shab Hill
Stand 2
Ground flora
Quadrat 4



Shab Hill
Stand 2
Ground flora
Quadrat 5



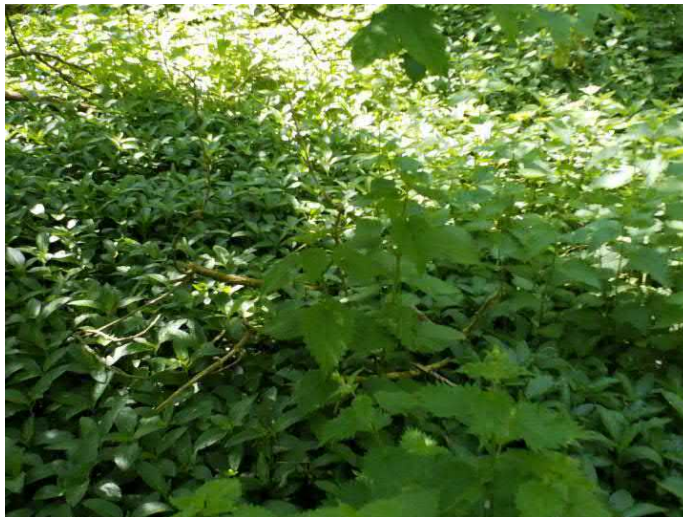
Shab Hill
Stand 3
Canopy
Quadrat



Shab Hill
Stand 3
Ground flora
Quadrat 1



Shab Hill
Stand 3
Ground flora
Quadrat 2



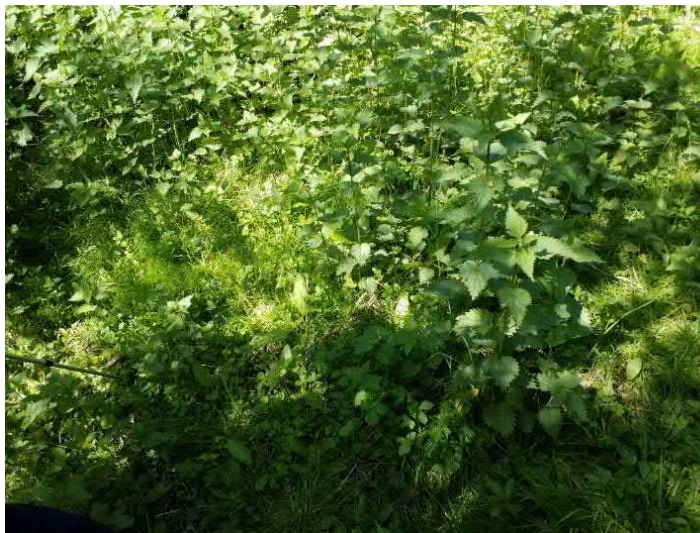
Shab Hill
Stand 3
Ground flora
Quadrat 3






Shab Hill
Stand 3
Ground flora
Quadrat 4



Shab Hill
Stand 3
Ground flora
Quadrat 5

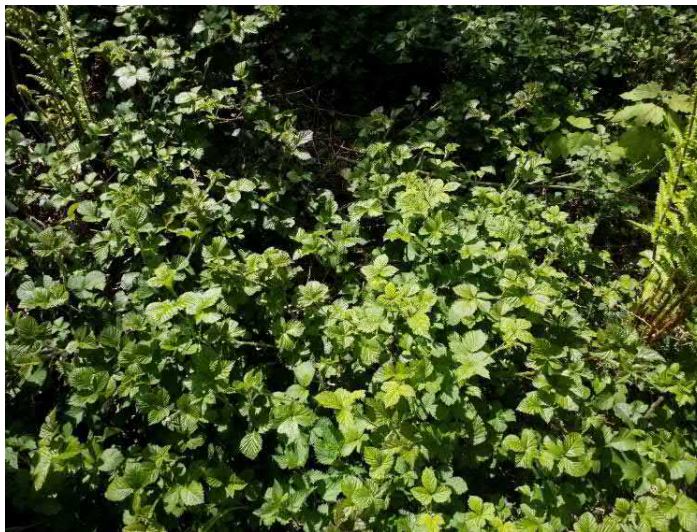


<p>Rushwood Kennels Canopy Quadrat</p>	
<p>Rushwood Kennels Ground flora Quadrat 1</p>	
<p>Rushwood Kennels Ground flora Quadrat 2</p>	
<p>Rushwood Kennels Ground flora Quadrat 3</p>	<p>No photo available</p>

Rushwood
Kennels
Ground flora
Quadrat 4



Rushwood
Kennels
Ground flora
Quadrat 5



Fly Up
Project
Canopy
Quadrat



Fly Up
Project
Ground flora
quadrat



Birdlip
Quarry
Canopy
Quadrat



Birdlip
Quarry
Ground flora
Quadrat 1



Birdlip
Quarry
Ground flora
Quadrat 2



Birdlip
Quarry
Ground flora
Quadrat 3



Birdlip
Quarry
Ground flora
Quadrat 4



Birdlip
Quarry
Ground flora
Quadrat 5



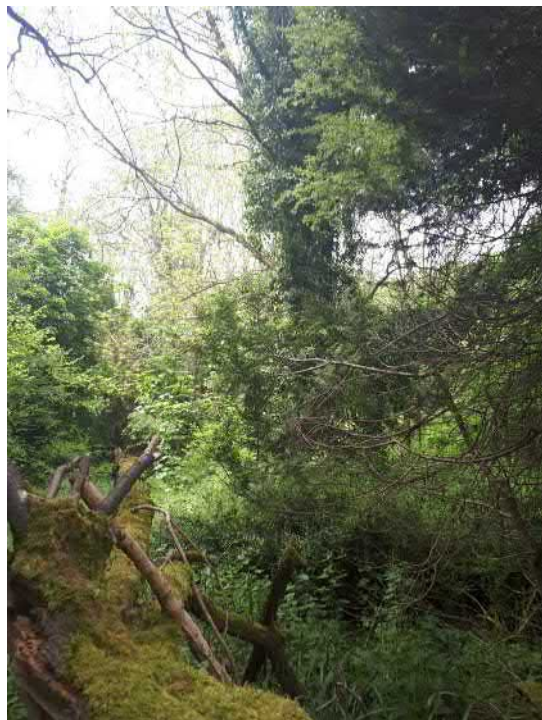
Woodland
north east of
Grove Farm
Canopy
Quadrat



Woodland
north east of
Grove Farm
Ground flora
Quadrat



Highways
England
woodland
(south of
A417)
Canopy
Quadrat



Highways
England
woodland
(south of
A417)
Ground flora
Quadrat 1



Highways
England
woodland
(south of
A417)
Ground flora
Quadrat 2



Highways
England
woodland
(south of
A417)
Ground flora
Quadrat 3



Highways
England
woodland
(south of
A417)
Ground flora
Quadrat 4



Highways
England
woodland
(south of
A417)
Ground flora
Quadrat 5



Land north
west of
Grove Farm
Canopy
Quadrat



Land north
west of
Grove Farm
Ground flora
Quadrat 1



Land north
west of
Grove Farm
Ground flora
Quadrat 2



Land north
west of
Grove Farm
Ground flora
Quadrat 3



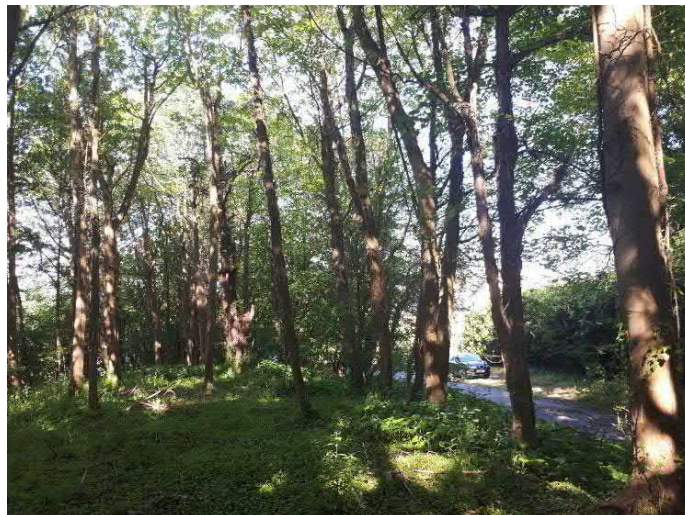
Land north
west of
Grove Farm
Ground flora
Quadrat 4



Land north
west of
Grove Farm
Ground flora
Quadrat 5



Woodland
(south of Dog
Lane)
Canopy
Quadrat



Woodland
(south of Dog
Lane)
Ground flora
Quadrat 1



Woodland
(south of Dog
Lane)
Ground flora
Quadrat 2



Woodland
(south of Dog
Lane)
Ground flora
Quadrat 3



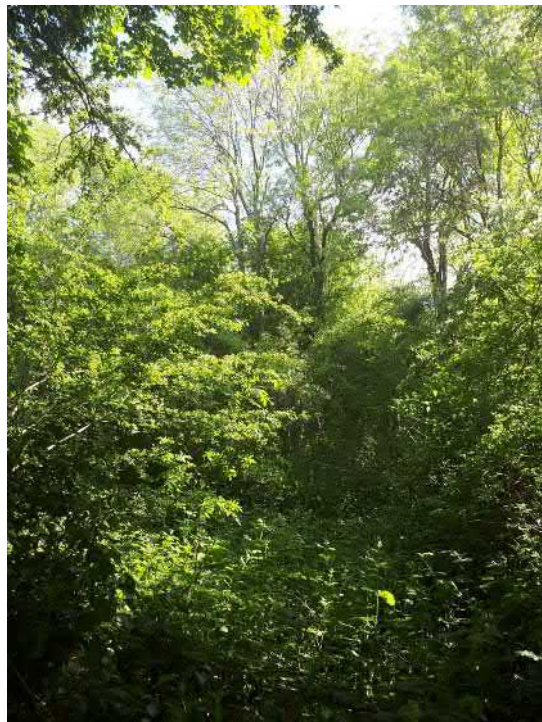
Woodland
(south of Dog
Lane)
Ground flora
Quadrat 4



Woodland
(south of Dog
Lane)
Ground flora
Quadrat 5



Woodland
(north of Dog
Lane)
Canopy
Quadrat



Woodland
(north of Dog
Lane)
Ground flora
Quadrat



Highways
England
woodland
(north of
A417)
Canopy
Quadrat



Highways
England
woodland
(north of
A417)
Ground flora
Quadrat 1



Highways
England
woodland
(north of
A417)
Ground flora
Quadrat 2



Highways
England
woodland
(north of
A417)
Ground flora
Quadrat 3



Highways
England
woodland
(north of
A417)
Ground flora
Quadrat 4



Highways
England
woodland
(north of
A417)
Ground flora
Quadrat 5



Woodland at
Birdlip Radio
Station
Canopy
Quadrat



Woodland at
Birdlip Radio
Station
Ground flora
Quadrat 1



Woodland at
Birdlip Radio
Station
Ground flora
Quadrat 2



Woodland at
Birdlip Radio
Station
Ground flora
Quadrat 3



Woodland at
Birdlip Radio
Station
Ground flora
Quadrat 4



Woodland at
Birdlip Radio
Station
Ground flora
Quadrat 5



Woodland at
Cukoopen
Barn Farm
Canopy
Quadrat



Woodland at
Cukoopen
Barn Farm
Ground flora
Quadrat 1



Woodland at
Cukoopen
Barn Farm
Ground flora
Quadrat 2



Woodland at
Cukoopen
Barn Farm
Ground flora
Quadrat 3



Woodland at
Cukoopen
Barn Farm
Ground flora
Quadrat 4



Woodland at
Cukoopen
Barn Farm
Ground flora
Quadrat 5



Appendix C Species Tables

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Beech	<i>Fagus sylvatica</i>	4						O
Ash	<i>Fraxinus excelsior</i>	8						F
SUB CANOPY								
Hawthorn	<i>Crataegus monogyna</i>	2						R
Elder	<i>Sambucus nigra</i>	2						R
GROUND FLORA LAYER								
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	2	1	4	4	1	V	F
Dog's mercury	<i>Mercurialis perennis</i>	4	8	9	5	5	V	LD
Wood avens	<i>Geum urbanum</i>	5		1	2	4	IV	LF
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>	4		4		4	III	LF
Bramble	<i>Rubus fruticosus</i> agg.	4		4	2		III	O
Violet species	<i>Viola</i> spp.				4	4	II	O
Dandelion	<i>Taraxacum officinale</i> agg.	1					I	R
Ivy	<i>Hedera helix</i>	3					I	R
Burdock species	<i>Arctium</i> spp.		3				I	R
Cleavers	<i>Galium aparine</i>		1				I	R
Common nettle	<i>Urtica dioica</i>		2				I	R
Hazel (seedlings)	<i>Corylus avellana</i> (seedlings)		1				I	R
Common feather-moss	<i>Kindbergia praelonga</i>		2				I	R
Barren strawberry	<i>Potentilla sterilis</i>				2		I	R
Hawthorn (seedlings)	<i>Crataegus monogyna</i> (seedlings)				1		I	R
Bare ground		9	4	5	9	4		
Species present not in quadrats								
Crosswort	<i>Cruciata laevipes</i>							LF
Pedunculate oak	<i>Quercus robur</i>							R
Ground-ivy	<i>Glechoma hederacea</i>							LF
Common knapweed	<i>Centaurea nigra</i>							R
Wood speedwell	<i>Veronica montana</i>							R
Salad burnet	<i>Sanguisorba minor</i>							R
Hogweed	<i>Heracleum sphondylium</i>							R
Cock's-foot	<i>Dactylis glomerata</i>							R
Perennial rye-grass	<i>Lolium perenne</i>							R
Curled dock	<i>Rumex crispus</i>							R
Broad-leaved dock	<i>Rumex obtusifolius</i>							LF
Lords-and-ladies	<i>Arum maculatum</i>							R
Lesser celandine	<i>Ficaria verna</i>							R
Smooth meadow-grass	<i>Poa pratensis</i>							R
Ivy-leaved speedwell	<i>Veronica hederifolia</i>							R
Grey willow	<i>Salix cinerea</i>							R
Common dog-violet	<i>Viola riviniana</i>							R
Sycamore	<i>Acer pseudoplatanus</i>							R
Common smoothcap	<i>Atrichum undulatum</i>							R
Hypnum moss	<i>Hypnum cupressiforme</i>							R
Beech (seedlings)	<i>Fagus sylvatica</i> (seedlings)							R

Barrow Wake Stand 2

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Grey Willow	<i>Salix cinerea subsp. oleifolia</i>	5						F
Sycamore	<i>Acer pseudoplatanus</i>	2						R
SUB CANOPY								
Hawthorn	<i>Crataegus monogyna</i>	2						R
Hazel	<i>Corylus avellana</i>	6						F
Elder	<i>Sambucus nigra</i>	3						O
GROUND FLORA LAYER								
Common nettle	<i>Urtica dioica</i>	4	4	4	5	2	V	F
Common feather-moss	<i>Kindbergia praelonga</i>	4		2	4	6	IV	F
Herb-robert	<i>Geranium robertianum</i>	4	1		5	1	IV	F
Dog's Mercury	<i>Mercurialis perennis</i>	5	7		4		III	O/LA
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>		4	4	5		III	F
Cleavers	<i>Galium aparine</i>				8	1	III	LA
Bramble	<i>Rubus fruticosus agg.</i>	4			2	5	III	O
Ivy-leaved speedwell	<i>Veronica hederifolia</i>	4		9		5	III	LD
Ground-ivy	<i>Glechoma hederacea</i>	4					I	R
Lords-and-ladies	<i>Arum maculatum</i>		1				I	R
Hogweed	<i>Heracleum sphondylium</i>			1			I	R
Wood avens	<i>Geum urbanum</i>					1	I	R
Lesser Celandine	<i>Ficaria verna</i>					2	I	R
Smooth meadow-grass	<i>Poa pratensis</i>					2	I	R
Violet species	<i>Viola spp.</i>					1	I	R
Bare ground		8	5	4	4	7		
Species present not in quadrats								
Great willowherb	<i>Epilobium hirsutum</i>							LF
White dead-nettle	<i>Lamium album</i>							R
Garlic mustard	<i>Alliaria petiolata</i>							R
Cow parsley	<i>Anthriscus sylvestris</i>							R
Dogwood	<i>Cornus sanguinea</i>							R
Male fern	<i>Dryopteris filix-mas</i>							R
Green alkanet	<i>Pentaglottis sempervirens</i>							R
Burdock species	<i>Arctium spp.</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Grey willow	<i>Salix cinerea</i>	2						R
Ash	<i>Fraxinus excelsior</i>	5						F
SUB CANOPY								
Hazel	<i>Corylus avellana</i>	5						F
Elder	<i>Sambucus nigra</i>	4						O
GROUND FLORA LAYER								
Bramble	<i>Rubus fruticosus agg.</i>	4		1	6	4	IV	F
Wood avens	<i>Geum urbanum</i>		5	2	4	4	IV	F
Ground-ivy	<i>Glechoma hederacea</i>	2	2		1	4	IV	F
Hogweed	<i>Heracleum sphondylium</i>	1			4	2	III	O
Cleavers	<i>Galium aparine</i>	1			4	1	III	O
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>	3	4		4		III	O
Common dog-violet	<i>Viola riviniana</i>	2	2	1			III	O
Smooth meadow-grass	<i>Poa pratensis</i>	2		2		2	III	O
Violet species	<i>Viola spp.</i>	2	2	4			III	O
Common feather-moss	<i>Kindbergia praelonga</i>	4				5	II	LF
Red campion	<i>Silene dioica</i>		2			4	II	O
Hypnum moss	<i>Hypnum cupressiforme</i>		1	1			II	R
Germander speedwell	<i>Veronica chamaedrys</i>	1					I	R
Lesser twayblade	<i>Listera ovata</i>	4					I	R
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)		2				I	R
Dandelion	<i>Taraxacum officinale agg.</i>	2					I	R
Traveller's joy	<i>Clematis vitalba</i>				3		I	R
Creeping thistle	<i>Cirsium arvense</i>				1		I	R
Bush vetch	<i>Vicia sepium</i>					1	I	R
Burdock species	<i>Arctium spp.</i>					6	I	R/LF
Bare ground		5	8		7	7		
Species present not in quadrats								
Hawthorn	<i>Crataegus monogyna</i>							O
Common ragwort	<i>Senecio jacobaea</i>							R
Smooth sow-thistle	<i>Sonchus oleraceus</i>							R
Salad burnet	<i>Sanguisorba minor</i>							R
Dog's mercury	<i>Mercurialis perennis</i>							O
Lesser celandine	<i>Ficaria verna</i>							R
Holly	<i>Ilex aquifolium</i>							R
Bluebell	<i>Hyacinthoides non-scripta</i>							R
Bugle	<i>Ajuga reptans</i>							R
Wood anemone	<i>Anemone nemorosa</i>							R
Sanicle	<i>Sanicula europaea</i>							R
Wood sage	<i>Teucrium scorodonia</i>							R
Pedunculate oak (seedlings)	<i>Quercus robur</i> (seedlings)							O
Male fern	<i>Dryopteris filix-mas</i>							R
Lords-and-ladies	<i>Arum maculatum</i>							R
Meadow buttercup	<i>Rununculus acris</i>							R
Cow parsley	<i>Anthriscus sylvestris</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	5						F
Pedunculate oak	<i>Quercus robur</i>	7						A
SUB CANOPY								
Hawthorn	<i>Crataegus monogyna</i>	6						F
GROUND FLORA LAYER								
Wood avens	<i>Geum urbanum</i>	5	5	4	2	3	V	F
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	5	5	4		4	IV	F
Smooth meadow-grass	<i>Poa pratensis</i>	3	3			2	III	O
Herb-robert	<i>Geranium robertianum</i>			4	2	4	III	O/LF
Dog's mercury	<i>Mercurialis perennis</i>			5	5	4	III	O/LF
Cleavers	<i>Galium aparine</i>			1	2		II	R
Dandelion	<i>Taraxacum officinale agg.</i>	1		1			II	R
Woodruff	<i>Galium odoratum</i>		5		5		II	O/LF
False brome	<i>Brachypodium sylvaticum</i>		3			1	II	R
Pedunculate oak (seedlings)	<i>Quercus robur</i> (seedlings)		3				I	R
Barren strawberry	<i>Potentilla sterilis</i>			4			I	R
Common feather-moss	<i>Kindbergia praelonga</i>				4		I	LF
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>			4			I	R
Woody nightshade	<i>Solanum dulcamara</i>	1					I	R
Bramble	<i>Rubus fruticosus agg.</i>	4					I	O
Common nettle	<i>Urtica dioica</i>				1		I	R
Male fern	<i>Dryopteris filix-mas</i>				1		I	R
Wild garlic	<i>Allium ursinum</i>					1	I	R
Germander speedwell	<i>Veronica chamaedrys</i>					1	I	R
Bare ground		8	8	5	5	10		
Species present not in quadrats								
Hogweed	<i>Heracleum sphondylium</i>							R
Burdock species	<i>Arctium spp.</i>							O
Broad-leaved dock	<i>Rumex obtusifolius</i>							R
Garlic mustard	<i>Alliaria petiolata</i>							R
Tufted hair-grass	<i>Deschampsia cespitosa</i>							R
Grey willow	<i>Salix cinerea</i>							R
Salad burnet	<i>Sanguisorba minor</i>							R
Perennial rye-grass	<i>Lolium perenne</i>							R
Common dog-violet	<i>Viola riviniana</i>							R
Bugle	<i>Ajuga reptans</i>							R
Wood anemone	<i>Anemone nemorosa</i>							R
Lords-and-ladies	<i>Arum maculatum</i>							R
Wood sage	<i>Teucreum scorodonia</i>							R
Holly	<i>Ilex aquifolium</i>							R
Hart's-tongue	<i>Asplenium scolopendrium</i>							R

Shab Hill Stand 1

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Beech	<i>Fagus sylvatica</i>	10						D
SUB CANOPY								
Hawthorn	<i>Crataegus monogyna</i>	5						R
Elder	<i>Sambucus nigra</i>	3						R
GROUND FLORA LAYER								
	<i>Mercurialis perennis</i>	4	7	4	5		IV	F
	<i>Brachythecium rutabulum</i>	4	5	2	4		IV	F
	<i>Arum maculatum</i>			2	2	2	III	O
	<i>Kinbergia praelonga</i>				4	2	II	O
	<i>Crataegus monogyna</i> (seedlings)	1			1		II	R
	<i>Urtica dioica</i>	2					I	R
Bare ground		9	8	10	9	10		
Species present not in quadrats								
Holly	<i>Ilex aquifolium</i>							R
Hogweed	<i>Heracleum sphondylium</i>							R
Male fern	<i>Dryopteris filix-mas</i>							R
Bramble	<i>Rubus fruticosus</i> agg.							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	5						F
SUB CANOPY								
Grey willow	<i>Salix cinerea subsp. oleifolia</i>	2						O
Hawthorn	<i>Crataegus monogyna</i>	6						F
Sycamore	<i>Acer pseudoplatanus</i>	2						O
Elder	<i>Sambucus nigra</i>	2						O
GROUND FLORA LAYER								
Common nettle	<i>Urtica dioica</i>	5	1	8		5	IV	F/LA
Common feather-moss	<i>Kindbergia praelonga</i>	8	1	4	4		IV	F
Enchanter's nightshade	<i>Circaea lutetiana</i>	3		1	1		III	O
Dog' mercury	<i>Mercurialis perennis</i>	7	10	4			III	F/LD
Cleavers	<i>Galium aparine</i>	1		1	2		III	O
Ground-ivy	<i>Glechoma hederacea</i>	4			4		II	O
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>			5	2		II	O/LF
Wood avens	<i>Geum urbanum</i>	2				5	II	O/LF
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	1					I	R
Smooth meadow-grass	<i>Poa pratensis</i>					5	I	R/LF
Wood forget-me-not	<i>Myosotis sylvatica</i>					4	I	R
broad-leaved dock	<i>Rumex obtusifolius</i>					3	I	R
Dandelion	<i>Taraxacum officinale agg.</i>					1	I	R
Bare ground		5	4	6	9	3		
Species present not in quadrats								
Ground elder	<i>Aegopodium podagraria</i>							R/LF
Creeping thistle	<i>Cirsium arvense</i>							R
Perennial rye-grass	<i>Lolium perenne</i>							R
Goat willow	<i>Salix caprea</i>							O
Male fern	<i>Dryopteris filix-mas</i>							R
Spear thistle	<i>Cirsium vulgare</i>							R
Dwarf cherry	<i>Prunus cerasus</i>							R
Bugle	<i>Ajuga reptans</i>							R
Creeping buttercup	<i>Ranunculus repens</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	6						F
Beech	<i>Fagus sylvatica</i>	4						O
SUB CANOPY								
Hawthorn	<i>Crataegus monogyna</i>	2						R
Sycamore	<i>Acer pseudoplatanus</i>	4						O
Elder	<i>Sambucus nigra</i>	1						R
GROUND FLORA LAYER								
Bramble	<i>Rubus fruticosus agg.</i>	7	8	8	8	8	V	F/LA
Cleavers	<i>Galium aparine</i>	1		2	2	1	IV	F
Common feather-moss	<i>Kinbergia praelonga</i>	6	5		4	4	IV	F
Sycamore (seedlings)	<i>Acer pseudoplatanus</i> (seedlings)	4	1	4		2	IV	F
Male Fern	<i>Dryopteris filix-mas</i>	2			4	4	III	F
Dandelion	<i>Taraxacum officinale agg.</i>	3		4		3	III	F
Spear thistle	<i>Cirsium vulgare</i>	1	1	2			III	O
Curled dock	<i>Rumex crispus</i>	4		4			II	O
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>			2	4	4	III	F
Creeping buttercup	<i>Ranunculus repens</i>	4	1				II	O
Smooth meadow-grass	<i>Poa pratensis</i>	5	4				II	O
Perforate St.John's wort	<i>Hypericum perforatum</i>	2	2				II	O
Enchanter's nightshade	<i>Circaea lutetiana</i>	1	1				II	O
Wood forget-me-not	<i>Myosotis sylvatica</i>	3					I	O
Broad-leaved willowherb	<i>Epilobium montanum</i>	3					I	O
Violet species	<i>Viola spp.</i>	3					I	O
Wood sedge	<i>Carex sylvatica</i>		8				I	R/LF
Traveller's joy	<i>Clematis vitalba</i>		5				I	R/LF
Germander speedwell	<i>Veronica chamaedrys</i>		2				I	R
Cock's-foot	<i>Dactylis glomerata</i>			2			I	R
Bare ground		5	3	4	5	5		
Species present not in quadrats								
Ground-ivy	<i>Glechoma hederacea</i>							R/LF
Dog's Mercury	<i>Mercurialis perennis</i>							R/LF
Common nettle	<i>Urtica dioica</i>							R/LF
False oat-grass	<i>Arrhenatherum elatius</i>							R
Crosswort	<i>Cruciata lavipes</i>							R
Hogweed	<i>Heracleum sphondylium</i>							R
Broad-leaved dock	<i>Rumex obtusifolius</i>							O
Perennial rye-grass	<i>Lolium perenne</i>							R
Burdock species	<i>Arctium spp.</i>							R
Common twayblade	<i>Listera ovata</i>							R
Primrose	<i>Primula vulgaris</i>							R
Bluebell	<i>Hyacinthoides non-scripta</i>							R
Imperforate St.John's wort	<i>Hypericum maculatum</i>							R
Ivy-leaved speedwell	<i>Veronica serpyllifolia</i>							R
Bugle	<i>Ajuga reptans</i>							R
Black bryony	<i>Dioscorea communis</i>							R
Compact rush	<i>Juncus conglomeratus</i>							R
Rowan	<i>Sorbus aucuparia</i>							R
Creeping thistle	<i>Cirsium arvense</i>							R
Annual meadow-grass	<i>Poa annua</i>							R
Soft rush	<i>Juncus effusus</i>							R
Great willowherb	<i>Epilobium hirsutum</i>							O
Hard rush	<i>Juncus inflexus</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	4						O
Beech	<i>Fagus sylvatica</i>	6						F
SUB CANOPY								
Hazel	<i>Corylus avellana</i>	5						F
Dogwood	<i>Cornus sanguinea</i>	2						R
GROUND FLORA LAYER								
Wood avens	<i>Geum urbanum</i>	5	2	4		6	IV	F
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	4		3	4	4	IV	F
Field maple (seedlings)	<i>Acer campestre</i> (seedlings)	1	2		1	1	IV	O
Hogweed	<i>Heracleum sphondylium</i>	3	1		2	4	IV	F
Beech (seedlings)	<i>Fagus sylvatica</i> (seedlings)	2			1	1	III	O
Cleavers	<i>Galium aparine</i>			3	2		II	R
Hazel (seedlings)	<i>Corylus avellana</i> (seedlings)	1			2		II	R
Smooth meadow-grass	<i>Poa pratensis</i>	3	2				II	R
Pedunculate oak (seedlings)	<i>Quercus robur</i> (seedlings)	1					II	R
Rough-stalked feather -moss	<i>Brachythecium rutabulum</i>			3	2		II	R
Cleavers	<i>Galium aparine</i>			3	2		II	R
Common nettle	<i>Urtica dioica</i>	1					I	R
Dandelion	<i>Taraxacum officinale</i> agg.	1					I	R
Wood speedwell	<i>Veronica montana</i>	1					I	R
Cock's-foot	<i>Dactylis glomerata</i>	1					I	R
Sycamore (seedlings)	<i>Acer pseudoplatanus</i> (seedlings)		1				I	R
Common feather-moss	<i>Kindbergia praelonga</i>		2				I	R
Hawthorn (seedlings)	<i>Crataegus monogyna</i> (seedlings)		1				I	R
Germander speedwell	<i>Veronica chamaedrys</i>		1				I	R
Herb-robert	<i>Geranium robertianum</i>			2			I	R
Ground-ivy	<i>Glechoma hederacea</i>					1	I	R
Bare ground		9	10	10	9	8		
Species present not in quadrats								
Wild garlic	<i>Allium ursinum</i>							R
Bramble	<i>Rubus fruticosus</i> agg.							O
Curled dock	<i>Rumex crispus</i>							R
False brome	<i>Brachypodium sylvaticum</i>							R
Common chickweed	<i>Stellaria media</i>							R
Wood melick	<i>Melica uniflora</i>							R
Whitebeam	<i>Sorbus aria</i>							R
Lesser celandine	<i>Ficaria verna</i>							R
Pignut	<i>Conopodium majus</i>							R
Common bent	<i>Agrostis capillaris</i>							R
Wood anemone	<i>Anemone nemorosa</i>							R
Enchanter's nightshade	<i>Circaea lutetiana</i>							R
Creeping buttercup	<i>Ranunculus repens</i>							R
Yorkshire fog	<i>Holcus lanatus</i>							O
Bugle	<i>Ajuga reptans</i>							R
Sweet vernal-grass	<i>Anthoxanthum odoratum</i>							R
Wild cherry	<i>Prunus avium</i>							R
Ivy-leaved speedwell	<i>Veronica serpyllifolia</i>							R
Barren strawberry	<i>Potentilla sterilis</i>							O
Holly	<i>Ilex aquifolium</i>							O
Wayfaring tree	<i>Virburnum lantana</i>							R
Imperforate St. John's wort	<i>Hypericum maculatum</i>							R
Red fescue	<i>Festuca rubra</i>							R
Cowslip	<i>Primula veris</i>							R
Elder	<i>Sambucus nigra</i>							R
Yellow archangel	<i>Lamiastrum galeobdolon</i>							R
Black horehound	<i>Ballota nigra</i>							R
Blackthorn	<i>Prunus spinosa</i>							R
Broad-leaved dock	<i>Rumex obtusifolius</i>							R
Sanicle	<i>Sanicula europaea</i>							R

Crickley Hill Stand 2

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	7						A
Beech	<i>Fagus sylvatica</i>	4						O
SUB CANOPY								
Hazel	<i>Corylus avellana</i>	3						R
Hawthorn	<i>Crataegus monogyna</i>	4						O
GROUND FLORA LAYER								
Wild garlic	<i>Allium ursinum</i>		7	8	9	9	IV	F/LD
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	1		4		3	III	F
Common feather-moss	<i>Kindbergia praelonga</i>	3		4	2		III	F
Dog's mercury	<i>Mercurialis perennis</i>	8		5			II	O/LA
Bluebell	<i>Hyacinthoides non-scripta</i>	1	1				II	R
Dogwood (seedlings)	<i>Cornus sanguinea</i> (seedlings)			1			II	R
Wood anemone	<i>Anemone nemorosa</i>				2	4	II	O
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>	1	2				II	O
Lords-and-ladies	<i>Arum maculatum</i>	1					I	R
Elder (seedlings)	<i>Sambucus nigra</i> (seedlings)		1				I	R
Hazel (seedlings)	<i>Corylus avellana</i> (seedlings)	1					I	R
Herb-paris	<i>Paris quadrifolia</i>				1		I	R
Common smoothcap	<i>Atrichum undulatum</i>					1	I	R
Bare ground		6	5	5	4	4		
Species present not in quadrats								
Pedunculate oak	<i>Quercus robur</i>							R
Traveller's joy	<i>Clematis vitalba</i>							R
Bramble	<i>Rubus fruticosus</i> agg.							O
Domestic apple	<i>Malus domestica</i>							R
Black horehound	<i>Ballotta nigra</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Sycamore	<i>Acer pseudoplatanus</i>	4						O
Ash	<i>Fraxinus excelsior</i>	5						F
SUB CANOPY								
Hawthorn	<i>Crataegus monogyna</i>	4						O
GROUND FLORA LAYER								
Sycamore (seedlings)	<i>Acer pseudoplatanus</i> (seedlings)	2		3	4	1	IV	F
Germander speedwell	<i>Veronica chamaedrys</i>	4	4		4		III	O
Common nettle	<i>Urtica dioica</i>			4	4	2	III	O
Wood speedwell	<i>Veronica montana</i>	6	8		4		III	O
Dandelion	<i>Taraxacum officinale</i> agg.	1	2		2		III	O
Hogweed	<i>Heracleum sphondylium</i>	2		3			II	O
Yorkshire fog	<i>Holcus lanatus</i>	6			3		II	R/LF
Hawthorn (seedlings)	<i>Crataegus monogyna</i> (seedlings)	1		1			II	R
Cock's-foot	<i>Dactylis glomerata</i>	4			2		II	O
Perennial rye-grass	<i>Lolium perenne</i>				7	1	II	R/LF
Smooth meadow-grass	<i>Poa pratensis</i>			4	4		II	R
Three-nerved sandwort	<i>Moehringia trinerva</i>					2	I	R
False oat-grass	<i>Arrhenatherum elatius</i>		4				I	R
Bush Vetch	<i>Vicia sepium</i>		2				I	R
Creeping bent	<i>Agrostis stolonifera</i>		5				I	R
Bramble	<i>Rubus fruticosus</i> agg.		2				I	R
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>			3			I	R
Bare ground		7	4	9	5	10		
Species present not in quadrats								
Beech	<i>Fagus sylvatica</i>							R
Creeping cinquefoil	<i>Potentilla reptans</i>							R
Cleavers	<i>Galium aparine</i>							R
Common sorrel	<i>Rumex acetosa</i>							R
Crosswort	<i>Cruciata laevipes</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	5						F
Sycamore	<i>Acer pseudoplatanus</i>	4						O
Wych-elm	<i>Ulmus glabra</i>	2						R
SUB CANOPY								
Elder	<i>Sambucus nigra</i>	4						O
Hazel	<i>Corylus avellana</i>	1						R
GROUND FLORA LAYER								
Ivy	<i>Hedera helix</i>	7	7	7	5	6	V	A
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	4		6	7	7	IV	F
Field maple (seedlings)	<i>Acer campestre</i> (seedlings)	1		1		1	III	O
Sycamore (seedlings)	<i>Acer pseudoplatanus</i> (seedlings)		2	4		3	III	O
Hawthorn (seedlings)	<i>Crataegus monogyna</i> (seedlings)				1	1	II	R
Herb-robert	<i>Geranium robertianum</i>	2	1				II	R
Cleavers	<i>Galium aparine</i>	1					I	R
Male fern	<i>Dryopteris filix-mas</i>		3				I	R
Hart's tongue	<i>Asplenium scolopendrium</i>		3				I	R
Wood avens	<i>Geum urbanum</i>				1		I	R
Hazel (seedlings)	<i>Corylus avellana</i> (seedlings)		2				I	R
Common twayblade	<i>Listera ovata</i>		2				I	R
Lords-and-ladies	<i>Arum maculatum</i>		2				I	R
Beech (seedlings)	<i>Fagus sylvatica</i> (seedlings)			4			I	R
Wych-elm (seedlings)	<i>Ulmus glabra</i> (seedlings)				1		I	R
Bare ground		7	6	6	7	7		
Species present not in quadrats								
Red campion	<i>Silene dioica</i>							O
Dog's Mercury	<i>Mercurialis perennis</i>							O
False oat-grass	<i>Arrhenatherum elatius</i>							O
Common ragwort	<i>Senecio jacobaea</i>							R
Traveller's-joy	<i>Clematis vitalba</i>							R
Pignut	<i>Conopodium majus</i>							R
Cock's-foot	<i>Dactylis glomerata</i>							O
Bracken	<i>Pteridium aquilinum</i>							R
Creeping thistle	<i>Cirsium arvense</i>							R
Bush Vetch	<i>Vicia sepium</i>							R
Mugwort	<i>Artemisia vulgaris</i>							R
Wood sage	<i>Teucreum scorodonia</i>							R
Common mallow	<i>Malva sylvestris</i>							R
Comfrey species	<i>Symphytum spp.</i>							R
Colt's-foot	<i>Tussilago farfara</i>							R
Bramble	<i>Rubus fruticosus agg.</i>							O
Ox-eye daisy	<i>Leucanthemum vulgare</i>							R
Burdock species	<i>Arctium spp.</i>							R
Ribwort plantain	<i>Plantago lanceolata</i>							R
Curled dock	<i>Rumex crispus</i>							R
Creeping cinquefoil	<i>Potentilla reptans</i>							R
Broad-leaved dock	<i>Rumex obtusifolius</i>							R
Hogweed	<i>Heracleum sphondylium</i>							R
False brome	<i>Brachypodium sylvaticum</i>							R
Cow parsley	<i>Anthriscus sylvestris</i>							R
Meadow buttercup	<i>Ranunculus acris</i>							R
Garlic mustard	<i>Alliaria petiolata</i>							R
Dandelion	<i>Taraxacum officinale agg.</i>							R
Smooth sow-thistle	<i>Sonchus oleraceus</i>							R
Common nettle	<i>Urtica dioica</i>							R
Wych-elm	<i>Ulmus glabra</i>							R
Hawthorn	<i>Crataegus monogyna</i>							R
Beech	<i>Fagus sylvatica</i>							R
Leyland cypress	<i>Cupressocyparis x leylandii</i>							R
Wild cherry	<i>Prunus avium</i>							R

Birdlip Quarry

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Beech	<i>Fagus sylvatica</i>	9						D
SUB CANOPY								
Elder	<i>Sambucus nigra</i>	1						R
Holly	<i>Ilex aquifolium</i>	2						R
Rhododendron	<i>Rhododendron ponticum</i>	2						R
GROUND FLORA LAYER								
Ivy	<i>Hedera helix</i>	4	4		4	5	IV	A
Bluebell	<i>Hyacinthoides non-scripta</i>	6		2	4	6	IV	A
Hypnum moss	<i>Hypnum cupressiforme</i>		3	4	5		III	F
Lords-and-ladies	<i>Arum maculatum</i>			2	3	2	III	O
Redcurrant	<i>Ribes rubrum</i>	1		1			III	O
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)		4		1	3	III	F
Wood avens	<i>Geum urbanum</i>	1					I	R
Dandelion	<i>Taraxacum officinale agg.</i>	3					I	R
Wall lettuce	<i>Mycelis muralis</i>	1					I	R
Hogweed	<i>Heracleum sphondylium</i>	1					I	R
Elder (seedlings)	<i>Sambucus nigra</i> (seedlings)			2			I	R
Common chickweed	<i>Stellaria media</i>	1					I	R
Common nettle	<i>Urtica dioica</i>		3				I	R
Violet species	<i>Viola sp.</i>					2	I	R
Bare ground		8	10	9	8	7		
Species present not in quadrats								
Smooth meadow-grass	<i>Poa pratensis</i>							R
Herb-robert	<i>Geranium robertianum</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Sycamore	<i>Acer pseudoplatanus</i>	5						F
Wych-elm	<i>Ulmus glabra</i>	4						O
Ash	<i>Fraxinus excelsior</i>	7						A
Field Maple	<i>Acer campestre</i>	1						R
SUB CANOPY								
Hazel	<i>Corylus avellana</i>	4						O
GROUND FLORA LAYER								
Dog's mercury	<i>Mercurialis perennis</i>							LF
Creeping cinquefoil	<i>Potentilla reptans</i>							R
Round-leaved crane's-bill	<i>Geranium rotundifolium</i>							R
Cleavers	<i>Galium aparine</i>							O
Herb-robert	<i>Geranium robertianum</i>							R
Wood forget-me-not	<i>Myosotis sylvatica</i>							R
Common nettle	<i>Urtica dioica</i>							O
Wood sedge	<i>Carex sylvatica</i>							R
Carnation sedge	<i>Carex panicea</i>							R
Creeping bent	<i>Agrostis stolonifera</i>							R
Marsh thistle	<i>Cirsium palustre</i>							R
Bramble	<i>Rubus fruticosus</i> agg.							R
Garlic mustard	<i>Alliaria petiolata</i>							R
Male fern	<i>Dryopteris filix-mas</i>							O
Daisy	<i>Bellis perennis</i>							R
Dandelion	<i>Taraxacum officinale</i>							R
Ivy	<i>Hedera helix</i>							O
Elder (seedlings)	<i>Sambucus nigra</i> (seedlings)							R
Crosswort	<i>Cruciata laevipes</i>							R
Wood melick	<i>Melica uniflora</i>							R
Common figwort	<i>Scrophularia nodosa</i>							R
Ground-ivy	<i>Glechoma hederacea</i>							R
Yorkshire fog	<i>Holcus lanatus</i>							R
Creeping buttercup	<i>Ranunculus repens</i>							R
Hogweed	<i>Heracleum sphondylium</i>							R
Broad-leaved dock	<i>Rumex obtusifolius</i>							R
Lords-and-ladies	<i>Arum maculatum</i>							O
Traveller's joy	<i>Clematis vitalba</i>							R
Hart's tongue	<i>Asplenium scolopendrium</i>							R
Black bryony	<i>Dioscorea communis</i>							R
Hazel (seedlings)	<i>Corylus avellana</i> (seedlings)							R
Sanicle	<i>Sanicula europaea</i>							R
False brome	<i>Brachypodium sylvaticum</i>							O
Yellow archangel	<i>Lamium galeobdolon</i>							R
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>							F
Bugle	<i>Ajuga reptans</i>							R
Tufted hair-grass	<i>Deschampsia cespitosa</i>							R
Common feather-moss	<i>Kindbergia praelonga</i>							F
Violet species	<i>Viola</i> spp.							O
Common dog-violet	<i>Viola riviniana</i>							R
Imperforate St.John's wort	<i>Hypericum maculatum</i>							R
Bluebell	<i>Hyacinthoides non-scripta</i>							R
Common spotted-orchid	<i>Dactylorhiza fuchsii</i>							R
Species present not in canopy quadrat								
Larch	<i>Larix decidua</i>							R
Beech	<i>Fagus sylvatica</i>							R
Hawthorn	<i>Crataegus monogyna</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	5						O
Field Maple	<i>Acer campestre</i>	3						R
Beech	<i>Fagus sylvatica</i>	1						R
Rowan	<i>Sorbus aucuparia</i>	1						R
GROUND FLORA LAYER								
False oat-grass	<i>Arrhenatherum elatius</i>	7	7		7	4	IV	A
Broad-leaved dock	<i>Rumex obtusifolius</i>	4	2			4	III	F
Ground ivy	<i>Glechoma hederacea</i>	3	4			1	III	F
Creeping thistle	<i>Cirsium arvense</i>	2		4		2	III	O
Creeping thistle	<i>Cirsium vulgare</i>	2				1	II	O
Cleavers	<i>Galium aparine</i>	6				6	II	O-LF
Wood forget-me-not	<i>Myosotis sylvatica</i>	3			2		II	O
Herb-robert	<i>Geranium robertianum</i>	4			1		II	O
Hogweed	<i>Heracleum sphondylium</i>		1	2			II	O
Creeping cinquefoil	<i>Potentilla reptans</i>		1		1		II	O
Dandelion	<i>Taraxacum officinale agg.</i>		1		2		II	O
Colt's-foot	<i>Tussilago farfara</i>			6	6		II	O-LF
Cowslip	<i>Primula veris</i>			1	2		II	O
Red fescue	<i>Festuca rubra</i>			4	5		II	O-LF
Common nettle	<i>Urtica dioica</i>				3	4	II	O
Creeping buttercup	<i>Ranunculus repens</i>	2					I	R
Horsetail species	<i>Equisetum spp.</i>		2				I	R
Male fern	<i>Dryopteris filix-mas</i>		6				I	R
Hawthorn (seedlings)	<i>Crataegus monogyna</i> (seedlings)		1				I	R
Burdock species	<i>Arctium spp.</i>	4					I	R
Wood avens	<i>Geum urbanum</i>		1				I	R
Cock's-foot	<i>Dactylis glomerata</i>			6			I	R
Sweet vernal-grass	<i>Anthoxanthum odoratum</i>			1			I	R
Common sorrel	<i>Rumex acetosa</i>			1			I	R
Wood speedwell	<i>Veronica montana</i>			2			I	R
Common mouse-ear	<i>Cerastium fontanum</i>			3			I	R
Creeping bent	<i>Agrostis stolonifera</i>			4			I	R
Hedge woundwort	<i>Stachys sylvatica</i>				1		I	R
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)				2		I	R
White dead-nettle	<i>Lamium album</i>				2		I	R
Traveller's-joy	<i>Clematis vitalba</i>				2		I	R
Cow parsley	<i>Anthriscus sylvestris</i>					6	I	R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Field maple	<i>Acer campestre</i>	5						O
Sycamore	<i>Acer pseudoplatanus</i>	8						A
SUB CANOPY								
Field maple	<i>Acer campestre</i>	1						R
GROUND FLORA LAYER								
Cleavers	<i>Galium aparine</i>	4	4	4	4	6	V	F
Ivy	<i>Hedera helix</i>	9	9	8	7	7	V	F-LD
Herb-robert	<i>Geranium robertianum</i>	3	3	4	6		IV	F
Common feather-moss	<i>Kindbergia praelonga</i>			2	3	2	III	O
Bramble	<i>Rubus fruticosus agg.</i>		2		4		II	O
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)		2	4			II	O
Ground-ivy	<i>Glechoma hederacea</i>				3	4	II	O
Winter heliotrope	<i>Petasites fragrans</i>				1	2	II	O
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>	4	4				II	O
Field maple (seedlings)	<i>Acer campestre</i> (seedlings)	1		2			II	R
Hawthorn (seedlings)	<i>Crataegus monogyna</i> (seedlings)	2					I	R
Dogwood (seedlings)	<i>Cornus sanguinea</i> (seedlings)		1				I	R
Stinking iris	<i>Iris foetidissima</i>			5			I	R
Common nettle	<i>Urtica dioica</i>				3		I	R
Gooseberry	<i>Ribes uva-crispa</i>		3				I	R
Sycamore (seedlings)	<i>Acer pseudoplatanus</i> (seedlings)					2	I	R
Bare ground		4	4	4	7	5		
Species present not in quadrats								
Wych-elm	<i>Ulmus glabra</i>	R						
Hawthorn	<i>Crataegus monogyna</i>	R						
Beech	<i>Fagus sylvatica</i>	R						
Dogwood	<i>Cornus sanguinea</i>	R						
Dog rose	<i>Rosa canina</i>	R						
Elder	<i>Sambucus nigra</i>	R						
False Brome	<i>Brachypodium sylvaticum</i>	R						
Cow parsley	<i>Anthriscus sylvestris</i>	R						
Broad-leaved speedwell	<i>Rumex obtusifolius</i>	R						
Hogweed	<i>Heracleum sphondylium</i>	R						
Spear thistle	<i>Cirsium vulgare</i>	R						
Wood avens	<i>Geum urbanum</i>	R						
White dead-nettle	<i>Lamium album</i>	R						
Germander speedwell	<i>Veronica chamaedrys</i>	R						
Bush Vetch	<i>Vicia sepium</i>	R						
Holly	<i>Ilex aquifolium</i> (seedlings)	R						
Male fern	<i>Dropteris filix-mas</i>	R						
Garlic mustard	<i>Alliaria petiolata</i>	R						
Hart's tongue	<i>Asplenium scolopendrium</i>	R						
Common field-speedwell	<i>Veronica persica</i>	R						
Lords-and-ladies	<i>Arum maculatum</i>	R						
Violet species	<i>Viola spp.</i>	R						
Wild garlic	<i>Allium ursinum</i>	R						
Cowslip	<i>Primula veris</i>	R						

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	5						F
Sycamore	<i>Acer pseudoplatanus</i>	2						R
Field maple	<i>Acer campestre</i>	1						R
SUB CANOPY								
Hawthorn	<i>Crataegus monogyna</i>	2						R
Field Maple	<i>Acer campestre</i>	2						R
GROUND FLORA LAYER								
Gooseberry	<i>Ribes uva-crispa</i>							R
Garlic Mustard	<i>Alliaria petiolata</i>							O-LF
Dandelion	<i>Taraxacum officinale agg.</i>							R
Wood avens	<i>Geum urbanum</i>							R
Cleavers	<i>Galium aparine</i>							O-LF
Cow parsley	<i>Anthriscus sylvestris</i>							LF
Common feather-moss	<i>Kindbergia praelonga</i>							O-LF
Barren strawberry	<i>Potentilla sterilis</i>							R
False brome	<i>Brachypodium sylvaticum</i>							O-LF
Dog's mercury	<i>Mercurialis perennis</i>							R
Dandelion	<i>Taraxacum officinale agg.</i>							LF
Broad-leaved dock	<i>Rumex obtusifolius</i>							R
Herb-robert	<i>Geranium robertianum</i>							R
Black bryony	<i>Dioscorea communis</i>							R
Perennial rye-grass	<i>Lolium perenne</i>							R
Germander speedwell	<i>Veronica chamaedrys</i>							R
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)							R
Hawthorn (seedlings)	<i>Crataegus monogyna</i> (seedlings)							R
Cock's-foot	<i>Dactylis glomerata</i>							R
Greater plantain	<i>Plantago major</i>							R
Bush vetch	<i>Vicia sepium</i>							R
Common nettle	<i>Urtica dioica</i>							F
Ground-ivy	<i>Glechoma hederacea</i>							R
Bramble	<i>Rubus fruticosus agg.</i>							O-LF
Wild garlic	<i>Allium ursinum</i>							R
Lords-and-ladies	<i>Arum maculatum</i>							R
Hart's tongue	<i>Asplenium scolopendrium</i>							R
Fat hen	<i>Chenopodium album</i>							R
Common chickweed	<i>Stellaria media</i>							R
Wood avens	<i>Myosotis sylvestris</i>							R
White dead-nettle	<i>Lamium album</i>							R
Hogweed	<i>Heracleum sphondylium</i>							R
Creeping bent	<i>Agrostis stolonifera</i>							R
Winter heliotrope	<i>Petasites fragrans</i>							R-LF
Field maple	<i>Acer campestre</i> (seedlings)							R
Pendulous sedge	<i>Carex pendula</i>							R
Traveller's joy	<i>Clematis vitalba</i>							R
Burdock species	<i>Arcium spp.</i>							R
Violet species	<i>Viola spp.</i>							R
Spear thistle	<i>Cirsium vulgare</i>							R
Creeping buttercup	<i>Ranunculus repens</i>							R
Elder (seedlings)	<i>Sambucus nigra</i> (seedlings)							R
Sycamore (seedlings)	<i>Acer pseudoplatanus</i> (seedlings)							R
Prickly sow-thistle	<i>Sonchus asper</i>							R
Bristly ox-tongue	<i>Helminthotheca echioides</i>							R
Stinking iris	<i>Iris foetidissima</i>							R
Barren brome	<i>Anisantha sterilis</i>							R
Marsh woundwort	<i>Stachys sylvatica</i>							R
Comfrey species	<i>Symphytum spp.</i>							R
Meadow buttercup	<i>Ranunculus acris</i>							R
Yorkshire fog	<i>Holcus lanatus</i>							R
Black medick	<i>Medicago lupulina</i>							R
Imperforate St. John's wort	<i>Hypericum maculatum</i>							R
Ox-eye daisy	<i>Leucanthemum vulgare</i>							R
Lesser stitchwort	<i>Stellaria graminea</i>							R
Ivy	<i>Hedera helix</i>							R
Species present not in canopy quadrat								
Hazel	<i>Corylus avellana</i>							O
English elm	<i>Ulmus procera</i>							R
Elder	<i>Sambucus nigra</i>							O

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Beech	<i>Fagus sylvatica</i>	7						A
SUB CANOPY								
Holly	<i>Ilex aquifolium</i>	4						O
Hazel	<i>Corylus avellana</i>	5						F
GROUND FLORA LAYER								
Wood anemone	<i>Anemone nemorosa</i>	3	3	4	2	1	V	F
Dog's mercury	<i>Mercurialis perennis</i>	5	4	5	4	8	V	F-LA
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>	2	2	3	1	1	V	F
Lords-and-ladies	<i>Arum maculatum</i>	1	2	1	2	2	V	F
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	1	1	2	1	1	V	F
Bluebell	<i>Hyacinthoides non-scripta</i>	1	4	2			III	O
Holly	<i>Ilex aquifolium</i> (seedlings)			4	4		II	O
Ivy	<i>Hedera helix</i>	1		1			II	O
Hazel (seedlings)	<i>Corylus avellana</i> (seedlings)	1				2	II	O
Hawthorn	<i>Crataegus monogyna</i> (seedlings)	1					I	R
Field maple (seedlings)	<i>Acer campestre</i> (seedlings)		1				I	R
Violet species	<i>Viola riviniana</i>	1					I	R
Beech	<i>Fagus sylvatica</i> (seedlings)				1		I	R
Traveller's-joy	<i>Clematis vitalba</i>					1	I	R
Common feather-moss	<i>Kinbergia praelonga</i>					1	I	R
Bare ground		8	9	8	9	5		
Species present not in quadrats								
Ground-ivy	<i>Glechoma hederacea</i>							R
Bramble	<i>Rubus fruticosus</i> agg.							O
Ribwort plantain	<i>Plantago lanceolata</i>							R
Germander speedwell	<i>Veronica chamaedrys</i>							R
Crosswort	<i>Cruciata laevipes</i>							R
Cleavers	<i>Galium aparine</i>							R
Creeping thistle	<i>Cirsium arvense</i>							R
Wood forget-me-not	<i>Myosotis sylvatica</i>							R
Cowslip	<i>Galium verum</i>							R
Barren strawberry	<i>Potentilla sterilis</i>							R
Common ragwort	<i>Senecio jacobaea</i>							R
Smooth sow-thistle	<i>Sonchus oleraceus</i>							R
Salad burnet	<i>Sanguisorba minor</i>							R
Lesser celandine	<i>Ficaria verna</i>							R
Thyme-leaved speedwell	<i>Veronica serpyllifolia</i>							R
Holly (seedlings)	<i>Ilex aquifolium</i> (seedlings)							R
Bugle	<i>Ajuga reptans</i>							R
Dandelion	<i>Taraxacum officinale</i> agg.							R
Sanicle	<i>Sanicula europaea</i>							R
Burdock species	<i>Arctium</i> spp.							R
Wood sage	<i>Teucreum scorodonia</i>							R
Pedunculate oak	<i>Quercus robur</i> (seedlings)							R
Male fern	<i>Dryopteris filix-mas</i>							R
Common nettle	<i>Urtica dioica</i>							R
Wood avens	<i>Geum urbanum</i>							R
Herb-robert	<i>Geranium robertianum</i>							R
Yellow archangel	<i>Lamiasastrum galeobdolon</i>							R
Wood sedge	<i>Carex sylvatica</i>							R
Annual meadow-grass	<i>Poa annua</i>							R
Elder	<i>Sambucus nigra</i>							R
Garlic mustard	<i>Alliaria petiolata</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	5						O
Beech	<i>Fagus sylvatica</i>	2						R
SUB CANOPY								
Hawthorn	<i>Crataegus monogyna</i>	2						R
Hazel	<i>Corylus avellana</i>	3						R
GROUND FLORA LAYER								
Bluebell	<i>Hyacinthoides non-scripta</i>	4	4	4	7	5	V	F
Dog's mercury	<i>Mercurialis perennis</i>	9	8	7	4	7	V	F-LD
Wood avens	<i>Geum urbanum</i>		4	4	3		III	O
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>	1		3		2	III	O
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	1			1		II	R
Enchanter's nightshade	<i>Circaea lutetiana</i>			2	2		II	R
Common feather-moss	<i>Kindbergia praelonga</i>				4	4	II	O
Male fern	<i>Dryopteris filix-mas</i>			4	4		II	O
Wild garlic	<i>Allium ursinum</i>	5					I	R
Woodruff	<i>Galium odoratum</i>		5				I	R
Bramble	<i>Rubus fruticosus</i> agg.		3				I	R
Tufted hair-grass	<i>Deschampsia cespitosa</i>			3			I	R
Wood sedge	<i>Carex sylvatica</i>			3			I	R
Fox-tailed feahter-moss	<i>Thamnobryum alopecurum</i>				2		I	R
Bare ground		4	4	5	4	7		
Species present not in quadrats								
False brome	<i>Brachypodium sylvaticum</i>							R
Dandelion	<i>Taraxacum officinale</i> agg.							O
Bugle	<i>Ajuga reptans</i>							R
Holly	<i>Ilex aquifolium</i>							O
Lords-and-ladies	<i>Arum maculatum</i>							R
Traveller's-joy	<i>Clematis vitalba</i>							R
Hogweed	<i>Heracleum sphondylium</i>							O
Hazel (seedlings)	<i>Corylus avellana</i> (seedlings)							R
Herb-robert	<i>Geranium robertianum</i>							R
Hawthorn	<i>Crataegus monogyna</i> (seedlings)							C
Violet species	<i>Viola</i> spp.							R
Ivy	<i>Hedera helix</i>							F
Swedish whitebeam	<i>Sorbus x intermedia</i>							R
Common lime	<i>Tilia x europaea</i>							R
Field maple	<i>Acer campestre</i>							R
Wild cherry	<i>Prunus avium</i>							R
Silver birch	<i>Betula pendula</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	5						O
Sycamore	<i>Acer pseudoplatanus</i>	4						O
Beech	<i>Fagus sylvatica</i>	3						R
Silver birch	<i>Betula pendula</i>	1						R
SUB CANOPY								
Hazel	<i>Corylus avellana</i>	4						O
GROUND FLORA LAYER								
Wild garlic	<i>Allium ursinum</i>	5		5	9	8	IV	F-LD
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	4	1	4		1	IV	F
Bluebell	<i>Hyacinthoides non-scripta</i>		4	4	4	5	IV	F
Common feather-moss	<i>Kindbergia praelonga</i>		4	7	5	4	IV	F-LA
Yellow archangel	<i>Lamium galeobdolon</i>		2	1	1		III	O
Dog's mercury	<i>Mercurialis perennis</i>	7	5	3			III	O-LA
Black horehound	<i>Ballota nigra</i>		1	1		1	III	O
Bramble	<i>Rubus fruticosus</i> agg.		1			1	II	O
Ground-ivy	<i>Glechoma hederacea</i>		2			2	II	O
Wood anemone	<i>Anemone nemorosa</i>	1				1	II	R
Woodruff	<i>Galium odoratum</i>	4	4				II	R
Tufted hair-grass	<i>Deschampsia cespitosa</i>		5			2	II	R
False brome	<i>Brachypodium sylvaticum</i>		3				I	R
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>	4					I	R
Dandelion	<i>Taraxacum officinale</i> agg.					1	I	R
Hawthorn (seedlings)	<i>Crataegus monogyna</i> (seedling)			1			I	R
Sanicle	<i>Sanicula europaea</i>		2				I	R
Bugle	<i>Ajuga reptans</i>		4				I	R
Wood melick	<i>Melica uniflora</i>		3				I	R
Wood avens	<i>Geum urbanum</i>		3				I	R
Common striated feather-moss	<i>Eurhynchium striatum</i>		5				I	R
Wood sedge	<i>Carex sylvatica</i>		2				I	R
Germander speedwell	<i>Veronica chamaedrys</i>		1				I	R
Violet species	<i>Viola</i> spp.			1			I	R
Beech (seedlings)	<i>Fagus sylvatica</i> (seedlings)			1			I	R
Pignut	<i>Conopodium majus</i>					1	I	R
Bare ground		4						
Species present not in quadrats								
Lords-and-ladies	<i>Arum maculatum</i>							R
Cowslip	<i>Primula veris</i>							R
Wood spurge	<i>Euphorbia amygdoloides</i>							R
Wood avens	<i>Geum urbanum</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	5						O
Horse chestnut	<i>Aesculus hippocastanum</i>	2						R
Common whitebeam	<i>Sorbus aria</i>	1						R
Sessile oak	<i>Quercus petraea</i>	1						R
SUB CANOPY								
Horse chestnut	<i>Aesculus hippocastanum</i>	1						R
Hazel	<i>Corylus avellana</i>	4						R
GROUND FLORA LAYER								
Wild garlic	<i>Allium ursinum</i>	6	5	6	7	9	V	F-LD
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	6	8	4	5	1	V	F-LA
Bluebell	<i>Hyacinthoides non-scripta</i>	4	2	3	4	3	V	F
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>	7	5	7	6	3	V	F-LA
Wood anemone	<i>Anemone nemorosa</i>	2	4	4	3		IV	F
Bramble	<i>Rubus fruticosus</i> agg.	1	2	2	2		IV	F
Dog's mercury	<i>Mercurialis perennis</i>	5	5	7			III	O-LA
Soft shield-fern	<i>Polystichum setiferum</i>		3	4		2	III	F
Fox-tailed feather-moss	<i>Thamnobryum alopecurum</i>			4	4		II	O
Common feather-moss	<i>Kindbergia praelonga</i>			4		3	II	O
Yellow archangel	<i>Lamiastrum galeobdolon</i>	1		1			II	R
Male fern	<i>Dryopteris filix-mas</i>	4			4		II	O
Hazel (seedlings)	<i>Corylus avellana</i> (seedlings)			2	1		II	R
Hawthorn (seedlings)	<i>Crataegus monogyna</i> (seedlings)	1		1			II	R
False brome	<i>Brachypodium sylvaticum</i>		1				I	R
Bush vetch	<i>Vicia sepium</i>		1				I	R
Sycamore (seedlings)	<i>Acer pseudoplatanus</i> (seedlings)			1			I	R
Bare ground		4	4	4	3			
Species present not in quadrats								
Silver birch	<i>Betula pendula</i>							R
Lords-and-ladies	<i>Arum maculatum</i>							R
Dogwood (seedlings)	<i>Cornus sanguineus</i> (seedlings)							R
Field maple	<i>Acer campestre</i>							R
Herb-paris	<i>Paris quadrifolia</i>							R
Tufted hair-grass	<i>Deschampsia cespitosa</i>							R
Common spotted-orchid	<i>Dactylorhiza fuchsii</i>							R
Wood melick	<i>Melica uniflora</i>							R
Woodruff	<i>Galium odoratum</i>							R
Wood sedge	<i>Carex sylvatica</i>							R-LA
Common striated feather-moss	<i>Eurhynchium striatum</i>							R
Dandelion	<i>Taraxacum officinale</i> agg.							R
Wood spurge	<i>Euphorbia amygdoloides</i>							R
Wood sorrel	<i>Oxalis acetosa</i>							R
Ground-ivy	<i>Glechoma hederacea</i>							R
Pignut	<i>Conopodium majus</i>							R
Yellow archangle	<i>Lamiastrum galeobdolon</i>							R
Wood avens	<i>Geum urbanum</i>							R
Beech	<i>Fagus sylvatica</i>							R

Species name	Scientific name	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Constancy	Dafor values
CANOPY								
Ash	<i>Fraxinus excelsior</i>	4						O
Leyland cypress	<i>Cupressocyparis leylandii</i>	2						R
Wych-elm	<i>Ulmus glabra</i>	2						R
Sessile oak	<i>Quercus petraea</i>	2						R
SUB CANOPY								
Hazel	<i>Corylus avellana</i>	4						O
GROUND FLORA LAYER								
Wild garlic	<i>Allium ursinum</i>	9	7	9	6	6	V	F-LD
Common feather-moss	<i>Kindbergia praelonga</i>	7	7	7	8	7	V	F-LA
Wood anemone	<i>Anemone nemorosa</i>	4	4	1	4	4	V	F
Male fern	<i>Dryopteris filix-mas</i>		4	1	4	3	IV	F
Dog's Mercury	<i>Mercurialis perennis</i>	5	5		8	7	IV	F-LA
Bluebell	<i>Hyacinthoides non-scripta</i>	4	5		4	5	IV	F
Yellow archangel	<i>Lamium galeobdolon</i>	2	4		4	4	IV	F
Ground-ivy	<i>Glechoma hederacea</i>	4			4	4	III	F
Wood sorrel	<i>Oxalis acetosella</i>				2	3	II	O
Rough-stalked feather-moss	<i>Brachythecium rutabulum</i>	6	7				II	O-LA
Ash (seedlings)	<i>Fraxinus excelsior</i> (seedlings)	3	4				II	O
Sort shield-fern	<i>Polystichum setiferum</i>		2			2	II	O
Lords-and-ladies	<i>Arum maculatum</i>	1					I	R
Hazel (seedlings)	<i>Corylus avellana</i> (seedlings)		1				I	R
Bramble	<i>Rubus fruticosus</i> agg.					1	I	R
Wood spurge	<i>Euphorbia amygdaloides</i>					1	I	R
Pignut	<i>Conopodium majus</i>					1	I	R
Common smoothcap	<i>Atrichum undulatum</i>					1	I	R
Bare ground				4				
Species present not in quadrats								
Silver birch	<i>Betula pendula</i>							R
Hawthorn (seedlings)	<i>Crataegus monogyna</i> (seedlings)							R
Common dog-violet	<i>Viola riviniana</i>							R
False brome	<i>Brachypodium sylvaticum</i>							R
Bush vetch	<i>Vicia sepium</i>							R
Herb-paris	<i>Paris quadrifolia</i>							R
Tufted hair-grass	<i>Deschampsia cespitosa</i>							R
Bugle	<i>Ajuga reptans</i>							R
Lesser celandine	<i>Ficaria verna</i>							R
Creeping bent	<i>Agrostis stolonifera</i>							R
Beech (seedlings)	<i>Fagus sylvatica</i> (seedlings)							R
Cleavers	<i>Galium aparine</i>							R
Wod sedge	<i>Carex sylvatica</i>							R-LA
Sycamore	<i>Acer pseudoplatanus</i>							R

Appendix D MAVIS Communities

Fly Up Project (GR112176)

NVC: W6b 23.41

NVC: W8d 21.92

NVC: W6 21.91

NVC: W8e 21.45

NVC: W13 20.17

NVC: W12a 20.10

NVC: W6e 18.60

NVC: W21a 18.20

NVC: W13a 17.57

NVC: W6d 17.53

Highways England woodland north of A417 (GR323231)

NVC: W8d 37.94

NVC: W12 34.73

NVC: W12a 34.20

NVC: W12b 33.84

NVC: W10c 33.83

NVC: W8e 31.45

NVC: W10 30.99

NVC: W8 29.70

NVC: W12c 28.35

NVC: W21c 28.20

Barrow Wake woodland Stands 1 (GR354675)

NVC: W8d 37.10

NVC: W13 34.87

NVC: W13b 34.78

NVC: W12c 33.81

NVC: W12 33.68

NVC: W8e 29.93

NVC: W8 29.67

NVC: W8a 29.24

NVC: W12b 28.96

NVC: W12a 27.85

Barrow Wake woodland Stand 2 (GR354675)

NVC: W6 42.08

NVC: W6a 41.63

NVC: W21b 40.11

NVC: W25a 37.81

NVC: W8f 37.09

NVC: W6d 36.97

NVC: W21 35.96

NVC: W24 35.87

NVC: W25 35.48

NVC: W24a 35.03

Barrow Wake woodland Stand 3 (GR354675)

NVC: W24 35.99

NVC: W24a 33.69

NVC: W8d 31.93

NVC: W6a 31.48

NVC: W8a 31.23

NVC: W12 31.02

NVC: W8e 30.71

NVC: W6d 30.35

NVC: W25a 29.99

NVC: W21c 29.73

Barrow Wake woodland Stand 4 (GR354675)

NVC: W24 35.87

NVC: W8d 35.44

NVC: W12 34.93

NVC: W12a 34.65

NVC: W24a 33.11

NVC: W8e 32.97

NVC: W12b 32.51

NVC: W24b 31.67

NVC: W6 30.33

NVC: W8 30.16

Crickley Hill woodland Stand 1 (GR32911)

NVC: W12 35.21

NVC: W12b 34.80

NVC: W8d 34.73

NVC: W12c 30.99

NVC: W8e 30.97

NVC: W24 30.20

NVC: W10d 30.06

NVC: W8 29.85

NVC: OV24 29.61

NVC: MG1b 29.32

Crickley Hill woodland Stand 2 (GR32911)

NVC: W12c 37.68

NVC: W8f 35.28

NVC: W8d 32.99

NVC: W12 32.32

NVC: W13 28.99

NVC: W8e 28.81

NVC: W21b 28.63

NVC: W12a 28.02

NVC: W10b 28.02

NVC: W8b 27.98

Woodland north east of Grove Farm (GR320093)

NVC: W8d 26.79

NVC: W8f 26.32

NVC: W8e 25.17

NVC: W12a 23.19

NVC: W8c 23.09

NVC: W8 21.08

NVC: W8g 21.00

NVC: W8b 20.78

NVC: W10e 19.89

NVC: W12 18.12

Highways England woodland south of A417 (GR326339, GR325786, GR19275, GR21956, GR21586)

NVC: W6 36.17

NVC: W21 35.05

NVC: W22 34.19

NVC: W21b 34.06

NVC: W25a 33.79

NVC: W21a 33.65

NVC: W8f 33.41

NVC: W6a 33.33

NVC: W21c 31.82

NVC: W22b 31.78

Land north west of Grove Farm (GR320093)

NVC: MG1b 49.14

NVC: W24 48.02

NVC: OV24b 44.94

NVC: OV24 44.62

NVC: MG1a 43.08

NVC: MG1 42.64

NVC: W24a 41.60

NVC: MG1c 41.28

NVC: OV24a 40.68

NVC: OV26d 39.96

Woodland at Cukoopen Barn Farm (GR136598)

NVC: W8d 45.53

NVC: W12 42.01

NVC: W12a 40.68

NVC: W8a 38.61

NVC: W8 37.11

NVC: W8e 36.89

NVC: W12c 36.89

NVC: W8f 36.23

NVC: W8b 34.18

NVC: W10 32.79

Woodland north of Dog Lane (GR95689)

NVC: W21b 35.58

NVC: W21c 31.75

NVC: W12b 31.67

NVC: W21a 31.48

NVC: W8d 31.08

NVC: W21 30.58

NVC: W8e 30.48

NVC: W12 30.47

NVC: W6a 29.38

NVC: W25a 29.23

Woodland north of Dog Lane (GR95689)

NVC: W8d 26.37

NVC: W12a 22.34

NVC: W8e 21.52

NVC: W8f 20.18

NVC: W12 19.21

NVC: W12c 18.45

NVC: W8b 18.32

NVC: W8c 17.61

NVC: W21a 17.44

NVC: W8g 16.57

Woodland at Birdlip Quarry (GR353298)

NVC: W8d 31.91

NVC: W10c 31.32

NVC: W21b 29.24

NVC: W21 28.23

NVC: W10b 28.17

NVC: W12a 27.30

NVC: W12 26.74

NVC: W10 26.22

NVC: W10a 26.07

NVC: W10d 25.82

Woodland at Birdlip Radio Station (GR252644)

NVC: MG1b 39.78

NVC: OV24 39.07

NVC: OV24b 37.36

NVC: W24 36.21
NVC: MG1a 35.86
NVC: W24b 34.28
NVC: MG1c 33.57
NVC: MG1 33.22
NVC: OV24a 33.01
NVC: SD18b 32.56

Woodland at Rushwood Kennels (GR138283)

NVC: W6 35.78
NVC: W6d 34.64
NVC: W8e 32.15
NVC: W6a 32.14
NVC: W8 30.57
NVC: W24a 29.72
NVC: W12c 29.57
NVC: W8b 29.23
NVC: W8d 29.07
NVC: W24 29.03

Shab Hill woodland Stand 1 (GR97761)

NVC: W13 39.74
NVC: W13b 35.79
NVC: W12c 34.36
NVC: W21b 32.18
NVC: W12 31.11
NVC: W8d 28.74
NVC: W8f 28.09
NVC: W12a 26.85
NVC: W21 26.14
NVC: W12b 24.21

Shab Hill woodland Stand 2 (GR97761)

NVC: OV24a 45.40
NVC: W6a 43.07
NVC: OV27b 42.48
NVC: OV24 42.00
NVC: W24a 40.64
NVC: W24 40.00
NVC: OV24b 38.50
NVC: SD18b 38.42
NVC: W6 37.96
NVC: W21b 37.88

Shab Hill woodland Stand 3 (GR97761)

NVC: W6 49.04
NVC: W6a 48.47
NVC: W6d 48.17
NVC: W21b 42.80
NVC: W25a 38.46
NVC: W21 37.89
NVC: W8e 37.14
NVC: SD18b 36.99
NVC: W12c 36.94
NVC: W6e 36.91

Woodland at The Scrubbs (GR32911)

NVC: W8d 40.36
NVC: W12 34.54
NVC: W8 32.30
NVC: W12a 31.84
NVC: W8e 31.29
NVC: W10b 30.77
NVC: W12c 30.62

NVC: W8b 30.50

NVC: W8f 30.26

NVC: W12b 28.92

Ullen Wood (GR346313)

NVC: W8d 45.39

NVC: W8b 45.08

NVC: W12 44.93

NVC: W12a 42.70

NVC: W10b 42.31

NVC: W10 41.27

NVC: W8e 40.31

NVC: W8a 40.11

NVC: W8 39.64

NVC: W10a 38.40

Ullen Wood (GR352384)

NVC: W8f 37.81

NVC: W8d 34.32

NVC: W8b 34.04

NVC: W12 33.74

NVC: W8e 33.24

NVC: W12a 33.17

NVC: W10b 31.75

NVC: W8 30.22

NVC: W8a 30.17

NVC: W10 27.93

Ullen Wood (GR354154)

NVC: W8b 44.89

NVC: W8f 42.61

NVC: W8d 39.30

NVC: W10b 37.77

NVC: W8e 37.36

NVC: W8a 36.97

NVC: W8 36.79

NVC: W10 34.76

NVC: W12 32.36

NVC: W12a 32.12

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.4
Botanical Assessment

28 September 2020

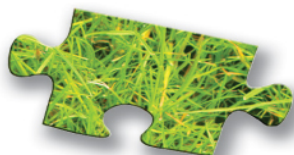


VEGETATION SURVEY & ASSESSMENT

A417 MISSING LINK

BOTANICAL ASSESSMENT

September 2019



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1. INTRODUCTION

1.1 Scope of Work and Objectives

This report brings together the results of a number of botanical surveys, all of which were undertaken in 2019 to provide a baseline of information about habitats and species within areas of land with potential to be directly or indirectly affected by the proposed alignment options for the A417 Missing Link road enhancement scheme.

1.2 Legislation and Conservation Context

The legislative provisions in Great Britain for the protection of wild plants are contained primarily in the Wildlife and Countryside Act, 1981, Section 13, with protected wild plants listed on Schedule 8. In practice, few British wild plants are directly protected by legislation relevant to the kind of impacts caused by major infrastructure projects.

Valuation of species conservation importance is generally determined against a set of national and regional criteria of rarity and threat (Table 1.1).

Table 1.1 Criteria used to define Plants of National/ Regional Conservation Importance

Conservation Category	Status	Definition	Reference
Extent	Nationally Rare (NR)	A taxon present in 1-15 10km Ordnance Survey grid squares in Britain post-1950	<i>New Atlas of the British and Irish Flora (2002)</i> by C.D. Preston, D.A. Pearman and T.D. Dines.
	Nationally Scarce (NS)	A taxon present in 16-100 10km Ordnance Survey grid squares in Britain post-1950	
Threat (IUCN Red List)	Critically Endangered (CR)	A taxon facing an extremely high risk of regional extinction in the wild in the near future.	<i>The Vascular Plant Red Data List for Great Britain (2005)</i> by JNCC (Eds. C.M. Cheffings and L. Farrell). Also: <i>A Vascular Plant Red List for England (2014)</i> by BSBI (Eds. P.A. Stroh et al)
	Endangered (EN)	A taxon that is not CR but facing a very high risk of regional extinction in the wild in the immediate future.	
	Vulnerable (VU)	A taxon that is not CR or EN, but facing a high risk of regional extinction in the medium-term future.	
Conservation	NERC Act Section 41	A taxon identified by the Secretary of State as being of principle importance for the purpose of conserving biodiversity in England.	Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006

Vegetation communities of the highest ecological importance are generally recognised and protected through the formal designation of sites including Sites of Special Scientific Interest (SSSIs). Where sites also support habitats listed on Annex I of the EU Habitats Directive many have also been notified as Special Areas of Conservation (SACs).

Outside statutory designated sites, many habitats of high ecological value have been recognised by selection of BAP Priority Habitats under the former UK Biodiversity Action Plan. In England, the UK BAP lists have subsequently been used to draw up statutory lists of habitats that are of principal importance for the conservation of biodiversity in under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006.

2. METHODOLOGY

2.1 Survey Locations

In several sites likely to be directly or indirectly impacted by the A417 realignment, a Phase I Habitat Survey in 2017 had indicated the potential presence of grassland of conservation importance and these areas were targeted for more detailed botanical investigation. These included:

- Shab Hill: a small valley centred at Ordnance Survey National Grid Reference SO 939152;
- Crickley Hill: within Crickley Hill and Barrow Wake Site of Special Scientific Interest (SSSI) and Crickley Hill Country Park between woodland known as The Scrubbs and the A417 road centred at SO 933161;
- Land west of Air Balloon Roundabout: two fields near the Air Balloon public house centred at SO 933160; no grassland of potential conservation interest was noted here by Phase I surveyors but the land abuts part of Crickley Hill and Barrow Wake SSSI; and
- Part of a field north of Shab Hill: this field, at SO 939156 was included latterly in the botanical survey when a large number of common orchids were seen there in summer 2019; this field had not been identified as having any grassland of potential conservation importance during the Phase I Habitat Survey.

To help understand the potential indirect impacts of the new road alignment on sites of high ecological importance that are likely to be particularly sensitive to local hydrological change, Bushley Muzzard, Brimpsfield SSSI, and its immediate surroundings (centred at SO943133) was also assessed. According to the SSSI Citation, *'it is one of a small number of marshes found in the Cotswolds and is of particular importance for its species richness and the presence of several uncommon plants.'*

2.2 National Vegetation Classification Survey

All fieldwork was undertaken in July and August 2019; the two Shab Hill sites and Crickley Hill on 10th and 11th July, Bushley Muzzard, Brimpsfield SSSI on the 6th and 7th August and land west of Air Balloon Roundabout on the 13th August. All surveys and analysis were undertaken by Sharon Pilkington, a professional botanist, bryologist and vegetation ecologist with 18 years' experience of botanical assessment.

At all of the sites, standard National Vegetation Classification (NVC) sampling methodology (Rodwell 2006) was employed to classify all grassland, marsh and spring-line vegetation likely to fall within the scope of the NVC. Five 2m x 2m quadrats were sampled in most stands of vegetation with distinct floristics and physiognomy in order to construct a floristic table ready for data analysis. Very small stands were sampled with a single quadrat. Sampling protocol followed Rodwell (2006) and included all vascular plants, mosses and liverworts.

MATCH¹ software was subsequently employed to analyse the quadrat data and to highlight potential affinities with published NVC communities/sub-communities. Such analysis produces a numerical coefficient of similarity on a scale from 0 to 100 for each dataset. It indicates a 'goodness of fit' with documented NVC communities/sub-communities and as a general rule, the higher the number, the more confidence there is with the result.

Surveyor experience and detailed descriptions of vegetation communities provided by Rodwell (1991 and 1992) were subsequently used to confirm the classification of each stand in NVC terms as appropriate. Stands of other kinds of vegetation e.g. tall herbaceous were assigned to NVC communities where appropriate in the field but were not sampled with quadrats.

¹ Vegetation analysis software developed by scientists from the University of Lancaster for NVC classification.

2.3 Limitations and Assumptions

All surveys were undertaken at an optimal time of year and in reasonable weather conditions and there were few constraints.

However, west of the Air Balloon public house, the larger of the two fields had been heavily grazed by ponies, which were still present at the time of survey. Quadrat sampling was therefore restricted to the western fringe where the sward retained some height and vegetation within the rest of the field was deduced by visual comparison of species composition to the longer sward. Within the curtilage of the public house, a children's play area was fenced off and cut very short, so it could not be sampled with quadrats. However, it was evident that the short-mowed grassland within was of very low botanical interest.

The single large field containing Bushley Muzzard, Brimpsfield SSSI had been grazed by cattle relatively recently and whilst partial recovery of the sward meant that quadrat sampling was possible, it is likely that some species occurring at low frequency within the richest spring-line vegetation were overlooked or under-represented.

3. RESULTS

Botanical nomenclature used in this report follows Stace (2019) for vascular plants and Hill *et al* (2008 as amended) for bryophytes. Appendix I shows tabulated data collected from all sites where NVC sampling was undertaken.

3.1 Shab Hill

3.1.1 Vegetation Communities

Figure 3.1 shows the vegetation communities present in the valley. The vegetation was quite complex and included neutral grassland that could not be placed confidently in any NVC community.

Limestone grassland was restricted to one south-facing slope, where it occurred in small relict patches as well as in a mosaic with neutral grassland and tall herbaceous vegetation. It was classified as **CG4c** *Brachypodium rupestre*² grassland (*Holcus lanatus* sub-community) and analysis of samples gave a relatively low coefficient of similarity (46.3). This reflected the poor condition of the vegetation, and elsewhere on the bank the transitional nature of the grassland was clearer. However, in the relict CG4c, Tor-grass *Brachypodium rupestre* was quite abundant, alongside many other calcicoles.

Most of the sloping ground on the valley sides was characterised by a form of coarse neutral grassland considered to be the **MG1e** *Centaurea nigra* sub-community of *Arrhenatherum elatius* grassland (coefficient of similarity 63.6). Although dominated by such grasses as False Oat-grass *Arrhenatherum elatius* and Yorkshire-fog *Holcus lanatus*, it also included variable amounts of Lady's Bedstraw *Galium verum*, Crosswort *Cruciata laevipes* and Field Scabious *Knautia arvensis*. The presence of occasional Tor-grass was distinctive, suggesting localised transitions to calcareous grassland, perhaps where underlying limestone lay close to the surface.

Grassland in the valley bottom conformed to **MG9b** *Arrhenatherum elatius* sub-community of *Holcus lanatus* – *Deschampsia cespitosa* grassland (coefficient of similarity 55.1). It was structurally distinctive, with many large tussocks of Tufted Hair-grass *Deschampsia cespitosa* over other common grasses and a few forbs in a species-poor coarse sward.

At the eastern end of the valley an indeterminate kind of species-poor neutral grassland (**MG unclassified**) was present within scattered scrub. It included elements of MG1 and MG9 but was mostly defined by high cover of Yorkshire-fog and Wood Dock *Rumex sanguineus*.

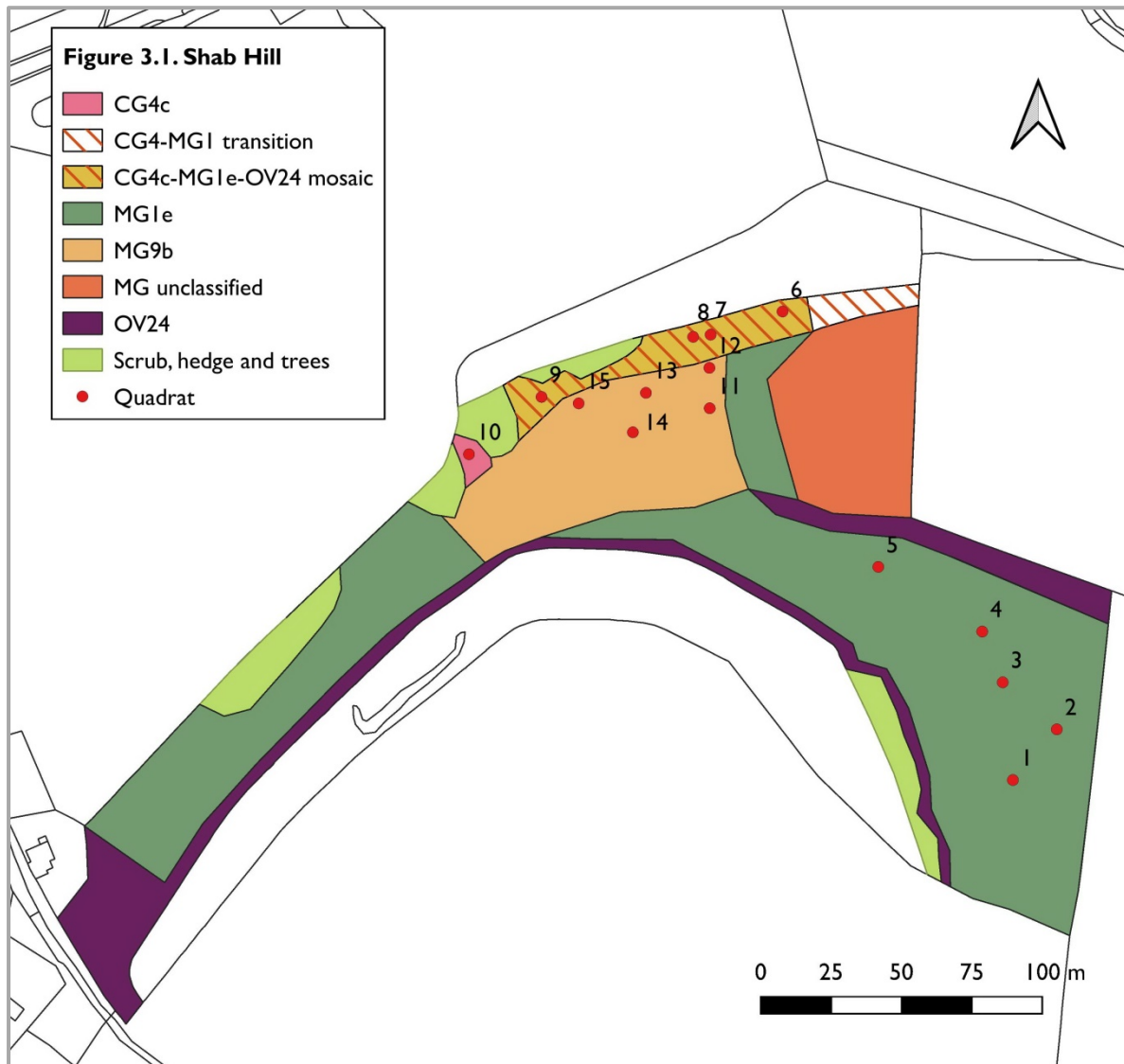
Other types of vegetation mapped but not sampled included **OV24** *Urtica dioica* – *Galium aparine* community, a species-poor kind of tall herbaceous vegetation where Common Nettle *Urtica dioica* and Cleavers *Galium aparine* were co-dominant, and small areas of dense Elder *Sambucus nigra* scrub. Both kinds of vegetation are common where there has been significant nutrient enrichment of soils.

3.1.2 Condition of Vegetation

The grassland communities had the appearance of not having been regularly grazed for a significant period of time. Evidence for this could be seen in the coarseness of the sward, the creeping advance of scrub and ruderal vegetation from the site perimeter and in the accumulation of thatch within the sward.

² NVC community name updated from CG4 *Brachypodium pinnatum* grassland

Remnant calcareous grassland was confined to one slope, where it was in poor condition, as shown by the dominance of rank Tor-grass, a lack of small calcicoles, the abundance of particular mesophiles e.g. False Oat-grass and invasion of Bramble *Rubus fruticosus* agg. and Cleavers.



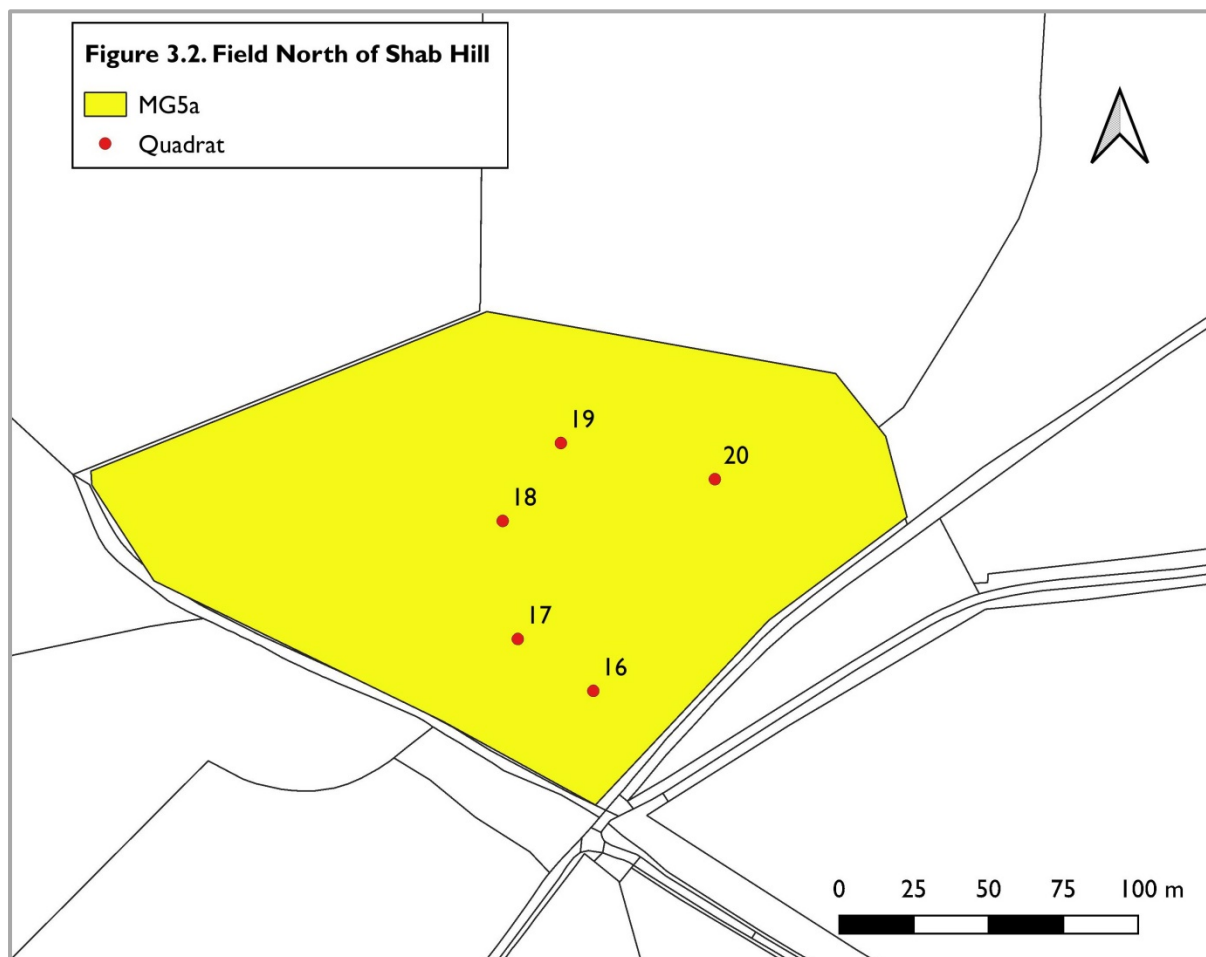
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3.2 Field North of Shab Hill

The survey area (which was part of a larger field) comprised a single vegetation community (Figure 3.2). Analysis of quadrat data gave a relatively good co-efficient of similarity to MG5a *Centaurea nigra* – *Cynosurus cristatus* grassland, *Lathyrus pratensis* sub-community (54.2). The most distinctive feature of this grassland was its diversity, with high cover of forbs. Prominent among these were Oxeye Daisy *Leucanthemum vulgare*, Red Clover *Trifolium pratense*, Cat's-ear *Hypochaeris radicata*, Meadow Buttercup *Ranunculus acris* and Sweet Vernal-grass *Anthoxanthum odoratum*. Yellow-rattle *Rhinanthus minor* was also very common in the sward, which appeared relatively uniform across the stand.

3.2.1 Condition of Vegetation

Whilst a large number of species was recorded in this stand, no species indicative of 'old hay meadow' were seen. Rodwell (1992) acknowledges that as long as grassland has a history of management that has traditionally involved grazing, cutting a hay crop and light application of natural organic manures, it can develop the floristic characteristics of MG5. Furthermore, the absence of rare species is not a reliable indicator of agricultural improvement and it was clear that regular and sympathetic agricultural management had maintained this grassland in good floristic condition.



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3.3 Crickley Hill

The survey area (northern part of Figure 3.3) primarily included two different kinds of neutral grassland community. Much of the open ground supported a colourful coarse grassland considered to be **MG1aii** (*Geranium pratense* variant of the *Festuca rubra* sub-community of *Arrhenatherum elatius* grassland). As well as False Oat-grass, other prominent species in this sward (co-efficient of similarity to MG1a 60.6) included Yorkshire-fog, Red Fescue *Festuca rubra*, Crosswort and Meadow Crane's-bill *Geranium pratense*.

A second, smaller area of grassland had a much shorter and more diverse sward and was classified as **MG5a** (coefficient of similarity 59.6). This stand was variable and degraded at the edges by trampling along grass paths. However, it was rich in forbs, including a number of species of short turf e.g. Self-

heal *Prunella vulgaris* and Rough Hawkbit *Leontodon hispidus* and it supported a number of meadow ant-hills, which are indicative of older grasslands which have been sheep-grazed.

Well-used grass paths through long grassland had the broad floristic composition of the **OV23** *Lolium perenne* – *Dactylis glomerata* community which is very typical of trampled grassy ground over neutral soils. Hairy Lady's-mantle *Alchemilla filicaulis* subsp. *vestita* was occasional in these paths. Other vegetation types present within the survey area included **OV24** and mixed scrub.

3.3.1 Condition of Vegetation

Within the MGIaii there was a significant accumulation of plant litter between plants indicating that this part of the country park may not have been grazed much recently. Bramble invading the edges of the grassland from neighbouring scrub, woodland and hedgerow also indicated a relaxed management regime in this area. Rabbit grazing of the MG5a grassland was evident but the frequency of False Oat-grass was an indication that the sward may be coarsening in response to a relaxation of traditional management.

3.4 Land West of Air Balloon Roundabout

Vegetation communities in this locality are shown on Figure 3.3 (southern part). Calcareous grassland occupied the two fields that make up most of the site. In the western field, heavily grazed **CG3c** (*Knautilia arvensis* – *Bellis perennis* sub-community of *Bromopsis erecta*³ grassland) was present (co-efficient of similarity 47.6) except for one small area of species-poor and unclassifiable neutral grassland. This sward was quite herb-rich and as is typical of CG3c, supported many different calcicoles and mesophiles together.

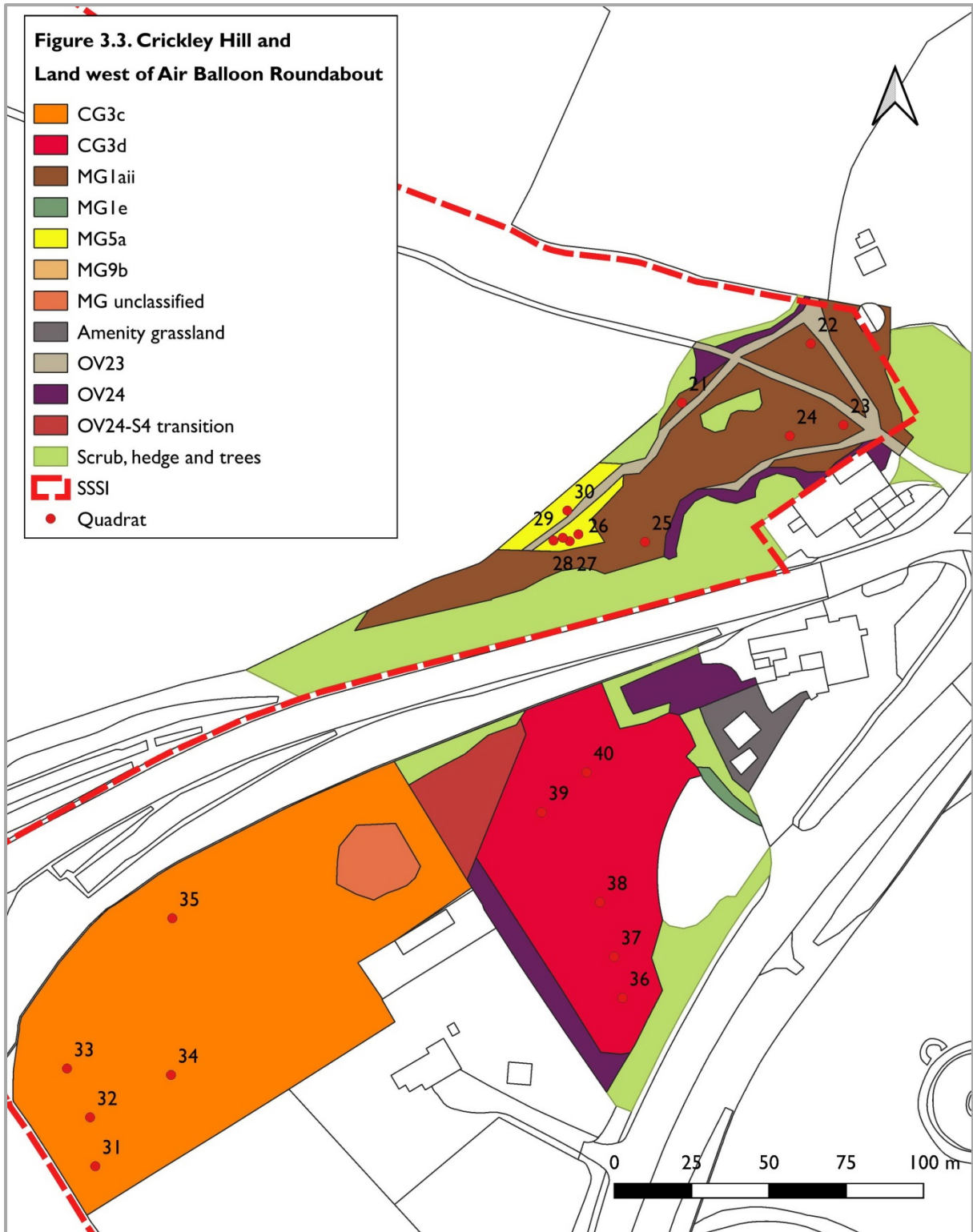
The eastern field did not appear to have been managed recently and supported **CG3d** (*Festuca rubra* – *Schedonorus arundinaceus* sub-community of *Bromopsis erecta* grassland). This had a coefficient of similarity of 46.5 and the stand was not a particularly good example. The sward was very variable and in places transitional to MGI *Arrhenatherum elatius* grassland. Large tussocks of Upright Brome *Bromopsis erecta* typically achieved high cover in a rank sward, alongside Common Knapweed *Centaurea nigra*, Greater Knapweed *C. scabiosa*, Yarrow *Achillea millefolium*, Lady's Bedstraw and False Oat-grass. Large meadow ant-hills were frequent within the sward and there was a thick layer of thatch below the plants.

Other minor areas of vegetation included **MGIe**, **OV24**, scrub and outgrown hedgerows, short-mown amenity grassland within a children's play area near the Air Balloon public house and low-lying ground characterised by OV24 grading into patches of near-pure Common Reed *Phragmites australis*. This latter area was considered to be transitional OV24-S4 *Phragmites australis* swamp and reed-beds vegetation.

3.4.1 Condition of Vegetation

Neither field of calcareous grassland was in optimal condition; in the western field it was over-grazed by ponies, in the other probable cessation of management had promoted a coarse, less diverse form of CG3 and probable loss of many of the smaller species typical of grazed calcareous grassland in this area. Without a resumption of management in the eastern field, it is likely that the grassland will continue to lose condition. In contrast, reduction (but not cessation) of the grazing intensity in the western field would quickly return its CG3 to good condition.

³ NVC community name updated from CG3 *Bromus erectus* grassland



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3.5 Bushley Muzzard, Brimpsfield SSSI and Adjacent Land

Bushley Muzzard, Brimpsfield SSSI occupies about a third of the large pasture which contains it (Figure 3.4). Within the SSSI, significant vegetation types include fen-meadow over a spring-line and limestone grassland.

The fen-meadow vegetation was very rich and included a large number of fen and wetland plants including several uncommon species such as Marsh Arrowgrass *Triglochin palustris*, Flat-sedge *Blysmus compressus* (cited as Vulnerable in the Red List for England), Long-stalked Yellow-sedge *Carex lepidocarpa* and Marsh Valerian *Valeriana dioica*. Analysis of quadrats sampled there helped to confirm it as the **M22b** *Briza media* – *Trifolium* spp. sub-community of *Juncus subnodulosus* – *Cirsium palustre* fen-meadow (coefficient of similarity 60.7). This stand appears to be an example of one lacking Blunt-flowered Rush *Juncus subnodulosus*, usually preferential to M22.

These springs and others fed small headwater streams which flowed downhill out of the SSSI. Vegetation in these was not as rich as the primary area of M22 fen-meadow but it could still be considered to be M22b (coefficient of similarity 48.1). The banks of the streams, which were poached by cattle, supported a population of Heath False-brome *Brachypodium pinnatum*, a relatively scarce grass of heavy neutral to calcareous soils.

A spring-fed rivulet elsewhere in the SSSI was of particular interest as it supported a population of the tufa-forming moss *Palustriella commutata* together with Marsh Arrowgrass and large tussocks of Long-stalked Yellow-sedge. Whilst it was still close to M22b, its vegetation appeared to be transitional to **M37** *Palustriella commutata*⁴-*Festuca rubra* spring vegetation.

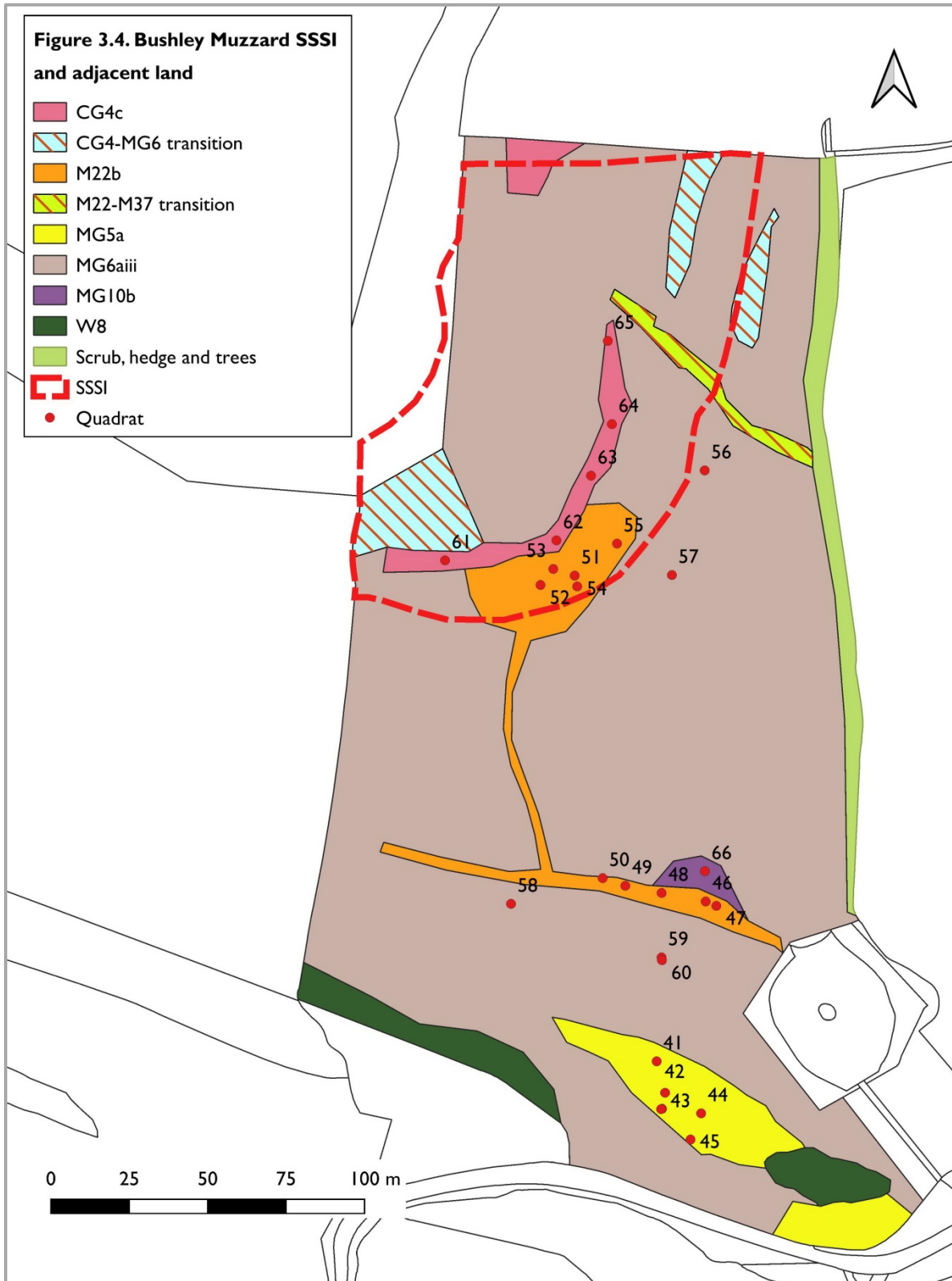
A bank of **CG4c** calcareous grassland occurred just above the main SSSI seepage line (coefficient of similarity 49.1). This differed from CG4c assessed in other sites in the area in being grazed and included more mesophiles, including species abundant in adjacent improved pasture such as Perennial Rye-grass *Lolium perenne* and White Clover *Trifolium repens*. Elsewhere in the survey area, small stands of CG4c transitional to MG6 *Lolium perenne*-*Cynosurus cristatus* grassland were also present.

Outside the SSSI, the only other stand of notable vegetation was a rich and varied bank of **MG5a** neutral grassland (co-efficient of similarity 73.2). It had a close-grazed, herb-rich turf supporting common MG5 species but also several more restricted forbs, including Tormentil *Potentilla erecta*, Hairy Lady's-mantle and Devil's-bit Scabious *Succisa pratensis*.

Other grassland included an extensive tract of **MG6aiii**, the *Deschampsia cespitosa* variant of the Typical sub-community of *Lolium perenne*-*Cynosurus cristatus* grassland (co-efficient of similarity 65.5). This grazed pasture was species-poor and dominated by Perennial Rye-grass, Common Bent *Agrostis capillaris* and Yorkshire-fog, with few herbaceous associates other than Creeping Buttercup *Ranunculus repens* and Meadow Buttercup *R. acris*. Tufted Hair-grass was frequent but patchily distributed.

One small area of rushy vegetation dominated by Hard Rush *Juncus inflexus* was assigned to **MG10b** (*Juncus inflexus* sub-community of *Holcus lanatus*-*Juncus effusus* rush-pasture). Apart from the rushes, the community was very grassy, with much Creeping Bent *Agrostis stolonifera*. Other indicators of wet ground included Creeping Buttercup *Ranunculus repens* and Common Spike-rush *Eleocharis palustris*. The rich-fen species of nearby M22 were absent from this community.

⁴ NVC community name updated from M37 *Cratoneuron commutatum*- *Festuca rubra* spring



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3.5.1 Condition of vegetation

The grazing and poaching of livestock have clearly been very important in maintaining the rich and varied flora within fen-meadow and species-rich grassland. Hydrological influences in this area are likely to be complex but will include the groundwater seepage characteristics and its chemical composition and these will also be playing a critical role in sustaining the high diversity and uncommon species of the M22 vegetation and its transitions to M37. All vegetation is regarded as being in good condition.

4. ECOLOGICAL CONTEXT

CG3 *Bromopsis erecta* grassland is characteristic of thin soils over limestone (including chalk) in the lowlands of southern Britain. The *Knautia arvensis* – *Bellis perennis* sub-community (CG3c) is frequent in the Cotswolds where the underlying oolite limestone weathers to produce deep, mesotrophic rendzinas. The more impoverished swards in the *Festuca rubra*- *Schedonorus arundinaceus* sub-community (CG3d) may develop when grazing ceases or becomes intermittent. CG3 is a qualifying NVC community of the Section 41 habitat *Lowland Calcareous Grassland*.

CG4 *Brachypodium rupestre* grassland is very characteristic of the Cotswold oolite. It is a community of situations where grazing has been relaxed or abandoned, allowing the strongly rhizomatous Tor-grass to become dominant. The *Holcus lanatus* sub-community (CG4c) includes a number of species more commonly associated with neutral swards and its development may be associated with cattle grazing. CG4 is a qualifying NVC community of the Section 41 habitat *Lowland Calcareous Grassland*.

M22 *Juncus subnodulosus*-*Cirsium palustre* fen-meadow is a scarce and declining vegetation type restricted to southern lowland Britain. It is found on a range of moist, base-rich and mesotrophic soils in and around springs, flushes and mires. It is most diverse if grazed and poached by livestock. The *Briza media* – *Trifolium* spp. sub-community (M22b) is especially characteristic of grazed spring-fens. M22 is a qualifying NVC community of the Section 41 habitat *Purple Moor-grass and Rush-pastures*.

M37 *Palustriella commutata*⁵-*Festuca rubra* spring vegetation is an uncommon community of northern and western Britain. Although it undoubtedly occurs in limestone districts of southern England, such examples have been poorly documented. M37 develops in springs, seepages and drip-lines where there is constant irrigation of base-rich, calcareous and nutrient-poor water. It is potentially a qualifying vegetation type in the SAC Annex I habitat 7220 Petrifying springs with tufa formation (*Cratoneurion*).

MG1 *Arrhenatherum elatius* grassland is ubiquitous on fertile, circumneutral and freely draining soil in the lowlands; it often represents formerly grazed land that has been abandoned. The *Geranium pratense* variant of the *Festuca rubra* sub-community (MG1aii) is characteristic of brown calcareous earths over limestone or other calcareous bedrock whilst the *Centaurea nigra* sub-community (MG1e) is normally found on mesotrophic soils.

MG5 *Centaurea nigra* – *Cynosurus cristatus* grassland is a scarce community of grazed hay-meadows over freely draining neutral soils in the lowlands and it is a qualifying NVC community of the Section 41 habitat *Lowland Meadows*. The *Lathyrus pratensis* sub-community (MG5a) favours circumneutral brown earths of heavy texture or other superficial deposits of low calcium content.

MG6 *Lolium perenne*-*Cynosurus cristatus* grassland is a ubiquitous permanent pasture of the type usually regarded as agriculturally improved grassland. The *Deschampsia cespitosa* variant of MG6a (Typical sub-community) is characteristic of undulating, poorly-drained pasture.

MG9 *Holcus lanatus*-*Deschampsia cespitosa* grassland is highly characteristic of permanently moist, gleyed clay soils. The *Arrhenatherum elatius* sub-community (MG9b) is usually found on slightly drier soils where there has been little or no recent grazing.

MG10 *Holcus lanatus*-*Juncus effusus* rush-pasture is found on consistently moist soils of varying pH, often where there is grazing. The *Juncus inflexus* sub-community (MG10b) is common in southern England on more calcareous soils.

⁵ NVC community name updated from M37 *Cratoneuron commutatum*- *Festuca rubra* spring

5. EVALUATION

Following analysis and interpretation of the NVC data for each site, each vegetation community has been accorded a relative intrinsic botanical value taking into account one or more of the following criteria:

- Its perceived nature conservation importance e.g. uncommon or rare NVC communities, NERC Act Section 41 habitats;
- Its goodness of fit with published NVC communities;
- The presence of plants of recognised conservation importance or other plant species of restricted ecological amplitude;
- Its botanical diversity;
- Its extent; and
- Its condition.

The evaluation is presented in Tables 5.1 to 5.5.

Table 5.1 Shab Hill

Vegetation Community	Botanical Value	Rationale
CG4c grassland	Moderate	<ul style="list-style-type: none"> • Section 41 habitat (Lowland calcareous grassland) • Poor condition likely to be irreversible • Small area
CG4-MG1 grassland transition	Low	<ul style="list-style-type: none"> • Not referable to any NVC community • Deterioration of calcareous grassland likely to be irreversible
CG4c-MG1e-OV24 mosaic	Low	<ul style="list-style-type: none"> • Not referable to any NVC type • Changes to former calcareous grassland likely to be irreversible
MG1e grassland	Low	<ul style="list-style-type: none"> • Common kind of grassland
MG9b grassland	Low	<ul style="list-style-type: none"> • Common kind of grassland
MG unclassified grassland	Negligible	<ul style="list-style-type: none"> • Not referable to any NVC community • Low diversity
OV24 community	Negligible	<ul style="list-style-type: none"> • Ubiquitous kind of ruderal vegetation

Table 5.2 Shab Hill (north)

Vegetation Community	Botanical Value	Rationale
MG5a grassland	High	<ul style="list-style-type: none"> • Section 41 habitat (Lowland meadows) • Extensive area • Good condition • Atypical example of MG5

Table 5.3 Crickley Hill

Vegetation Community	Botanical Value	Rationale
MG1aii grassland	Low	<ul style="list-style-type: none"> • Common kind of grassland • <i>Geranium pratense</i> variant characteristic of the Cotswold Hills
MG5a grassland	Moderate	<ul style="list-style-type: none"> • Section 4I habitat (Lowland meadows) • Small area • In reasonable condition but probably deteriorating from trampling at edges • Atypical example of MG5
OV23 community	Low	<ul style="list-style-type: none"> • Ubiquitous kind of vegetation • Supports population of Hairy Lady's-mantle
OV24 community	Negligible	<ul style="list-style-type: none"> • Ubiquitous kind of ruderal vegetation

Table 5.4 Land west of Air Balloon Roundabout

Vegetation Community	Botanical Value	Rationale
CG3c grassland	High	<ul style="list-style-type: none"> • Section 4I habitat (Lowland calcareous grassland) • Substantial area • Condition negatively affected by heavy grazing but could be improved.
CG3d grassland	Moderate	<ul style="list-style-type: none"> • Section 4I habitat (Lowland calcareous grassland) • Substantial area • In poor condition
MG1e grassland	Low	<ul style="list-style-type: none"> • Common kind of grassland • Moderately diverse
MG unclassified grassland	Negligible	<ul style="list-style-type: none"> • Not referable to any NVC community • Low diversity
OV24 community	Negligible	<ul style="list-style-type: none"> • Ubiquitous kind of ruderal vegetation
OV24 grassland-S4 swamp transition	Negligible	<ul style="list-style-type: none"> • Not referable to any NVC community • Very low diversity
Amenity grassland	Negligible	<ul style="list-style-type: none"> • Intensively managed grassland • Very low diversity

Table 5.5 Bushley Muzzard SSSI and adjacent land

Vegetation Community	Botanical Value	Rationale
CG4c grassland	High	<ul style="list-style-type: none"> • Section 41 habitat (Lowland calcareous grassland) • In good condition • Small area
CG4-MG6 grassland transition	Moderate	<ul style="list-style-type: none"> • Not referable to any single NVC community • Could revert to CG in time given suitable low-input treatment and continued livestock grazing
M22b spring fen	High	<ul style="list-style-type: none"> • Section 41 habitat (Purple Moor-grass and Rush-pastures) • Scarce vegetation type • High diversity • Supports several uncommon and/or declining species • In good condition
M22-M37 transition	Moderate	<ul style="list-style-type: none"> • Not referable to any single NVC community but with affinities to two scarce kinds of vegetation • High diversity • Supports uncommon and/or declining species • Small area
MG5a grassland	High	<ul style="list-style-type: none"> • Section 41 habitat (Lowland meadows) • High diversity • Good condition • Atypical example of MG5
MG6aiii grassland	Low	<ul style="list-style-type: none"> • Common kind of grassland
MG10b grassland	Low	<ul style="list-style-type: none"> • Common kind of grassland

6. CONCLUSIONS

In areas likely to be directly affected by the proposed road alignments, vegetation of moderate or high conservation importance is highly localised. In the Shab Hill valley, little remains of any calcareous grassland and what there is has almost been lost to neglect.

The most extensive tract of calcareous grassland is present in two small fields west of the Air Balloon Roundabout and though not currently managed well (for its botanical interest at least) it is still of high or moderate conservation importance and has potential for restoration.

Species-rich neutral grassland of high conservation importance is extensive in a field north of the Shab Hill valley, where it is well managed and in good condition. A very small tract of similar MG5 is the only vegetation of significant conservation importance in the surveyed part of Crickley Hill Country Park, although it appears to be declining in extent and condition there.

Though away from any direct impacts of the new road alignment, groundwater-fed vegetation in Bushley Muzzard, Brimpsfield SSSI is also considered to be of high conservation importance and is currently maintained well by grazing. The fen-meadow (M22) vegetation is highly dependent on the sustained irrigation of a series of base-rich springs rising within the SSSI and may therefore be sensitive to changes in local groundwater conditions caused by the new road.

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APPENDIX I. NVC DATA

SHAB HILL: QUADRATS I-10

Site name		Shab Hill	Shab Hill	Shab Hill	Shab Hill	Shab Hill	Shab Hill	Shab Hill	Shab Hill	Shab Hill	Shab Hill
Grid reference		SO 94100	SO 94116	SO 94097	SO 94090	SO 94053	SO 94019	SO 93993	SO 93987	SO 93933	SO 93907
Quadrat number		15159	15178	15194	15212	15235	15326	15318	15317	15296	15275
Veg unit		MG1e	MG1e	MG1e	MG1e	MG1e	CG4c	CG4c	CG4c	CG4c	CG4c
	<i>Plant litter</i>	4	5	5	5	6	5	5	5	5	4
Agrimonia eupatoria	Agrimony									1	1
Agrostis capillaris	Common Bent		3	3	3	3					2
Alopecurus pratensis	Meadow Foxtail					1					
Anthoxanthum odoratum	Sweet Vernal-grass	3	3	3	3	3					1
Arrhenatherum elatius	False Oat-Grass	7	7	6	6	7	4	4	4	4	4
Avenula pubescens	Downy Oat-grass					1					
Brachypodium rupestre	Tor-grass	4		5		5	8	8	8	8	7
Bromopsis erecta	Upright Brome								2		2
Carex flacca	Glaucous Sedge						1	1			
Centaurea nigra	Common Knapweed										2
Cerastium fontanum	Common Mouse-ear			1		1	1		1		2
Cirsium acaule	Dwarf Thistle						4	1			
Cirsium arvense	Creeping Thistle				1	2		1	4	5	
Cirsium eriophorum	Woolly Thistle						1				5
Clinopodium vulgare	Wild Basil						4				4
Convolvulus arvensis	Field Bindweed	1	3	2		1	2	1	4	4	
Cruciata laevipes	Crosswort	4	5		5		2	3		4	5
Dactylis glomerata	Cock's-foot	4	5	5	5	4	3	2	2		1
Deschampsia cespitosa	Tufted Hair-grass			4		4					
Festuca rubra	Red Fescue	4	4	4	4	4					2
Galium aparine	Cleavers		1					2	3	3	
Galium verum	Lady's Bedstraw	4			1	4	5	4	5	4	5
Glechoma hederacea	Ground-ivy							4	3	3	
Heracleum sphondylium	Hogweed	1	1	4	3	4		1		4	1
Holcus lanatus	Yorkshire-fog	6	5	5	6	6	2	3	3		4
Hypericum maculatum	Imperforate St John's-wort			5							
Knautia arvensis	Field Scabious		4	4	4		4	4	2	4	2
Lathyrus pratensis	Meadow Vetchling		1		2	4	4	1	3	1	3
Lotus corniculatus	Common Bird's-foot-trefoil				2			2	4	1	3
Medicago lupulina	Black Medick								1		
Ononis repens	Common Restharrow						2	4	4		4
Plantago lanceolata	Ribwort Plantain										1
Poa pratensis	Smooth Meadow-grass						2		3		1
Poa trivialis	Rough Meadow-grass	2	3	3	3	3					
Potentilla reptans	Creeping Cinquefoil			2	4					1	
Poterium sanguisorba subsp.	Salad Burnet						2	4	4		2
Ranunculus acris	Meadow Buttercup		1		1						
Ranunculus repens	Creeping Buttercup	1									
Rubus fruticosus agg.	Bramble	1				4	2	4	5	4	4
Rumex acetosa	Common Sorrel	3	3	2							
Schedonorus pratensis	Meadow Fescue								2		
Stellaria graminea	Lesser Stitchwort	4									
Taraxacum agg.	Dandelion									1	
Trisetum flavescens	Yellow Oat-grass	2			3	2	3		1		
Urtica dioica	Common Nettle		2								
Veronica chamaedrys	Germander Speedwell		2	4	2	1	4	2			
Vicia cracca	Tufted Vetch	1	1							2	
Vicia sativa	Common Vetch	1	2								
Vicia sepium	Bush Vetch			1						1	
Viola hirta	Hairy Violet						1		4		2

Abundance within quadrats is recorded using the Domin scale, where:

1	< 4%: few individuals	6	26 - 33%
2	< 4%: several individuals	7	34 - 50%
3	< 4%: many individuals	8	51 - 75%
4	4 - 10%	9	76 - 90%
5	11 - 25%	10	91 - 100%

SHAB HILL: QUADRATS 11-15

Site name		Shab Hill	Shab Hill	Shab Hill	Shab Hill	Shab Hill
Grid reference		SO 93993 15291	SO 93993 15306	SO 93970 15297	SO 93965 15283	SO 93946 15293
Quadrat number		11	12	13	14	15
Veg unit		MG9b	MG9b	MG9b	MG9b	MG9b
	<i>Plant litter</i>	4	5	5	5	6
Agrostis capillaris	Common Bent	5	4	3	3	3
Alopecurus pratensis	Meadow Foxtail			3	4	2
Arrhenatherum elatius	False Oat-Grass	5	8	4	7	4
Cirsium arvense	Creeping Thistle	4	1	4	1	1
Convolvulus arvensis	Field Bindweed					5
Dactylis glomerata	Cock's-foot	4	2		3	4
Deschampsia cespitosa	Tufted Hair-grass	5		6	4	7
Festuca rubra	Red Fescue		4	3	3	4
Galium aparine	Cleavers	4	1	1	1	3
Galium verum	Lady's Bedstraw	1				
Holcus lanatus	Yorkshire-fog	5	2	2	2	
Lathyrus pratensis	Meadow Vetchling	2	4	2		
Poa trivialis	Rough Meadow-grass	3	2	3		3
Taraxacum agg.	Dandelion			1		
Urtica dioica	Common Nettle	1	4	4		4
Veronica chamaedrys	Germander Speedwell	1				

FIELD NORTH OF SHAB HILL: QUADRATS 16-20

Site name		Shab Hill N	Shab Hill N	Shab Hill N	Shab Hill N	Shab Hill N
Grid reference		SO 93975 15625	SO 93950 15642	SO 93945 15681	SO 93964 15707	SO 94016 15695
Quadrat number		16	17	18	19	20
Veg unit		MG5a	MG5a	MG5a	MG5a	MG5a
	<i>Plant litter</i>					4
Agrostis capillaris	Common Bent		2	3	3	3
Anacamptis pyramidalis	Pyramidal Orchid		2	1		1
Anthoxanthum odoratum	Sweet Vernal-grass	4	4	2	4	4
Arrhenatherum elatius	False Oat-Grass	5	4	4	4	5
Bellis perennis	Daisy	1				
Brachythecium rutabulum	Rough-stalked Feather-moss				4	4
Bromus hordeaceus	Soft-brome	3	2	3	3	3
Calliergonella cuspidata	Pointed Spear-moss			3	2	
Crepis capillaris	Smooth Hawk's-beard	1	2			1
Crepis vesicaria	Beaked Hawk's-beard	1		1		1
Cynosurus cristatus	Crested Dog's-tail	2	4	2	2	
Dactylis glomerata	Cock's-foot	4	2			4
Euphrasia agg.	Eyebright		2			
Festuca rubra	Red Fescue	4	2	3	4	5
Geranium dissectum	Cut-leaved Crane's-bill	2				1
Holcus lanatus	Yorkshire-fog	4	4	3	3	4
Hypericum perforatum	Perforate St John's-wort					5
Hypochaeris radicata	Cat's-ear	4	5	4	4	4
Jacobaea erucifolia	Hoary Ragwort				1	
Jacobaea vulgaris	Common Ragwort	2	2			1
Leucanthemum vulgare	Oxeye Daisy	5	6	5	4	5
Medicago lupulina	Black Medick	2	4	5	5	5
Plantago lanceolata	Ribwort Plantain	1	2	1	1	
Poa humilis	Spreading Meadow-grass				1	
Poa pratensis	Smooth Meadow-grass				2	3
Pseudoscleropodium purum	Neat Feather-moss					4
Ranunculus acris	Meadow Buttercup	3	5	3	3	3
Rhinanthus minor	Yellow-rattle	4	4	4	4	4
Rhytidiadelphus squarrosus	Springy Turf-moss	6	6	5	4	
Rumex acetosa	Common Sorrel		1			
Scorzoneroides autumnalis	Autumn Hawkbit		1			
Taraxacum agg.	Dandelion	5	4	5	5	4
Tragopogon pratensis	Goat's-beard	1		4	4	3
Trifolium dubium	Lesser Trefoil	1		2	2	2
Trifolium pratense	Red Clover	5	4	4	5	
Trifolium repens	White Clover		2			
Trisetum flavescens	Yellow Oat-grass	3	4			
Veronica chamaedrys	Germander Speedwell	1				
Vicia sativa	Common Vetch		1		1	1

CRICKLEY HILL: QUADRATS 21-30

Site name		Crickley Hill	Crickley Hill	Crickley Hill	Crickley Hill	Crickley Hill	Crickley Hill	Crickley Hill	Crickley Hill	Crickley Hill	Crickley Hill
Grid reference		SO 93389	SO 93432	SO 93441	SO 93424	SO 93377	SO 93355	SO 93352	SO 93350	SO 93347	SO 93352
Quadrat number		16162	16184	16156	16153	16118	16121	16118	16120	16119	16128
Veg unit		MG1aii	MG1aii	MG1aii	MG1aii	MG1aii	MG5a	MG5a	MG5a	MG5a	MG5a
	<i>Plant litter</i>	4		2	3	4					
Achillea millefolium	Yarrow						1		1		1
Agrostis capillaris	Common Bent								2	3	3
Agrostis stolonifera	Creeping Bent									4	1
Anacamptis pyramidalis	Pyramidal Orchid				1						
Anthoxanthum odoratum	Sweet Vernal-grass					3	4	4	4	5	4
Anthriscus sylvestris	Cow Parsley				4	1					
Arrhenatherum elatius	False Oat-Grass	6	8	6	7	6	4	5	4	4	2
Avenula pubescens	Downy Oat-grass						1				
Carex flacca	Glaucous Sedge						3				
Carex hirta	Hairy Sedge				4						
Centaurea nigra	Common Knapweed									1	
Cerastium fontanum	Common Mouse-ear	3				2	2	3	2	2	3
Cirsium arvense	Creeping Thistle	1	1	1							
Cirsium eriophorum	Woolly Thistle					4					
Crepis capillaris	Smooth Hawk's-beard					1	1	1	4	4	4
Cruciata laevipes	Crosswort	7	5		1	2	6				
Dactylis glomerata	Cock's-foot	2	1	4		5	4	4	5	4	4
Dactylorhiza fuchsii	Common Spotted-orchid					1					
Festuca rubra	Red Fescue	4	4	4	4		5	5	5	5	5
Galium verum	Lady's Bedstraw							4	4	5	
Geranium dissectum	Cut-leaved Crane's-bill	1									
Geranium pratense	Meadow Crane's-bill			7	4						
Heracleum sphondylium	Hogweed		4		1	2					
Holcus lanatus	Yorkshire-fog	4	5	4	4	4	3	4	4	4	3
Jacobaea vulgaris	Common Ragwort								1		
Knautia arvensis	Field Scabious					1					
Lathyrus pratensis	Meadow Vetchling						4				
Leontodon hispidus	Rough Hawkbit					1	4	4	4	2	6
Lotus corniculatus	Common Bird's-foot-trefoil						2				
Luzula campestris	Field Wood-rush							2			
Medicago lupulina	Black Medick										4
Persicaria maculosa	Redshank									1	
Plantago lanceolata	Ribwort Plantain			1		4	4	4	4	4	4
Poa sp.	a meadow-grass	2						2	2		
Potentilla anserina	Silverweed	4								2	
Poterium sanguisorba	Salad Burnet										
subsp. sanguisorba								4			
Primula veris	Cowslip							4	1		
Prunella vulgaris	Selfheal							1	3	1	4
Ranunculus acris	Meadow Buttercup	1		2	1	4	2	2			4
Ranunculus repens	Creeping Buttercup	4				4	2	4	5	7	2
Rubus fruticosus agg.	Bramble	6				5					
Rumex acetosa	Common Sorrel				4	4	3	1	2		
Rumex crispus	Curled Dock									1	
Rumex obtusifolius	Broad-leaved Dock		1	1							
Schedonorus arundinaceus	Tall Fescue			1							
Schedonorus pratensis	Meadow Fescue						1	1			
Taraxacum agg.	Dandelion			1		1					
Trifolium pratense	Red Clover	2		2			4		4	2	4
Trifolium repens	White Clover						2				2
Trisetum flavescens	Yellow Oat-grass							2			
Urtica dioica	Common Nettle	1	2								
Veronica chamaedrys	Germander Speedwell					2	3	4	3	3	4
Vicia cracca	Tufted Vetch						2				

LAND WEST OF AIR BALLOON ROUNDABOUT: QUADRATS 31-40

Site name		W of Air Balloon	W of Air Balloon	W of Air Balloon	W of Air Balloon	W of Air Balloon	W of Air Balloon	W of Air Balloon	W of Air Balloon	W of Air Balloon	W of Air Balloon
Grid reference											
Quadrat number		31	32	33	34	35	36	37	38	39	40
Veg unit		CG3c	CG3c	CG3c	CG3c	CG3c	CG3d	CG3d	CG3d	CG3d	CG3d
	<i>Plant litter</i>						3	4	3	4	4
Achillea millefolium	Yarrow		4	4	5		5	4	3		
Agrostis stolonifera	Creeping Bent	2	1		3	3					
Anthoxanthum odoratum	Sweet Vernal-grass						1		3		2
Arenaria serpyllifolia	Thyme-leaved Sandwort		1	2	3						
Arrhenatherum elatius	False Oat-Grass	1	2	3	3	2	5	5	4	7	5
Avenula pubescens	Downy Oat-grass		4	3	3	4	2	3			2
Blackstonia perfoliata	Yellow-wort		2		4						
Brachypodium rupestre	Tor-grass	4									
Brachythecium rutabulum	Rough-stalked Feather-moss			2		2					
Bromopsis erecta	Upright Brome	4	2	3	2	6	5	5	7	6	8
Calliergonella cuspidata	Pointed Spear-moss		2	3	2		2	3	3	2	
Campanula rotundifolia	Harebell		2	2							
Carex flacca	Glaucous Sedge						1	4	3		4
Centaurea nigra	Common Knapweed						6	6	5	4	
Centaurea scabiosa	Greater Knapweed							4	4		
Cerastium fontanum	Common Mouse-ear	4	3	3	3	3	1				
Cirsium arvense	Creeping Thistle									4	4
Cirsium vulgare	Spear Thistle	1									
Clinopodium vulgare	Wild Basil								4		
Convolvulus arvensis	Field Bindweed	1	4	4						4	4
Crataegus monogyna	Hawthorn							1			
Crepis capillaris	Smooth Hawk's-beard	2	2	2	2	2					
Dactylis glomerata	Cock's-foot	4	5	4	4	4	2	2	1	1	2
Festuca rubra	Red Fescue	4	5	4	4	5	4		2	2	2
Galium verum	Lady's Bedstraw			6	6	4	2	4	4	4	4
Glechoma hederacea	Ground-ivy						4	4	4		5
Heracleum sphondylium	Hogweed									1	
Holcus lanatus	Yorkshire-fog	2	3	4		2	2	2	2	3	2
Hypericum hirsutum	Hairy St John's-wort							4			
Hypericum perforatum	Perforate St John's-wort								1		
Hypochaeris radicata	Cat's-ear		1			4					
Jacobaea vulgaris	Common Ragwort	4	2		4						1
Knautia arvensis	Field Scabious						4		1	1	
Lathyrus pratensis	Meadow Vetchling	1	2	1		4	4	1	3		2
Leucanthemum vulgare	Oxeye Daisy	5	5	4	4	4					
Lolium perenne	Perennial Rye-grass	3									
Lotus corniculatus	Common Bird's-foot-trefoil			4	4		2	3	3		
Medicago lupulina	Black Medick	1	1	2	2	6					
Pimpinella saxifraga	Burnet-saxifrage	3	4	4	2		2		2	1	1
Plantago lanceolata	Ribwort Plantain	5	5	4	5	5	2		2		
Poa humilis	Spreading Meadow-grass			2	1						
Poa pratensis	Smooth Meadow-grass		2	3			1				
Poterium sanguisorba	Salad Burnet										
subsp. sanguisorba				4				4			
Primula veris	Cowslip	1				1		2	1	1	4
Prunella vulgaris	Selfheal					1					
Pseudoscleropodium purum	Neat Feather-moss				2	2	4	4	5	2	3
Ranunculus acris	Meadow Buttercup			1		2					
Rhytidiadelphus squarrosus	Springy Turf-moss			2	2	2	4	3	3	3	4
Rubus fruticosus agg.	Bramble						4		4		
Rumex acetosa	Common Sorrel	4	4	4	1						
Sonchus asper	Prickly Sow-thistle	1									
Taraxacum agg.	Dandelion	1	2	1	1	1					
Trifolium dubium	Lesser Trefoil					2					
Trifolium pratense	Red Clover	5	5	5		6					
Trifolium repens	White Clover	2	2		4	2					
Trisetum flavescens	Yellow Oat-grass		3	2	2	2					
Veronica chamaedrys	Germander Speedwell	5	3	1					3		
Vicia cracca	Tufted Vetch	4	4	4	4			1			
Vicia sepium	Bush Vetch						1				

BUSHLEY MUZZARD SSSI AND ADJACENT LAND: QUADRATS 41-45

Site name		Bushley Muzzard	Bushley Muzzard	Bushley Muzzard	Bushley Muzzard	Bushley Muzzard
Grid reference		SO 94328 13194	SO 94330 13184	SO 94329 13179	SO 94342 13178	SO 94338 13169
Quadrat number		41	42	43	44	45
Veg unit		MG5a	MG5a	MG5a	MG5a	MG5a
	<i>Plant litter</i>					
<i>Achillea millefolium</i>	Yarrow	1	1	4	2	4
<i>Agrostis capillaris</i>	Common Bent	5	5	5	6	5
<i>Agrostis stolonifera</i>	Creeping Bent					1
<i>Ajuga reptans</i>	Bugle					1
<i>Alchemilla filicaulis</i> subsp. <i>vestita</i>	Common Lady's mantle		1			
<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass	2	2		2	
<i>Arrhenatherum elatius</i>	False Oat-Grass					1
<i>Avenula pubescens</i>	Downy Oat-grass		2		3	
<i>Bellis perennis</i>	Daisy			1	1	
<i>Betonica officinalis</i>	Betony	4			5	4
<i>Brachypodium rupestre</i>	Tor-grass		4	2	4	5
<i>Brachythecium rutabulum</i>	Rough-stalked Feather-moss			2		1
<i>Briza media</i>	Quaking-grass			1	1	
<i>Bromopsis erecta</i>	Upright Brome					4
<i>Calliergonella cuspidata</i>	Pointed Spear-moss			1		
<i>Carex flacca</i>	Glaucous Sedge			4	2	1
<i>Centaurea nigra</i>	Common Knapweed	4	4	4	4	2
<i>Cerastium fontanum</i>	Common Mouse-ear	1	2		1	1
<i>Cirsium arvense</i>	Creeping Thistle	1	1	1		
<i>Cirsium palustre</i>	Marsh Thistle	5	5	4	4	4
<i>Cynosurus cristatus</i>	Crested Dog's-tail	4	4	4	5	4
<i>Dactylis glomerata</i>	Cock's-foot	5	5	5	5	5
<i>Festuca rubra</i>	Red Fescue	4	4	4	3	4
<i>Galium verum</i>	Lady's Bedstraw			6	4	1
<i>Heracleum sphondylium</i>	Hogweed		1			1
<i>Holcus lanatus</i>	Yorkshire-fog	4	4		4	3
<i>Hypericum tetrapterum</i>	Square-stalked St John's-wort					
<i>Hypochaeris radicata</i>	Cat's-ear		4	2	4	4
<i>Jacobaea vulgaris</i>	Common Ragwort					1
<i>Juncus inflexus</i>	Hard Rush	1				
<i>Knautia arvensis</i>	Field Scabious				1	5
<i>Lathyrus pratensis</i>	Meadow Vetchling	4	4	4	4	4
<i>Leucanthemum vulgare</i>	Oxeye Daisy	1	4	2	4	
<i>Lolium perenne</i>	Perennial Rye-grass	4	4	4	4	4
<i>Lotus corniculatus</i>	Common Bird's-foot-trefoil	4	4	6	6	7
<i>Phleum bertolonii</i>	Smaller Cat's-tail		1			
<i>Pimpinella saxifraga</i>	Burnet-saxifrage			1		1
<i>Plantago lanceolata</i>	Ribwort Plantain	6	5	6	6	5
<i>Poa</i> sp.	a meadow-grass	1			1	
<i>Potentilla erecta</i>	Tormentil	2	4			
<i>Potentilla sterilis</i>	Barren Strawberry				2	
<i>Poterium sanguisorba</i> subsp.	Salad Burnet		2	4	5	
<i>Primula veris</i>	Cowslip			4		1
<i>Prunella vulgaris</i>	Selfheal	4	4	4	3	5
<i>Pseudoscleropodium purum</i>	Neat Feather-moss	4	4	4	2	4
<i>Pulicaria dysenterica</i>	Common Fleabane					
<i>Ranunculus acris</i>	Meadow Buttercup	5	6	5	5	5
<i>Ranunculus flammula</i>	Lesser Spearwort					
<i>Ranunculus repens</i>	Creeping Buttercup	4	4	4		
<i>Rhytidiadelphus squarrosus</i>	Springy Turf-moss	2	1	4	4	4
<i>Rumex acetosa</i>	Common Sorrel	2	2	3		
<i>Scorzoneroideis autumnalis</i>	Autumn Hawkbit		1			
<i>Succisa pratensis</i>	Devil's-bit Scabious				5	
<i>Taraxacum</i> agg.	Dandelion	4	4	2	2	1
<i>Trifolium pratense</i>	Red Clover	1	4	4	4	4
<i>Trifolium repens</i>	White Clover	5	6	5	5	
<i>Veronica chamaedrys</i>	Germander Speedwell	4		2	2	
<i>Vicia sepium</i>	Bush Vetch				1	

BUSHLEY MUZZARD, BRIMPSFIELD SSSI & ADJACENT LAND: QUADRATS 56-66

Site name		Bushley Muzzard	Bushley Muzzard	Bushley Muzzard	Bushley Muzzard	Bushley Muzzard	Bushley Muzzard	Bushley Muzzard	Bushley Muzzard	Bushley Muzzard	Bushley Muzzard	Bushley Muzzard
Grid reference		SO 94343	SO 94332	SO 94281	SO 94329	SO 94329	SO 94260	SO 94296	SO 94307	SO 94313	SO 94312	SO 94343
Quadrat number		56	57	58	59	60	61	62	63	64	65	66
Veg unit		MG6a	MG6a	MG6a	MG6a	MG6a	CG4c	CG4c	CG4c	CG4c	CG4c	MG10b
	<i>Plant litter</i>											
Achillea millefolium	Yarrow						4	4			3	
Agrostis capillaris	Common Bent	6	4	1	5	3	3	4	4	5	5	
Agrostis stolonifera	Creeping Bent		3	3		1						4
Alchemilla filicaulis subsp. vestita	Common Lady's mantle									4		
Anthoxanthum odoratum	Sweet Vernal-grass						2				2	
Arrhenatherum elatius	False Oat-Grass			1			1					
Avenula pratensis	Meadow Oat-grass									1		
Avenula pubescens	Downy Oat-grass									2		
Betonica officinalis	Betony									4		
Brachypodium rupestre	Tor-grass						4	7	7	6	5	
Briza media	Quaking-grass						3			3		
Bromopsis erecta	Upright Brome						6		4	2		
Bryum sp.	a moss											2
Calliergonella cuspidata	Pointed Spear-moss									1	2	3
Carex flacca	Glaucous Sedge						4	4	2	3		
Carex hirta	Hairy Sedge		4	4	4				2		4	2
Centaurea nigra	Common Knapweed						4	2				
Cerastium fontanum	Common Mouse-ear				3		1	1	1			1
Cirsium acaule	Dwarf Thistle						4			4		
Cirsium arvense	Creeping Thistle	1	1		4		2	2	2	1	4	
Cirsium palustre	Marsh Thistle							4				
Cirsium vulgare	Spear Thistle								1			
Crepis capillaris	Smooth Hawk's-beard						1		1	2	4	
Cynosurus cristatus	Crested Dog's-tail		2		2		4	3		4	3	
Dactylis glomerata	Cock's-foot		4	5			3	4	4	4	5	
Deschampsia cespitosa	Tufted Hair-grass	4			2			4			4	
Eleocharis palustris	Common Spike-rush											4
Festuca rubra	Red Fescue	4	8	7	3		3	2	4	4	4	4
Galium verum	Lady's Bedstraw						4	2	4	4	5	
Geranium dissectum	Cut-leaved Crane's-bill								1			
Holcus lanatus	Yorkshire-fog	6	4	4	5	4		3	4		4	4
Juncus articulatus	Jointed Rush											2
Juncus inflexus	Hard Rush											7
Lathyrus pratensis	Meadow Vetchling						4		4	3	3	
Leontodon hispidus	Rough Hawkbit						6					
Lolium perenne	Perennial Rye-grass	5	5	6	8	7	3	3	4	3	3	
Lotus corniculatus	Common Bird's-foot-trefoil						4			4	3	
Medicago lupulina	Black Medick						4		2			
Phleum bertolonii	Smaller Cat's-tail									2		
Phleum pratense	Timothy	3	1		4	4						3
Pilosella officinarum	Mouse-ear-hawkweed							2		1		
Plantago lanceolata	Ribwort Plantain						1	4				
Plantago major	Greater Plantain						1					
Poa sp.	a meadow-grass			2								
Poa trivialis	Rough Meadow-grass											3
Potentilla anserina	Silverweed								1			
Potentilla reptans	Creeping Cinquefoil						1	5	2	4		
Potentilla sterilis	Barren Strawberry								1	3		
Poterium sanguisorba subsp.	Salad Burnet						4			4		
Prunella vulgaris	Selfheal							4		4		2
Pseudoscleropodium purum	Neat Feather-moss									4	3	
Ranunculus acris	Meadow Buttercup	2	4	2	4	5	2	4		4	4	
Ranunculus repens	Creeping Buttercup	4	1	2	4	4		2		2	2	4
Rhynchospora squarrosus	Springy Turf-moss										4	
Rumex acetosa	Common Sorrel					2		2				
Rumex conglomeratus	Clustered Dock											4
Schedonorus arundinaceus	Tall Fescue	4						1	4	4		
Schedonorus pratensis	Meadow Fescue				2		2					4
Sonchus asper	Prickly Sow-thistle										1	
Stellaria graminea	Lesser Stitchwort											1
Taraxacum agg.	Dandelion		1		2	4	2	1	4	2	3	
Trifolium pratense	Red Clover				4	2	5			4	2	
Trifolium repens	White Clover	3		2	3	4	4	4	5	5	1	2
Urtica dioica	Common Nettle	1		1								
Veronica beccabunga	Brooklime											3
Veronica chamaedrys	Germander Speedwell							2		3	1	
Veronica serpyllifolia	Thyme-leaved Speedwell									1		
Vicia sepium	Bush Vetch								4			

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.6
Bat Activity Survey Report

28 September 2020

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Executive Summary

The proposed A417 Missing Link scheme (hereafter referred to as ‘the scheme’) aims to provide a dual carriageway to a stretch of single carriageway between the Cowley roundabout and Crickley Hill in Gloucestershire; the 5.5km section is the only remaining section of single carriageway. The scheme would increase capacity by creating a free-flowing link between the Brockworth Bypass and Cowley roundabout and remove the at-grade junction with the A436, resulting in a continuous flow between the M4 Junction 15 (Swindon) and the M5 Junction 11a (Gloucester/Cheltenham).

All native species of bat afford full protection under the Conservation of Habitats and Species Regulations 2017(as amended), the Countryside and Rights of Way (CRoW) Act 2000, the Natural Environment and Rural Communities (NERC) Act and the Wildlife and Countryside Act (WCA) 1981 (as amended). Four species of bat, comprising barbastelle, Bechstein’s bat, greater horseshoe bat and lesser horseshoe bat are given extra protection, being listed as an Annex II species of the EU Habitats Directive 1992.

In order to assess which bat species are present in the survey area, and how habitats within them are used by these species, the following surveys were undertaken:

- Walked transects, to assess the activity levels and identify important commuting routes and foraging grounds of bats along defined routes within the survey area.
- Static bat detector recorded assessment, to assess activity levels and species present at designated points around each transect route.

Surveys identified the presence of at least 11 species of bat: barbastelle; long-eared bat; common pipistrelle; greater horseshoe; Leisler’s bat; lesser horseshoe; *Myotis* sp.; Nathusius’ pipistrelle; noctule; serotine; and, soprano pipistrelle. It is likely that more than 1 *Myotis* species is present, with habitat suitable for a range of *Myotis* species, including Bechstein’s. Therefore, it is likely that more than 11 species of bat are present within the surveyed area.

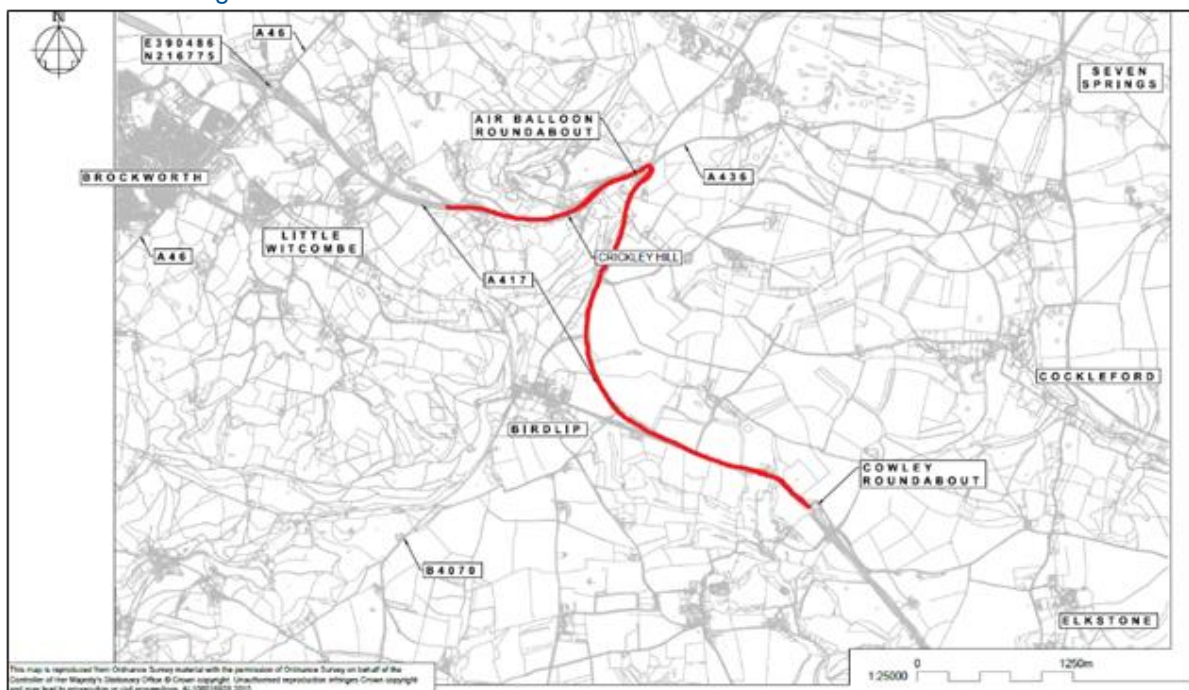
The majority of bats recorded both during transects and static surveys were common pipistrelle, with high activity levels recorded across the majority of the site for this species. Key areas of activity identified during the transect surveys included along the convergence of a number of linear features along the track to the northeast of Birdlip Radio station, with next highest levels of activity south of Crickley Hill along the lane to Cold Slad. Lesser horseshoe were recorded across all transect routes and static locations across the scheme, with the highest levels of activities found south of Crickley Hill along the Cold Slad lane (transect route 7) and at the southern point of the scheme (A417 roundabout next to Birdlip Quarry). Greater horseshoe were recorded rarely, with only 1 recording during transect surveys. There was a peak of greater horseshoe activity at static 4b (south of A417 north east of Crickley Hill Farm). Low levels of barbastelle activity were recorded across the scheme during transect and static surveys.

1. Introduction

1.1. Background

- 1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and as an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'missing link', forms the only section of single carriageway along the route, with an at-grade junction located at the 'Air Balloon' public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5km stretch shown on Figure 1 below.

Figure 1: A417 Missing Link Scheme Location Plan



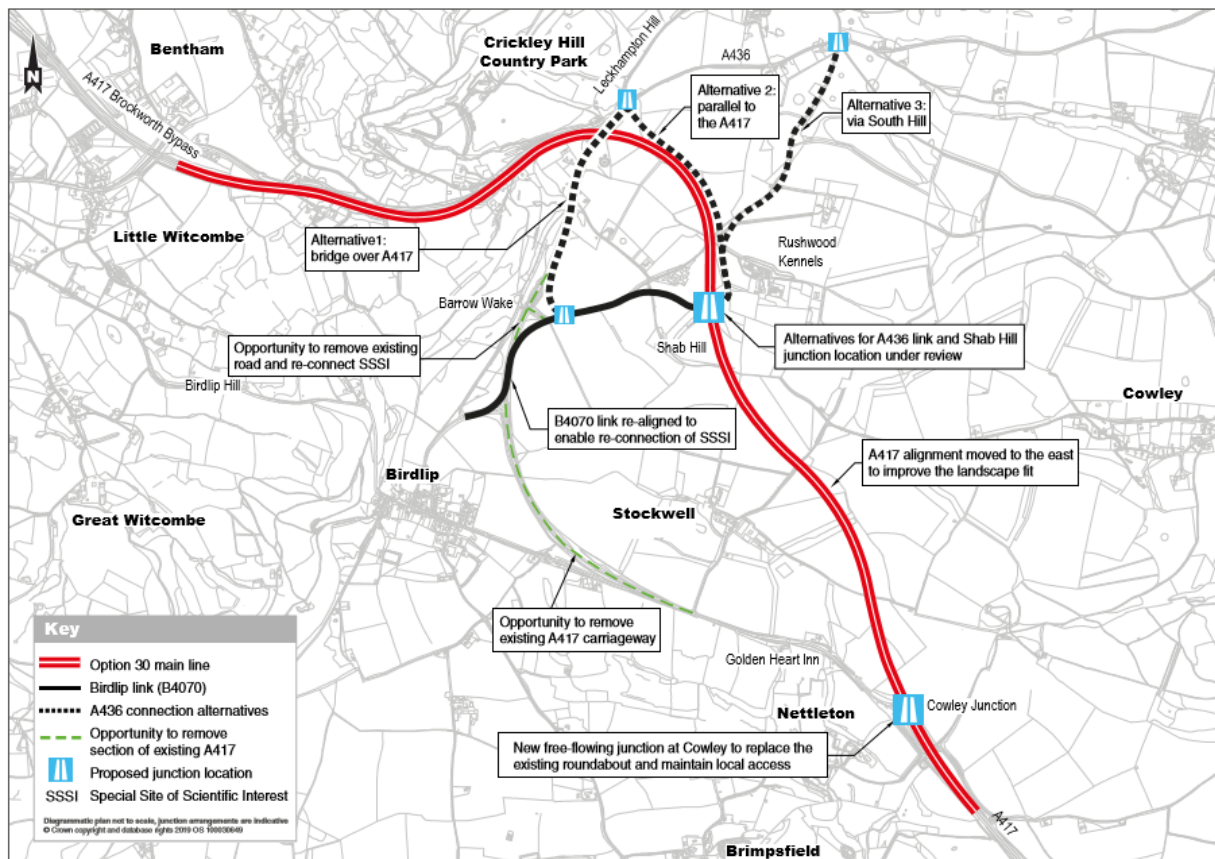
Source: GiGi GIS Portal. Crown Copyright 2016 100030649

1.2. Scheme proposals

- 1.2.1. The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill.
- 1.2.2. Any proposed scheme would aim to increase capacity by creating a free flowing link between the Brockworth Bypass and the Cowley roundabout and remove the at-grade junction with the A436 (Air Balloon roundabout). This Missing Link will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester / Cheltenham (M5 Junction 11a).

1.2.3. At the time of commencement of the A417 bat surveys there were two options under consideration, Option 12 and Option 30. The preferred route for the Scheme was confirmed as Option 30 by the Secretary of State in March 2019 (see Figure 2 below). The Scheme comprises the construction of a new dual carriageway to replace the existing single carriageway section between Brockworth bypass and Cowley Roundabout. It is predominately an “offline” Scheme but approximately a third of the route follows the existing A417 route corridor at Crickley Hill.

Figure 2: A417 Preferred Route Announcement



1.2.4. Figure 2 above shows how there are three A436 link road alternative connections. Alternative 2, parallel to the A417, is the selected route proceeded with for assessment in the Environmental Statement.

1.3. Scope of report

1.3.1. Mott MacDonald Sweco has been commissioned to undertake a suite of ecological surveys to inform the ecological impact assessment of the scheme. This report presents the results of bat activity levels within the Zone of Influence (Zol) of the A417 scheme, including both transect surveys and static detector surveys.

1.3.2. The objectives of this report are:

- To inform the Environmental Impact Assessment (EIA)
- To present the survey methodology used to assess the activity levels within the Zol of the Scheme and detail any constraints encountered during these surveys
- To present the results for the bat activity within the Zol

1.3.3. This report does not attempt to assess the potential impacts of the scheme on foraging and commuting bats, nor does it provide recommendations for mitigation and enhancement measures, but provides the information to enable this impact assessment and mitigation design to be undertaken.

1.4. Legislation

1.4.1. All native bat species are afforded full protection under the Conservation of Habitats and Species Regulations 2017 (as amended), the Countryside and Rights of Way (CROW) Act 2000, the Natural Environment and Rural Communities (NERC) Act and the Wildlife and Countryside Act (WCA) 1981 (as amended).

1.4.2. Under Regulation 41 of the Conservation of Habitats and Species Regulations it is illegal to:

- Deliberately capture, injure or kill any UK bat species
- Deliberately disturb bats (in particular, disturbance which is likely to impair their ability to survive, to breed or reproduce, or to rear or nurture their young, to hibernate or migrate or to affect significantly the local distribution or abundance of the species to which they belong)
- Damage or destroy a breeding site or resting place of any UK bat

1.4.3. Under Schedule 5 of the Wildlife and Countryside Act 1981 it is illegal to:

- Deliberately capture, injure or kill a bat
- Intentionally or recklessly disturb a bat in its roost
- Deliberately disturb a group of bats
- Damage or destroy a bat roosting place (even if not occupied at the time)
- Possess or advertise/exchange a bat (dead or alive) or any part of a bat
- Intentionally or recklessly obstruct access to a bat roost

1.4.4. The Conservation of Habitats and Species Regulations 2017 strengthens protection given under the WCA 1981, making it an offence to disturb bats, particularly where this may impair their ability to survive, breed, reproduce,

hibernate, nurture or rear their young, or significantly affect the local distribution or abundance of a species.

- 1.4.5. The CRoW Act 2000 further strengthens the WCA 1981, requiring the conservation of biodiversity in accordance with the Convention on Biological Diversity (CBD) 1992.
- 1.4.6. The NERC Act 2006 places obligation on public authorities to take the conservation of species and habitats of principal importance, for conserving biodiversity, into consideration. Section 41 of the Act contains a list of habitats and species of principal importance in England.
- 1.4.7. The following bat species are listed as Annex II species within the EU Habitats Directive 1992, and therefore are given additional protection:
 - Barbastelle *Barbastella barbastellus*
 - Bechstein's bat *Myotis bechsteinii*
 - Greater horseshoe *Rhinolophus ferrumequinum*
 - Lesser horseshoe *Rhinolophus hipposideros*
- 1.4.8. This means that these species have been assessed as meeting the criteria for site selection of Special Areas of Conservation (SAC), to specifically observe them. Site selection is based on evidence of a large and robust population of one or more of these bat species.

1.5. Status of bats at the national level

- 1.5.1. There are 18 species of bat within the UK, 17 of which are known to be breeding. Bat populations are known to have decreased significantly over the last century, with this largely attributed to threats associated with development. These threats include direct impacts on roosts from building and development work requiring tree removal and the demolition of buildings and other structures, in addition to severance of important commuting corridors by roads, other linear infrastructure and vegetation removal. Habitat loss has also resulted in the loss and degradation of important foraging grounds for bat populations. Increased disturbance from light and noise associated with development both through construction and operation, and the installation of wind turbines are also thought to have contributed to the decline in the numbers of bats
- 1.5.2. The following species were previously listed as UK Biodiversity Action Plan (UKBAP) species and are now listed as species of 'principal importance' for the conservation of biodiversity in England, under Section 41 of the NERC Act':

- Barbastelle *Barbastella barbastellus*
- Bechstein's bat *Myotis bechsteinii*
- Brown long-eared bat *Plecotus auritus*
- Greater horseshoe bat *Rhinolophus ferrumequinum*
- Lesser horseshoe bat *Rhinolophus hipposideros*
- Noctule *Nyctalus noctula*
- Soprano pipistrelle *Pipistrellus pygmaeus*

1.5.3. Following the production of 'Biodiversity 2020: the national strategy for England', actions were identified to help the recovery of Schedule 41 listed species. Specific species actions, their attributed action priority and the priority group Natural England has classified each species into are detailed in Appendix A, Table 9.

1.6. Status of bats at county level

1.6.1. A total of 15 bat species have been recorded in the county. Gloucestershire Bat Group¹ provides the following information on the distribution and status of bat species within the county:

- **Barbastelle** *Barbastella barbastellus*: A rare species in Gloucestershire, as it is elsewhere in the UK, but recorded in scattered locations throughout the county. Barbastelles typically, but not always, roost in trees in mature woodland during the summer months, and in underground sites during the winter, so their distribution may be influenced by availability of these habitats in the county.
- **Bechstein's** *Myotis bechsteinii*: A rare species on the edge of its range in Gloucestershire. Bechstein's bats roost in tree holes in mature woodland during the summer months, which possibly explains their presence in the Forest of Dean and along the Cotswold scarp, but not apparently elsewhere in the county.
- **Brandt's** *Myotis brandtii*: Brandt's, whiskered *Myotis mystacinus* and the rare Alcathe bat *Myotis alcathe* (which has not yet been recorded in Gloucestershire) can only reliably be distinguished by close examination or DNA testing, so both (or perhaps all three) are likely to be under-recorded. However, it does appear that Brandt's bat is rarer and more restricted in its distribution than whiskered bat in Gloucestershire.
- **Whiskered** *Myotis mystacinus*: Whiskered, Brandt's and the rare alcathe bat can only reliably be distinguished by close examination or DNA testing, so are likely to be under-recorded. However, it does

¹ <https://glosbats.org.uk/bats-in-gloucestershire/>

appear that whiskered bat is commoner and more widespread than Brandt's bat in Gloucestershire.

- **Daubenton's *Myotis daubentonii*:** As a species which rarely roosts in houses, Daubenton's bat is hopefully under-recorded in Gloucestershire. As its flight behaviour is distinctive, flight records for this species may give a more accurate picture of its distribution in the county than the roost records indicate.
- **Natterer's *Myotis nattereri*:** Natterer's bat is widespread in Gloucestershire (its range extends north to Scotland), but does not appear to be common anywhere in the county except possibly in the Cotswold Water Park, though this may be due to increased recording effort in this area.
- **Brown long-eared *Plecotus auritus*:** A widespread and relatively common species in Gloucestershire. Brown long-eared bats feed mainly in woodland but often roost in buildings, so their roosts are more likely to be recorded than tree-roosting species. Apparent clusters of roosts in the Forest of Dean, Stroud valleys and Cotswold Water Park may be partly due to greater survey effort in these areas compared to elsewhere in the county. The rare grey long-eared bat *Plecotus austriacus* has not been recorded in the county and the county is outside of the known range of this species which is largely restricted to southern counties.
- **Common pipistrelle *Pipistrellus pipistrellus*:** The commonest and most widespread bat species in Britain, but apparently not the most widespread species in Gloucestershire, with relatively few records in the north and east of the county. However, old records of pipistrelle bats have been omitted, as this species and the soprano pipistrelle were only identified as separate species in the early 1990s.
- **Soprano pipistrelle *Pipistrellus pygmaeus*:** A very common and widespread species, so it is surprising how few records there are, particularly in the far south and north-east of the county where there must surely be roosts. As with common pipistrelle, old records have been omitted, as this species and the common pipistrelle were only identified as separate species in the early 1990s.
- **Nathusius' pipistrelle *Pipistrellus nathusii*:** Nathusius' pipistrelles are often associated with lakes or other large water bodies, so it is perhaps not surprising that what evidence we have of this species is associated with the Cotswold Water Park. It is likely to be under-recorded, as flight records suggest a more widespread distribution in the county.
- **Greater horseshoe *Rhinolophus ferrumequinum*:** Gloucestershire has two maternity colonies of greater horseshoe bats, which are on the edge of their UK range in the county. One of these is the famous Woodchester Mansion colony which has been extensively studied by Dr

Roger Ransome: the longest continuous study of any wild mammal population by a single person in the world. Their distribution in the county reflects the two areas surrounding the maternity roosts.

- **Lesser horseshoe** *Rhinolophus hipposideros*: As a woodland foraging species which roosts in buildings and underground sites, Gloucestershire and the Forest of Dean District in particular are thought to be a stronghold for this species. The distribution map suggests the Stroud Valleys are also important; this may be true but may also be influenced by greater survey effort in this area.
- **Leisler's** *Nyctalus leisleri*: Mainly a tree roosting species, which can be difficult to distinguish reliably from noctule bats using echolocation calls alone, Leisler's is likely to be under-recorded but, even so, is probably a rare species in the county.
- **Noctule** *Nyctalus noctula*: Compared to some of our other species which tend not to roost in buildings or underground sites, noctule bats appear fairly widespread in the county. However, flight records suggest that the species is present in the far south and north-east of the county, so it is very likely that roosts are under-recorded.
- **Serotine** *Eptesicus serotinus*: A species with an apparently scattered distribution in the county. The distribution map suggests that the Stroud Valleys and Cotswold Water Park are both important areas for this species in Gloucestershire, but lack of records elsewhere may reflect additional recording effort in these two areas.

1.7. Bat ecology

- 1.7.1. All bat species in the UK are nocturnal, emerging from their roosts at dusk, or shortly after. Bats have been found to roost in a number of places, including; trees, barns, buildings (within lofts, basements and cavity walls), caves and bridges. Their preferred roosting location depends on a number of factors; species, gender, time of year. Bats require different conditions when hibernating compared to summer roosts.
- 1.7.2. Bats utilise an array of habitats as foraging grounds, including riparian habitats, woodland and grassland, feeding on a variety of insect species. Foraging grounds and insect prey differ between each species of bat, with different species adapted for hunting in a variety of ways. Many bat species are also known to use multiple different habitat types to forage, highlighting the importance of landscape scale assessment to ensure the persistence of a mosaic of habitats across important foraging areas.

- 1.7.3. In order to navigate between their roosts and foraging grounds, bats use linear features as commuting corridors. These are most commonly seen to be hedgerow and treelines, in addition to small patches of woodland, rivers and streams. Where these features are comprised of diverse plant assemblages, suitable to support insect populations, they may be used during opportunistic foraging, with bats feeding on the way to their main foraging grounds.

- 1.7.4. A detailed biological records search was requested from Gloucestershire Centre for Environmental Records (GCER) in February 2017, for records of bats within a 2km radius of the Scheme. To ensure updated information is included in the baseline data, the GCER records search was updated in September 2019 and the radius extended to 10km. To ensure that outdated information did not have an effect on the assessment and impacts of the scheme of bats, only records from the last 20 years were considered from the desk study. These results for bats can be found within Appendix B.

2. Methodology

2.1. Desk study

- 2.1.1. A detailed biological records search was requested from Gloucestershire Centre for Environmental Records (GCER) in February 2017, for records of bats within a 2km radius of the Scheme. To ensure updated information is included in the baseline data, the GCER records search was updated in September 2019 and the radius extended to 10km. To ensure that outdated information did not have an effect on the assessment and impacts of the scheme of bats, only records from the last 20 years were considered from the desk study. These results for bats can be found within Appendix B.
- 2.1.2. A desktop study was undertaken in 2017, as part of the Preliminary Ecological Appraisal Report (PEAR) and updated in September 2019 to identify Statutory and non-statutory designated sites with 2km of the proposed scheme, extending to 30km for Special Areas of Conservation (SACs) designated for bats; these were identified using DEFRA's Multi Agency Geographic Information for the Countryside (MAGIC) online mapping tool and the Joint Nature Conservation Committee (JNCC) website.
- 2.1.3. Additional data was obtained through consultation with Gloucestershire Wildlife Trust and the National Trust in 2018 for data related to the reserves at Crickley Hill and Barrow wake which are owned and managed by these bodies. This included the Crickley Hill Nature Conservation Evaluation report².
- 2.1.4. Statutory and non-statutory designated sites with 2km of the proposed scheme were considered, extending to 30km for Special Areas of Conservation (SACs) designated for bats; these were identified using DEFRA's MAGIC online mapping tool.

2.2. Field Surveys

- 2.2.1. The methods described in this section were designed for data collection throughout the 2018 and 2019 bats surveys, to enable robust baseline data on all of the UK species within the survey area of the scheme.
- 2.2.2. A meeting was held with Natural England on 14 June 2017 to discuss proposed protected species surveys and in particular bat surveys for the A417 Missing Link scheme. In advance of this meeting, Natural England

² National Trust (2016) Nature Conservation Evaluation – Crickley Hill Gloucestershire

were sent a memo outlining the proposed surveys. A copy of this memo and the Natural England meeting response are provided in Appendix C. Natural England agreed that the scope of proposed surveys was appropriate but recommended that it would be better for surveys to be undertaken across more than 1 year, as at the time of consultation, an earlier DCO date would mean that only 1 year of surveys was possible. This original DCO date was moved back and surveys have been undertaken across two years.

- 2.2.3. The proposed scheme lies within the known distribution of listed Annex II bat species lesser horseshoe, greater horseshoe, barbastelle and Bechstein’s bats (EU Habitats Directive, 1992), and these species have the potential to be using features and habitats within the study area. Where these species were recorded, the need for advance survey techniques was identified to provide sufficient information to assess the likely impact on these species. These advanced surveys include trapping surveys and radio tracking. Advanced bat surveys were carried out by Arup during 2019. This report should be read in conjunction with the bat radiotracking report for a comprehensive understanding of bat activity within the Zol of the scheme.

2.3. Activity surveys (walked transects)

- 2.3.1. Transects were designed to identify species composition and general distribution of bats along the length of the proposed scheme, focusing on linear features with potential importance for commuting bats, in addition to habitats potentially used as foraging grounds.
- 2.3.2. When assessing potential foraging and commuting habitats, the guidelines below (Table 1) within the BCT Good Practice Guidelines (Collins, 2016) were followed.

Table 1: Defining suitability of bat foraging and commuting habitat

Suitability of commuting and foraging habitat	Description
High	<p>Continuous, high-quality habitat that is well connected to the wider landscape that is likely to be used regularly by commuting bats such as river valleys, streams, hedgerows, lines of trees and woodland edge.</p> <p>High-quality habitat that is well connected to the wider landscape that is likely to be used regularly by foraging bats such as broadleaved woodland, treelined watercourses and grazed parkland.</p> <p>Site is close to and connected to known roosts.</p>
Moderate	<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>

Low	Habitat that could be used by small numbers of commuting bats such as a fragmented hedgerow or unvegetated stream, but isolated, i.e. not very well connected to the surrounding landscape by another habitat. 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.
Negligible	Negligible habitat features on site likely to be used by commuting or foraging bats.

Source: Bat Surveys – Good Practice Guidelines 3rd Edition (Collins, 2016)

- 2.3.3. The transect surveys aimed to indicate species and numbers of bats utilising habitats within and near the proposed scheme, and existing features within the landscape considered important for bat foraging, navigation, and orientation that may be adversely affected by the proposed scheme.
- 2.3.4. Each transect was assigned 10 stopping points of 5 minutes, associated with differentiating areas of habitat which had the potential to be important for foraging or commuting. These included established hedgerows, streams or woodland edges. Particular focus was given to high quality habitats which are likely to be directly impacted by the construction footprint, or those areas connected to such habitats.
- 2.3.5. In accordance with the bat memo agreed with Natural England (Appendix C), due to the length of the scheme, the suitability of the foraging and commuting habitat is variable, ranging from low to high. Low value habitats include intensively farmed areas containing large arable/pastoral fields divided by heavily managed hedgerows. High value habitats include areas of broadleaved woodland and smaller less intensively managed fields bordered by mature species-rich hedgerows with trees. To ensure survey effort was proportional, the agreed survey effort of one survey per month (April to October) is based on the ‘moderate’ habitat suitability outlined in the BCT survey guidelines (2016). This effort is considered adequate for the assessment due to the mix of habitats present across the scheme and given that the surveys are supplemented by crossing point surveys, targeted on the higher quality habitats. Additionally, advanced survey techniques were used, including mist netting and radiotracking, to provide further assessment of high-quality habitats, due to the presence of Annex II species. Together, these survey techniques provide robust survey data to enable the assessment of the impacts of the schemes on bats.
- 2.3.6. Each transect route was surveyed a total of 7 times over the active bat periods of 2018 and 2019, with a transect undertaken for each of the active months (April to October). Commencement of surveys and months surveyed each year were dependent on the dates when land access was granted.

- 2.3.7. Dusk transects began at sunset and lasted for three hours afterwards to account for late-emerging bat species; notably the horseshoe species. Dawn transects started three hours before sunrise, finishing at sunrise. Transects were walked at a steady pace and the direction of passage was alternated each time the route was walked to ensure that different areas of each transect was sampled at different times before/after sunrise/sunset.
- 2.3.8. Each of the July transects were subject to a single follow-up dawn survey, which was undertaken within the same 24-hour period as the previous dusk.
- 2.3.9. All surveys were aimed to be conducted during suitable weather conditions (start temperature of 10°C or above, no rain or strong winds), as defined in Collins (2016). Some surveys were carried out in close to optimal conditions and the lead ecologist made the final decision on whether a survey was to continue if conditions deteriorated for more than half an hour. Some transect surveys (transects 1, 2, 4 and 6) carried out in the month of April were in suboptimal temperatures due to the time of year. Two transects in May (transects 2 and 7) were undertaken in temperatures just below optimal with start temperatures of 9°C.
- 2.3.10. For the activity transect surveys two active full spectrum detector models were used, the Anabat Walkabout and Batlogger M. These were set to automated recording, where the detectors would record a sound file that passed its trigger criteria to record until these criteria are no longer met. These were then analysed using their respective software, Batlogger M was analysed with Bat Explorer and Anabat Walkabouts with Anabat Insight. Whilst two types of detector were used, the sensitivity of each of these detectors is similar and they are both record in full spectrum, and therefore data collected is considered comparable.
- 2.3.11. Analysis of the bat passes to create heat maps of bat activity were undertaken using ArcGIS and the Kernel density tool. Settings were set to 0.1 output with a search radius of 50m. The data was then classified into 11 categories indicating density of bat calls. The bottom class had no colour classified to it, to indicate that there weren't sufficient calls.

2.4. Static surveys

- 2.4.1. Three static detectors were installed for each transect, resulting in a total deployment of 21 detectors. This is in accordance with BCT Good Practice Guidelines (Collins, 2016). An additional detector (5D) was placed within the Shab Hill woodland for part of the survey season to provide supplementary information on bat activity here as a number of lesser horseshoe passes had been recorded during emergence surveys in this

locality. Each detector was deployed for one week per month between April and October over the bat active periods in 2018 and 2019, to collect data over five consecutive nights per month. Static detectors were set up to begin recording 30 minutes before sunset and stop recording 30 minutes after sunrise. The location of each static detector was selected based on the alignment of the scheme and presence of potential habitat features which could be used by foraging and commuting bats. Static detectors were deployed within a range of suitable habitats considered to be directly or indirectly affected by the proposed scheme. This included hedgerows, woodland, and scrub habitats. Detectors were secured within a cable lock and locked with an individual key; the number of which was recorded within the proforma at deployment. The detector microphones were located so that ambient or extraneous noise recorded was minimised. Positions were also adjusted where solid objects would impede the passage of sound to the microphone.

- 2.4.2. To ensure consistency across hardware, the same type of automated full spectrum detectors were used across all sites (Wildlife Acoustic SM4). Prior to deployment, fully charged batteries and empty SD cards were fitted. The SD cards were individually numbered and recorded within the proforma.
- 2.4.3. Analysis of bat calls was undertaken using Wildlife Acoustics Kaleidoscope Pro software. Bat calls were initially analysed using Kaleidoscope Pro Automatic Identification. Calls were then subject to manual verification by an experienced ecologist. Classifiers for pipistrelle species are well established, and calls assigned to common pipistrelle and soprano pipistrelle were not subject to manual verification. Calls for *Nathusius pipistrelle* were however subject to manual verification, as were calls for *Myotis* species, noctule, serotine, Leisler's, horseshoe species and barbastelle. Noise files and unidentified calls were also subject to analysis and were frequently found to contain bat calls.

2.5. Grouping of bat species calls

- 2.5.1. Calls from bats belonging to the species *Myotis* are all known to produce very similar sounding calls, which are difficult to distinguish between both in the field, and when using bat call analysis software. For the purposes of this assessment the following species have been grouped to be reported as *Myotis* sp.

- Alcatthoe bat
- Bechstein's bat
- Brandt's bat

- Daubenton's bat
- Natterer's bat
- Whiskered bat

- 2.5.2. This grouping is required to lower the probability of misidentification of species recorded during surveys. However, it is not expected to significantly impact the results of this assessment, with any *Myotis* sp. recordings of significance (such as a confirmed roost with the potential to be directly impacted by the proposed scheme) to undergo more in-depth analysis to determine which species this may belong to. The trapping and radio-tracking surveys would also identify whether any populations of Bechstein's bat (the rarest *Myotis* species) are present within the Zol.
- 2.5.3. With calls which look and sound the same, that have peak frequencies only 10kHz apart, common pipistrelle and soprano pipistrelle calls often overlap as a result of call plasticity allowing bats to adapt their calls to the habitats they are in. Therefore, to avoid misidentification of species, the label *Pipistrellus* sp. has been used for any calls falling within the range of peak frequency where call overlap is known to occur between 49kHz and 51kHz.
- 2.5.4. This is also the case for common pipistrelle and Nathusius' pipistrelle, with the lower end of the common pipistrelle call range overlapping with the higher end of the Nathusius' pipistrelle range. As all three species of pipistrelle have been recorded within the survey area, *Pipistrellus* sp., has been used as a species identifier where calls have been recorded in the overlap ranges, but definitive calls from all three species has not been recorded during a specific survey or at that location. The purpose of which is to ensure that none of these three species are underreported within this assessment.

2.6. Analysis of static data

- 2.6.1. Comparison and analysis of data collected during static surveys was undertaken using Microsoft Excel spreadsheets and pivot tables. Additionally, the project analysed the data using the Ecobat tool³. Ecobat is a web-based tool for supporting evidence-based decision-making by offering a standardised method of interpreting bat activity data. Previously there was no way of interpreting bat activity data in context, for example 100 bat passes could be interpreted as either high or low activity depending on context. The tool uses percentiles to provide a numerical indicator of the relative importance of a nights' worth of bat activity on the

³ <http://www.ecobat.org.uk/>

project site by comparing it with a national database. Relative activity levels are based on the following categories:

- low activity: 0-20th percentiles;
- low to moderate activity: 21st-40th percentiles;
- moderate activity: 41st-60th percentiles;
- moderate to high activity: 61st-80th percentiles; and
- high activity: 81st-100th percentiles

2.6.2. For this scheme, the reference range dataset was stratified to include only records from within 100 kilometres² of the survey location. This was the reference range recommended by Ecobat based on the available data and provides an analysis of data based on the local geographic region.

2.7. Constraints

2.7.1. Specific survey constraints were noted during the surveys as outlined below.

2.7.2. Access was denied for several land-parcels, though not all of these were required directly during the activity surveys. This means that it has not been possible to fully assess the activity levels of bats within these land parcels. There were also restrictions for some land parcels during certain periods within the survey season. Details of which land parcels that could not be accessed, as well as having restrictions are provided in Table 2.

Table 2: Land Parcels where access was constrained or refused for activity surveys.

Building Number / Land Parcel Number	Details
GR382246	Access denied to farmhouse and the immediate surrounding area. Access to whole land parcel was restricted in July 2018 with access only being permitted within the more northern section of the parcel that are closest to the existing A417. Access was refused for the August 2018 transect (Surveyed in August 2019).
GR298558, GR258761, GR306305	Access denied – no buildings but land parcels may contain trees with bat roost potential, particularly GR306305 which includes Emma’s Grove mature semi-natural broadleaved woodland. From aerial photography analysis and observations from adjacent land parcels, Emma’s grove appears to provide high quality foraging habitat for bats, as well as supporting potential tree roosts.

2.7.3. This lack of access affected transect route 5 for the entirety of the 2018 and 2019 survey seasons and therefore was not possible to collect transect data from this area of the scheme. Therefore, for the rest of this report transect 5 has not been included within transect assessment results.

Automated static detectors were placed in land bordering transect route 5, in land where access was granted, to gain understanding of how the land parcel might be used. Transects were also undertaken in land either side of this land parcel to provide some indication of bat activity within vicinity of this land parcel. However, there is a potential that key activity within this land parcel, such as along hedgerows or high-quality habitat such as Emma's Grove woodland will have been missed.

- 2.7.4. Each detector also records the GPS point with the sound file, to show location for activity mapping. There is a limitation, as accuracy is affected by cloud cover and surrounding vegetation, so some bat recordings can appear to be further away from the transect route than they actually are.
- 2.7.5. GPS locations were not recorded along some transects due to equipment issues (such as not being able to connect to satellites). Where recordings lacked GPS locations, their locations were plotted based on the timing of the recording, notes made and the timings of point counts along each route to give an approximate location.
- 2.7.6. Static 4c was initially placed within land parcel GR382246 (Crickley Hill Farm) at point SO 92174 15510 (location 4c-a). After land access was restricted to sections of this land parcel, the automated static detector was then moved to a new location, SO 92270 15734 (location 4c-b).
- 2.7.7. Some static deployments failed due to corruption of the SD card. Failed deployments during the 2018 survey season were repeated during the 2019 survey season, to provide data at all transects across each active month. There were two failed deployments in May 2019 due to SD cards being corrupt at sites 1B and 5B. This is not considered to have a significant impact on the overall bat assessment due to the amount of data collected across the site, however consideration should be made for these two locations when assessing bat activity across the site.
- 2.7.8. Access restrictions to land parcel GR159309 in 2019 due to the concern of the landowner regarding disturbance of lambing within certain areas of the farm, meant that transect routes 1, 2 and 6 were altered. This is not considered to have a significant impact on the activity survey results as these altered transect routes provided good coverage of affected habitats.

3. Results

3.1. Desk study

- 3.1.1. There is one European Special Area for Conservation (SAC) designated for bats which is located within 30km of the scheme. Two Sites of Special Scientific Interest (SSSIs) contain habitats that could support numerous bat species and are located within 2km of the scheme. Two Gloucestershire Wildlife Trust (GWT) reserves, 12 Key Wildlife Sites (KWS), 3 potential KWS and 1 conservation road verge (CRV) were also identified within 2km of the scheme, although not designated for bats. The statutory designated sites are detailed below.

European Designated Sites

Wye Valley and Forest of Dean Bat Sites SAC

- 3.1.2. Wye Valley and Forest of Dean Bat Sites SAC (UK0014794) is a 142.70 ha site, which straddles the border between England (Gloucestershire) and Wales (Monmouthshire). This site supports two Annex II bat species, which act as the reason for its selection.
- 3.1.3. Lesser Horseshoe Bat. The complex of the sites within the SAC contain the greatest concentration of Lesser Horseshoes in the UK, totalling approximately 26% of the national population at the time of designation in 2005. The habitats within the area support an exceptional breeding population, with most sites being maternity roosts. The immediate and surrounding habitat provides good foraging and hibernation opportunities as well.
- 3.1.4. Greater Horseshoe Bat. The complex of sites within the SAC contains the main maternity roost for the species in the northern part of its range, supporting 6% of the UK population. The disused mines in the area provide excellent hibernation opportunities, whilst the extensive surrounding woodland is optimal foraging habitat.
- 3.1.5. This site is of European importance for Lesser Horseshoe and Greater Horseshoe bats.

Nationally Designated Sites

- 3.1.6. Four SSSIs have been identified within 2km of the scheme. A further five SSSIs have been identified to be further than 2km from the scheme, but within 200m of the strategic road network (SRN). Information regarding the

distance, orientation, importance to bats and potential impacts of the scheme on bats is given in Table 3 below.

Table 3: Location of nationally designated sites in relation to the scheme, and their potential to be used by bats.

Site Name	Distance and orientation from Scheme	Potential use of site by bats
Crickley Hill & Barrow Wake SSSI	Adjacent	Broadleaved semi-natural habitats provide potential roosting and foraging resources to a number of bat species. Ground flora has the potential to support invertebrate populations which could be utilised by foraging bats.
Bushley Muzzard SSSI	257m southwest	Marsh areas surrounding by species-rich calcareous grassland and permanent pasture. Floral diversity and presence of uncommon species has the potential to support an array of invertebrate species, which in turn makes it potentially viable as a foraging ground for bats.
Knap House Quarry SSSI	268m west	The site itself is designated for geological reasons only, but exists adjacent to the SSSI below and within woodland which provides roosting and foraging opportunities for bats.
Cotswold Commons and Beechwoods SSSI	426m west	Habitats on site comprise of chalk grassland and woodland and is noted to support a diverse floral assemblage and array of invertebrates with the potential to be used as a foraging resource for bats. The Beech, Ash, Maple woodlands within the site have the potential to support roosting and foraging bats. The citation for the SSSI notes that some disused limestone mines within the notified area are used as winter roosts by several bat species.
Leckhampton Hill and Charlton Kings Common SSSI -	1.5km north	One of a series of unimproved Jurassic limestone grassland sites found along the Cotswold Scarp. The site includes former quarry faces and vegetated quarry spoil and is of biological and geological interest. The limestone grasslands and woodland provide high quality foraging habitat and the site contains a number of rock fissures and a number of caves which are likely to provide high quality roosting habitat.
Lineover Wood SSSI	5.2km north-east	The species-rich hedgerows and ancient broadleaved woodland of Beech, Ash and Maple within the site have the potential to support roosting and foraging bats. Calcareous grassland and streams provide further foraging opportunities by supporting invertebrate populations. Dry stone walls may even be suitable for hibernating bats, depending on their condition.
Hucclecote Meadows SSSI	4.1km west	A species-rich, unimproved lowland ancient pasture. Traditional management and grazing leads to greater diversity of flora, which supports invertebrate species that are potential preyed on by bats. Hedgerows bordering the fields provide roosting and commuting opportunities for bats.
North Meadow SSSI	22.5km south-east	Grazed neutral grassland has great floral diversity, supporting a plethora of invertebrates which could be utilised by bats. Hedgerows provide commuting routes and potential roosting opportunities.

Westwell Gorse SSSI	26.7km east	A small area of calcareous grassland, scrub and woodland which supports considerable floral diversity. The ground flora has the potential to support invertebrate populations which could be utilised by bats, but the small pocket of woodland may only provide limited roosting opportunities.
Upham Meadow and Summer Leasow SSSI	21.3km North (both)	Upham Meadow is managed as a hay meadow and the Summer Leasow is managed as pasture grassland which is subject to restricted common grazing rights. the semi-improved neutral grassland is subject to annual winter flooding and is notified primarily for its breeding waders and over-wintering populations of waders and wildfowl. The site is likely to provide high quality bat foraging habitat.

Regionally Designated Sites

3.1.7. There are three potential Key Wildlife Sites (pKWS), 12 Key Wildlife Sites (KWS) and one Conservation Road Verge (CRV) within 2km of the study area. Additionally, the two Gloucestershire Wildlife Trust (GWT) reserves of Crickley Hill Country Park and Barrow Wake (also part of the aforementioned SSSI of the same name) are within the study area. Their distance and orientation from the scheme are detailed in Table 4 below, alongside any features that may potentially support native bat species. These sites are of regional importance although none have been designated for bats.

Table 4: Regionally designated sites in relation to the scheme and their potential to support UK bat species.

Site name	Code	Distance and orientation from the Scheme	Presence of notable features with the potential to be used by bats.
Crickley Hill Country Park GWT Reserve	N/A	125m North	Semi-natural woodland, scrub and species-rich calcareous grassland. Potential to be used by roosting, foraging and commuting bats.
Barrow Wake GWT Reserve	N/A	Adjacent	Unimproved lowland, calcareous grassland and semi-natural broadleaved woodland. Potential to be used by roosting, foraging and commuting bats.
Ullen Wood KWS	SO91/020	122m north-east	Ancient semi-natural broadleaved woodland site larger than 2ha. Potential to support roosting, foraging and commuting bats.
Coldwell Bottom KWS	SO91/011	1km east	Calcareous and semi-natural grasslands. Potential to support foraging and commuting bats.
Witcombe Reservoirs KWS	SO91/008	1.3km south-west	Lakes, gravel pits and reservoirs, all larger than 0.25 ha. Potential to support foraging bats.
Little Bittomes KWS	SO91/050	750m south-west	Designated for invertebrate interest, but within broadleaved woodland.

			Adjacent habitat provides potential to support roosting, foraging and commuting bats.
Hawcote Hill Wood KWS	SO91/038	1.1km west	Ancient semi-natural broadleaved woodland site larger than 2ha. Potential to support roosting, foraging and commuting bats.
Cowley & Wards Woods KWS	SO91/042	710m east	Ancient semi-natural broadleaved woodland site larger than 2ha. Potential to support roosting, foraging and commuting bats.
Park Wood (Brimpsfield) KWS	SO91/041	640m south	Ancient semi-natural broadleaved woodland site larger than 2ha. Potential to support roosting, foraging and commuting bats.
Poston, Syde & Ostrich Woods KWS	SO91/032	675m south	Ancient semi-natural broadleaved woodland site larger than 2ha. Potential to support roosting, foraging and commuting bats.
Groveridge Banks KWS	SO91/010	1.4km south-west	Unimproved and semi-natural grasslands. Part of site includes woodland and scattered trees. Limited potential for roosting but potential to support foraging and commuting bats.
Stoneyhill Valley KWS	SO91/036	1.7km south-west	Unimproved and semi-natural grasslands. Part of site includes scattered trees, with woodland edges bordering either side. Limited potential for roosting but may be utilised for foraging depending on invertebrate assemblage. Commuting bats may use adjacent woodland edges.
Hazel Hanger Wood KWS	SO91/033	1.9km south	Ancient semi-natural broadleaved woodland site larger than 2ha. Potential to support roosting, foraging and commuting bats.
River Frome Mainstream & Tributaries KWS	SO80/142	300m west	Structural diversity with significant botanical and animal interest. Adjacent to many other KWS. Potential to be used by foraging and commuting bats.
Ostrich Bank	SO91/031	1.8km south	Scrubby and herb-rich calcareous grassland. Limited potential for roosting but potential to support foraging bats and possible commuting using bordering hedgerows.
Haroldstone Fields (Crickley Hill) pKWS	SO91/066	Adjacent	Mosaic neutral and calcareous grasslands. Limited potential for roosting but potential to support foraging and commuting bats.
Bentham, Dog Lane Fields pKWS	SO91/070	Adjacent	Rough grassland, tall herbs, ponds, scrub, wetland and veteran trees. Potential for roosting, foraging and commuting bats.

Historic Bat Records

3.1.8. A significant number of bat records were returned from Gloucestershire Centre for Environmental Records (GCER) within 10 kilometres of the scheme. Appendix B shows the distribution of these records and a summary of the results is provided in Table 5 below.

Table 5: Historic bat records within 2km of the proposed scheme.

Species	Number of records within 10 km	Notes on significant records
Bats	263	Including 2 noted as maternity roosts (bat species not recorded). Closest of which is at Cold Slad 275 m north of the scheme
Lesser Horseshoe Bat	291	Including 3 maternity roosts – closest to A417 at Cowley Manor 1.8km northeast of the scheme Including 2 hibernation roosts – closest 8.5km northeast of the scheme
Common Pipistrelle	227	Including 1 maternity roost 1.8km west of the scheme
Unidentified Bat	123	Including 1 <i>Myotis</i> species hibernation roost 9.5km south of the scheme
Soprano Pipistrelle	122	Including 1 hibernation roost 8km north of the scheme
Noctule Bat	117	
Brown Long-eared Bat	102	Including 2 maternity roosts. Closest of which is at National Star College 860m northwest of scheme
Pipistrelle	90	Including 1.7km west of the scheme
Serotine	56	
Natterer's Bat	53	Including 2 hibernation roosts the closest of which is 8.5km northeast of scheme
Pipistrelle Bat species	49	
Daubenton's Bat	48	Including 1 hibernation roost
Long-eared Bat species	34	
Whiskered Bat	31	
Greater Horseshoe Bat	28	Including 1 hibernation roost 1.95km north of scheme at Greenway Hotel, Shurdington
Western Barbastelle	24	Records from 4 separate sites. Closest record 5.5 km northwest in Lineover Wood SSSI.
Bechstein's Bat	11	Records from 5 separate sites. Closest record 5.5 km northwest in Lineover Wood SSSI.
Lesser Noctule	8	
Nathusius's Pipistrelle	7	
Brandt's Bat	6	
Nyctalus Bat species	3	
Whiskered/Brandt's Bat	3	

3.1.9. The data search results show the importance of the area for lesser horseshoe bats, with lesser horseshoe records representing the highest number of records, with 291 records within 10 kilometres of the scheme, including 3 maternity roosts and 2 hibernation roosts. At least 16 species of bats have been recorded within 10 kilometres of the scheme.

Existing Bat Mitigation Licences

- 3.1.10. A search for current and historic bat mitigation licences identified a single bat mitigation licence within 2km of the scheme. This licence is for a common pipistrelle non-maternity roost approximately 1,200 meters southwest of the scheme in Brimpsfield. A search for mitigation licences in the wider area up to 10 kilometres from the scheme identified a total of 36 bat mitigation licences, including 6 affecting breeding roosts. Species affected included common pipistrelle, soprano pipistrelle, brown long-eared, lesser horseshoe, Natterer's, whiskered, Brandt's, Daubenton's and a single licence for barbastelle.

Other Records

- 3.1.11. During surveys on land parcel GR348273, the survey team were made aware of bat surveys that had been undertaken as part of planning application 18/01259/FUL (Tewksbury Borough Council) for the conversion of Haroldstone House, Crickley Hill. The buildings covered by this application are 160 metres and 170 metres from the scheme and so are well outside of the 100m survey buffer for building assessments. However, the ecological assessment for this proposed development has identified the presence of a lesser horseshoe maternity colony using these two buildings. Surveys in 2018 identified a maximum count of 41 lesser horseshoe bats using the two buildings. The surveys also identified day roosts for greater horseshoe, common pipistrelle, Natterer's and brown long-eared. No evidence of hibernating bats was recorded in the buildings.

3.2. Field Surveys

- 3.2.1. Information obtained from the bat surveys undertaken throughout the 2018 and 2019 survey seasons is presented below within their respective survey sections. This includes species identification during each survey type and potential features used for foraging and commuting bats.

Bat Activity Transects

- 3.2.2. All of the transects described below were designed prior to the route announcement and any detailed design. Transect routes therefore covered both the Option 30 alignment and Option 12 alignment. Appendix D shows the location of each transect route. Table 6 below provides dates and weather conditions for the transect surveys.

Table 6: Activity transect survey details

Transect Number	Survey Date	Weather Conditions	Sunset/Sunrise Time	Start /Finish Time
1	17/06/2019	14-13°C, 100% cloud cover, light winds, dry.	21:30	21:30 – 00:30
	04/07/2018	19-17°C, 50% cloud cover, light winds, dry.	21:30	21:25 – 00:30
	05/07/2018	16-17°C, 50% cloud cover, light winds, dry.	04:57	01:52 – 04:57
	07/08/2018	18°C, 50% cloud cover, light winds, dry.	20:48	20:48 – 23:48
	10/09/2018	16-15°C, 100% cloud cover, moderate winds, dry.	19:36	19:36 – 22:36
	04/10/2018	14°C, 20% cloud cover, light winds, dry.	18:39	18:39 – 21:39
	15/04/2019	9-8°C, 70% cloud cover, light winds, dry.	20:09	20:09 – 23:09
	14/05/2019	13-11°C, 20% cloud cover, light winds, dry.	20:53	20:53 – 23:53
2	07/06/2018	16-15°C, 100% cloud cover, light winds, dry.	21:24	21:24 – 00:11
	04/07/2018	18°C, 50% cloud cover, light winds, dry.	21:30	21:30 – 00:30
	05/07/2018	16-17°C, 50% cloud cover, light winds, dry.	04:55	01:52 – 04:55
	08/08/2018	18-16°C, 30% cloud cover, light winds, dry.	20:46	20:46 – 23:46
	10/09/2018	16-15°C, 100% cloud cover, moderate winds, dry.	19:36	19:36 – 22:36
	08/10/2018	12-11°C, 20% cloud cover, light winds, dry.	18:31	18:31 – 21:31
	10/04/2019	7-3°C, 10% cloud cover, light winds, dry.	19:57	19:57 – 22:27
	08/05/2019	9-8°C, 100% cloud cover, light winds, drizzle until 20:55 then dry.	20:44	20:44 – 23:31
3	27/06/2018	24-18°C, 0% cloud cover, light winds, dry.	21:32	21:32 – 00:32
	24/07/2018	21-18°C, 50% cloud cover, light winds, dry.	21:08	21:08 – 00:14
	25/07/2018	15-16°C, 50% cloud cover, light winds, dry.	05:20	02:14 – 05:20
	19/08/2019	13-11°C, 0% cloud cover, light winds, dry.	20:25	20:38 – 23:25
	17/09/2018	18-13°C, 10% cloud cover, moderate winds, dry.	19:19	19:19 – 22:19
	08/10/2018	11-10°C, 100% cloud cover, light winds, dry.	18:30	18:30 – 21:30
	16/04/2019	10-9°C, 80% cloud cover, light winds, dry.	20:07	20:07 – 23:08
	15/05/2019	13-10°C, 10% cloud cover, light winds, dry.	20:55	20:55 – 23:55

4	19/06/2018	18-17°C, 50% cloud cover, light winds, dry.	21:31	21:31 – 00:31
	24/07/2018	22-18°C, 50% cloud cover, light winds, dry.	21:11	21:11 – 00:11
	25/07/2018	15°C, 10% cloud cover, light winds, dry.	05:20	02:20 – 05:20
	13/08/2019	16-15°C, 60% cloud cover, moderate winds, dry.	20:37	20:37 – 23:37
	18/09/2018	19-18°C, 60% cloud cover, moderate winds, dry.	19:17	19:17 – 22:20
	10/10/2018	19-16°C, 10% cloud cover, light winds, dry.	18:26	18:26 – 21:26
	09/04/2019	08-5°C, 80% cloud cover, light winds, dry.	19:58	19:58 – 23:15
	21/05/2019	16-11°C, 20% cloud cover, light winds, dry.	21:02	21:02 – 00:02
6	28/06/2018	20-17°C, 10% cloud cover, light winds, dry.	21:32	21:32 – 00:32
	17/07/2018	24-18°C, 50% cloud cover, light winds, dry.	21:18	21:18 – 00:18
	18/07/2018	15-16°C, 0% cloud cover, light winds, dry.	05:13	02:13 – 05:13
	14/08/2019	20°C, 50% cloud cover, light winds, dry.	20:35	20:35 – 23:40
	17/09/2018	17-16°C, 10% cloud cover, moderate winds, dry.	19:21	19:21 – 22:21
	10/10/2018	15-14°C, 0% cloud cover, moderate winds, dry.	18:26	18:26 – 21:26
	11/04/2019	8-3°C, 0% cloud cover, still, dry.	19:58	19:58 – 22:39
	02/05/2019	10-8°C, 80% cloud cover, light winds, dry.	20:34	20:34 – 23:34
7	08/06/2018	18-15°C, 100% cloud cover, light winds, dry until light rain at end of survey (00:00).	21:24	21:24 – 00:24
	04/07/2018	20°C, 70% cloud cover, light winds, dry.	21:30	21:30 – 00:30
	05/07/2018	17-16°C, 70% cloud cover, light winds, dry.	04:57	01:57 – 04:57
	07/08/2019	22-20°C, 30% cloud cover, light winds, dry.	20:48	20:48 – 23:48
	19/09/2018	14-12°C, 100% cloud cover, moderate winds, light rain showers.	19:14	19:14 – 22:14
	10/10/2018	18-17°C, 0% cloud cover, moderate winds, dry.	18:24	18:24 – 21:24
	01/04/2019	12-11°C, 10% cloud cover, still, dry.	19:40	19:40 – 22:22
	09/05/2019	9-8°C, 50% cloud cover, light winds, very light rain showers at end of survey.	20:45	20:45 – 23:30

3.2.3. At least 11⁴ species were recorded across all the transects between 2018-19:

- Barbastelle *Barbastella barbastellus*
- Long-eared bat *Plecotus sp.*
- Common pipistrelle *Pipistrellus pipistrellus*
- Greater horseshoe *Rhinolophus ferrumequinum*
- Leisler's bat *Nyctalus leisleri*
- Lesser horseshoe *Rhinolophus hipposideros*
- *Myotis sp.*
- Nathusius's pipistrelle *Pipistrellus nathusii*
- Noctule *Nyctalus noctula*
- Serotine *Eptesicus serotinus*
- Soprano pipistrelle *Pipistrellus pygmaeus*

3.2.4. See below Table 7 below for a breakdown of bat species recorded across the six transect routes for 2018-2019.

Table 7: Activity transect route species counts

Species	Transect Route Number						Species Totals
	1	2	3	4	6	7	
Barbastelle	5	4	4	3	0	5	21
Common pipistrelle	91	663	588	352	217	735	2646
Greater Horseshoe	0	0	0	1	0	0	1
Leisler's bat	0	0	2	0	0	2	4
Lesser Horseshoe	8	6	9	4	1	46	74
<i>Myotis sp.</i>	31	23	36	73	23	55	241
Nathusius's pipistrelle	0	1	1	0	0	0	2
Noctule	26	60	42	12	6	139	285
<i>Nyctalus sp.</i>	0	0	1	1	0	2	4
<i>Pipistrellus sp.</i>	0	1	3	8	0	13	25
<i>Plecotus sp.</i>	6	14	14	1	4	43	82
Serotine	6	8	6	23	0	11	54
Soprano pipistrelle	0	2	6	5	0	15	28
Total transect call number	173	782	712	483	251	1066	3467
Percentage of total calls across all transects	4.99	22.56	20.54	13.93	7.24	30.75	

3.2.5. Appendix E includes drawings showing point data for all bat calls, and separate drawings for *Myotis sp.*, *Pipistrelle sp.*, *Horseshoe sp.*, *Nyctaloid sp.* and *barbastelle* calls recorded during all the transects. Appendix D also

⁴ It is likely that more than 1 *Myotis* species is present and therefore 11 represents the minimum number of species present.

shows heat density maps of the calls for all bat calls, *Myotis* sp., *Pipistrelle* sp., Horseshoe sp. and *Nyctaloid* sp.

Transect 1

- 3.2.6. Transect 1 had 7 species including occasional barbastelle and lesser horseshoe passes. Barbastelle (5 recordings) were found along the road (unnamed road leading to Cowley) at the southern end of the transect that leads up to stopping point 10. There is a potential that these could be commuting bats moving between the large area of woodland at Harcombe Bottom/Cowley Wood to the northeast, and the large area of woodland to the southwest of the A417 including Poston Wood and The Rookery, potentially passing under the A417 Cowley Bridge, although no bats were observed flying under the bridge during the transect survey. Lesser horseshoe were recorded along this same minor road which provides a good linear corridor linking up to the high-quality habitat around Harcombe Bottom/Cowley Wood. Lesser horseshoe bats were also recorded foraging around the Birdlip Quarry.
- 3.2.7. As with all the transects, the majority of activity was attributed to common pipistrelle, with *Myotis* species and then noctule being the next most frequently recorded species. The main areas of overall bat activity were along the minor road and around Birdlip Quarry. Overall, activity along the transect was low compared with the other transects, with approximately 5% of the total bat passes recorded.

Transect 2

- 3.2.8. This transect route had a high level of bat activity (of which the majority was attributed to common pipistrelle) with the overall second highest levels of activity compared with the other transects (23% of overall calls). Ten species of bat were recorded along this transect with the majority of passes being common pipistrelle. Noctule passes were the next most frequently recorded, followed by *Myotis* species.
- 3.2.9. The transect includes good linear features along Cowley Lane suitable for commuting between foraging grounds and nearby roosts at Stockwell Farm, which includes a confirmed common pipistrelle maternity roost. There were 7 recordings of lesser horseshoe along the route, which were along the edge of Cally Hill Plantation and in between the plantation and a small woodland block to the south. These are likely to be commuting horseshoe bats moving between woodland blocks to forage within.
- 3.2.10. The highest levels of activity were along Cowley Lane which passes through Stockwell Farm leading north east. This road has mature trees on

either side of the road extending to Hill Barn (east of Green Hatch Farm). These trees offer very good commuting corridors as well as good foraging opportunities. with links to the known roosts at Stockwell. The other area of high activity along this transect was around Shall Hill. This is most likely due to high quality foraging habitat around Shab Hill including a line of very mature deciduous trees and surrounding rough pasture. There are also nearby roosts at Shab Hill (common pipistrelle day roost, long-eared transitional roost and lesser horseshoe night roost) and a common pipistrelle day roost at Birdlip Radio Station, and bats associated with these roosts will likely commute and forage within these areas.

Transect 3

- 3.2.11. Activity levels along this transect were similar to transect 2, with 21% of the overall calls across all transects. Common pipistrelle was the dominant species recorded with Noctule and *Myotis* species the next most frequently recorded. Low numbers of lesser horseshoe and barbastelle were recorded along this transect. Nathusius' s pipistrelle were also recorded in low numbers along this transect within an area of high activity along the track which runs northwest of the radio station towards Ullen Wood.
- 3.2.12. This transect recorded the highest density of bat calls within a particular section of transect, which is at a convergent point where five linear features come together at the track between the radio station and Ullen Wood. These linear features provide good foraging and commuting habitat with excellent connectivity to nearby woodland, pasture and arable fields and surrounding buildings. There is a large species composition along the transect route, again having a high percentage of common pipistrelle bats. Several *Myotis* species recordings have also been recorded in this area. Given the proximity of ancient semi natural woodland nearby, there is a potential that some of these *Myotis* calls could belong to Bechstein's.

Transect 4

- 3.2.13. This transect covered a large area and was adjusted at times due to restricted land access. During this transect both greater (1 recording) and lesser (4 recordings) horseshoe species as well as barbastelle (1 recording) were recorded. The route had a large common pipistrelle species composition, with *Myotis* being the second highest. Additionally, serotine and noctule were also recorded along this transect.
- 3.2.14. The route includes large areas of high-quality bat foraging habitat, which include pastures, grassland, scattered mature trees, tree lines, hedgerows and running water. In particular, the riparian habitat along Norman's Brook, which runs parallel with the A417 provides high quality foraging and

commuting habitat. There are 5 recorded roosts at Crickley Hill Farm including 2 common pipistrelle day roosts in buildings and 2 common pipistrelle day roosts and 1 *Myotis* species day roost in trees. There are also roosts in the vicinity of Grove Farm, including a lesser horseshoe and brown long-eared day roost and a common pipistrelle day roost. Bats associated with these roosts are likely to be foraging and commuting within the habitat along this transect.

- 3.2.15. There is an even spread of activity across the site, with the highest activity along the riparian habitat along Normans Brook.

Transect 6

- 3.2.16. The transect for this route had to be changed due to lambing and rearing young calves, so access to the fields in which they were situated were restricted.
- 3.2.17. There was only a single recording of a lesser horseshoe, which could have been a commuting bat as no additional recording for this species along this route was detected.
- 3.2.18. The main composition of bats call was that of common pipistrelle (likely due to the maternity roost at Stockwell Farm) and the majority of the calls were recorded along a mature tree line along a wet ditch with a pond at its eastern end. This feature provides high quality foraging habitat within an area surrounded by lower quality arable fields. Other species recorded along this route included occasional *Myotis* sp., long-eared sp. and noctule.
- 3.2.19. There was little to no activity along the western section of the transect that runs parallel to the A417 around the edges of arable fields. There is also very little to no vegetation along the majority of the boundary with only standard highways boundary fencing in place, which together with the disturbance levels from the traffic and intensively managed arable fields means this section is of low value to bats both commuting and foraging. In addition to the tree lined ditch feature, the other area of main bat activity is around large pheasant pens within an area of coniferous plantation woodland, south west of Stockwell Farm. Occasional bats were recorded commuting along a farm track that runs west from Stockwell Farm, including the single lesser horseshoe recording. This track offers limited foraging potential with only scattered low-quality scrub along this feature.

Transect 7

- 3.2.20. Transect 7 has the largest amount of lesser horseshoe recordings across the scheme, with the highest levels of activity recorded along the minor

road that goes around Crickley Hill and passes directly north of Haroldstone House, towards Cold Slad. There are a lot of mature trees around this area as well as pasture fields to the north of this point which offer high quality foraging and commuting habitat. The large rock faces along Crickley Hill offer nearby suitable roosting opportunities for horseshoe species as well as crevice dwelling species. The nearby Scrubs Woodland within Crickley Hill SSSI supports a number of ancient, veteran and over-mature trees, within an area of mature woodland providing further high-quality roosting and foraging habitat.

- 3.2.21. As with all other transects, the main species recorded is that of common pipistrelle. Other species recorded included *Myotis* species, soprano pipistrelle, long-eared species, noctule, Leisler's and serotine. Given the quality of woodland habitat in the vicinity of the transect, there is a potential that the *Myotis* species calls may include Bechstein's. There are a number of areas of high bat activity including along the lane to Cold Slad, in the vicinity of the Devil's Table, and along the track that passes through the Scrubs woodland.
- 3.2.22. This transect also has the highest level of noctule activity across the scheme, which was along Cotswold Way and surrounding Crickley Hill café, as well as the more open area near the Air Balloon roundabout.
- 3.2.23. During the dawn transect on the 5 July 2018, 10 common pipistrelle bats were observed re-entering building 20 (located along the lane to Cold Slad) with at least another 15 bats observed swarming around the building. These surveys indicate that building 20 supports a common pipistrelle maternity roost.
- 3.2.24. Haroldstone House is a known maternity colony for lesser horseshoe bats, and therefore the high levels of lesser horseshoe activity recorded along this transect, and in particular along the lane to Cold Slad, are likely to be foraging and commuting bats associated with this roost.

Static Bat Detectors

- 3.2.25. Three static recorders are associated with each transect route, please see Appendix F for static location points. The following data has been produced using The Mammal Society Ecobat Tool.
- 3.2.26. In total bats were detected on 217 survey nights between April and October.
- 3.2.27. Information obtained from static bat recorders placed along transects is summarised below with additional data in Appendix G.

3.2.28. Overall, the same 11⁵ species recorded on the transects were also recorded across the static automated bat detectors between 2018-19.

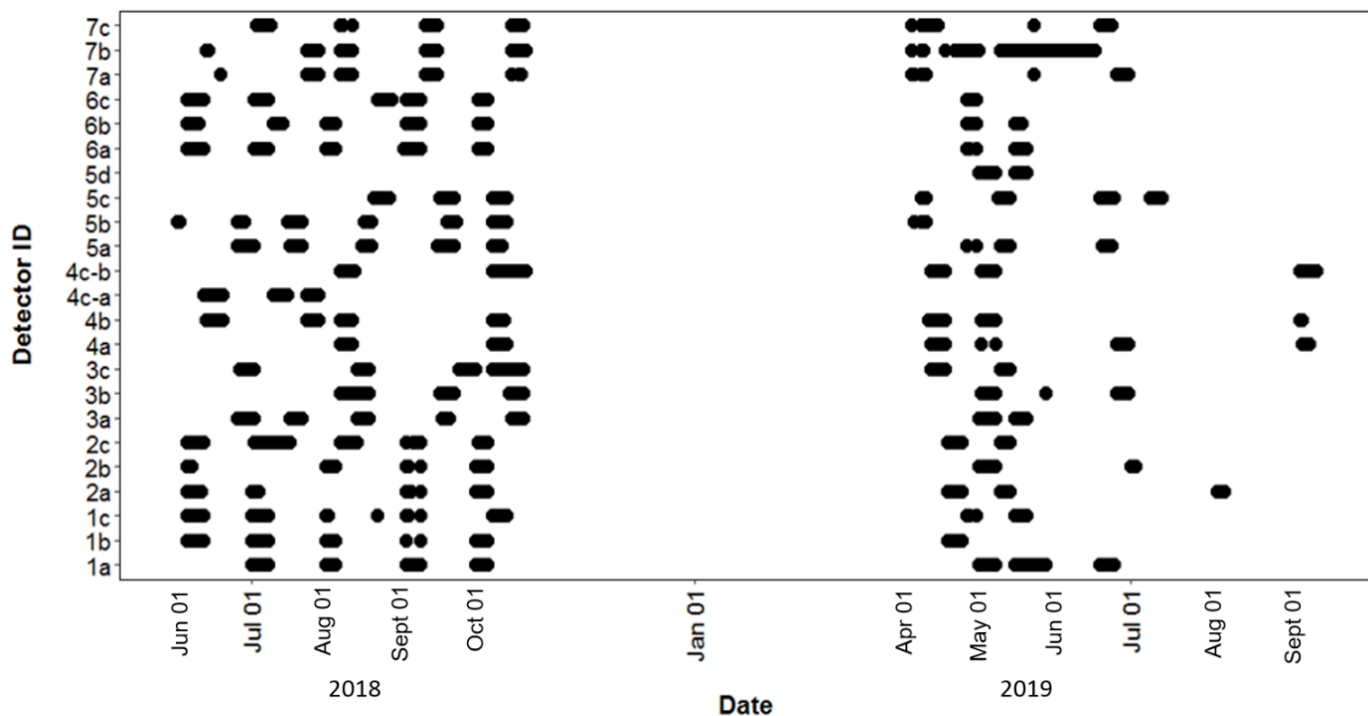
- Barbastelle
- Long-eared bat
- Common pipistrelle
- Greater horseshoe
- Leisler's bat
- Lesser horseshoe
- *Myotis* sp.
- Nathusius's pipistrelle
- Noctule
- Serotine
- Soprano pipistrelle

Survey Nights

3.2.29. As outlined in the method section, surveys were split between two years due to the late commencement of surveys in 2018, land access issues and static detector issues. Figure 3 illustrates which nights static detectors recorded bats in each location, split over the 2018 and 2019 survey seasons.

⁵ Note: the Eco bat report refers to 14 species of bat, but this includes groupings for *Pipistrellus* species, *Nyctaloid* species and *Nyctalus* species. As all *Myotis* species have been grouped together it is likely that more than 11 species are present.

Figure 3: A417 Static Survey Nights



Percentile Analysis

3.2.30. Figure 4 illustrates the results of the percentile analysis to give a comparison of bat activity recorded on site, to identify relative bat activity levels compared to existing records in the same region. This enables the survey data to be contextualised against reference levels recorded in the same region. The reference dataset used for comparison was stratified to include records within 100 kilometres² of the survey location. The 100 kilometres² dataset was selected by Ecobat based on the existing dataset available, to provide a comparison of the site survey data with existing data held on the Ecobat database for the local geographic area, to identify the relative activity levels recorded during the surveys. The reference dataset is based on existing records held by Ecobat including the NBN Gateway⁶.

3.2.31. Relative activity levels are based on the following categories:

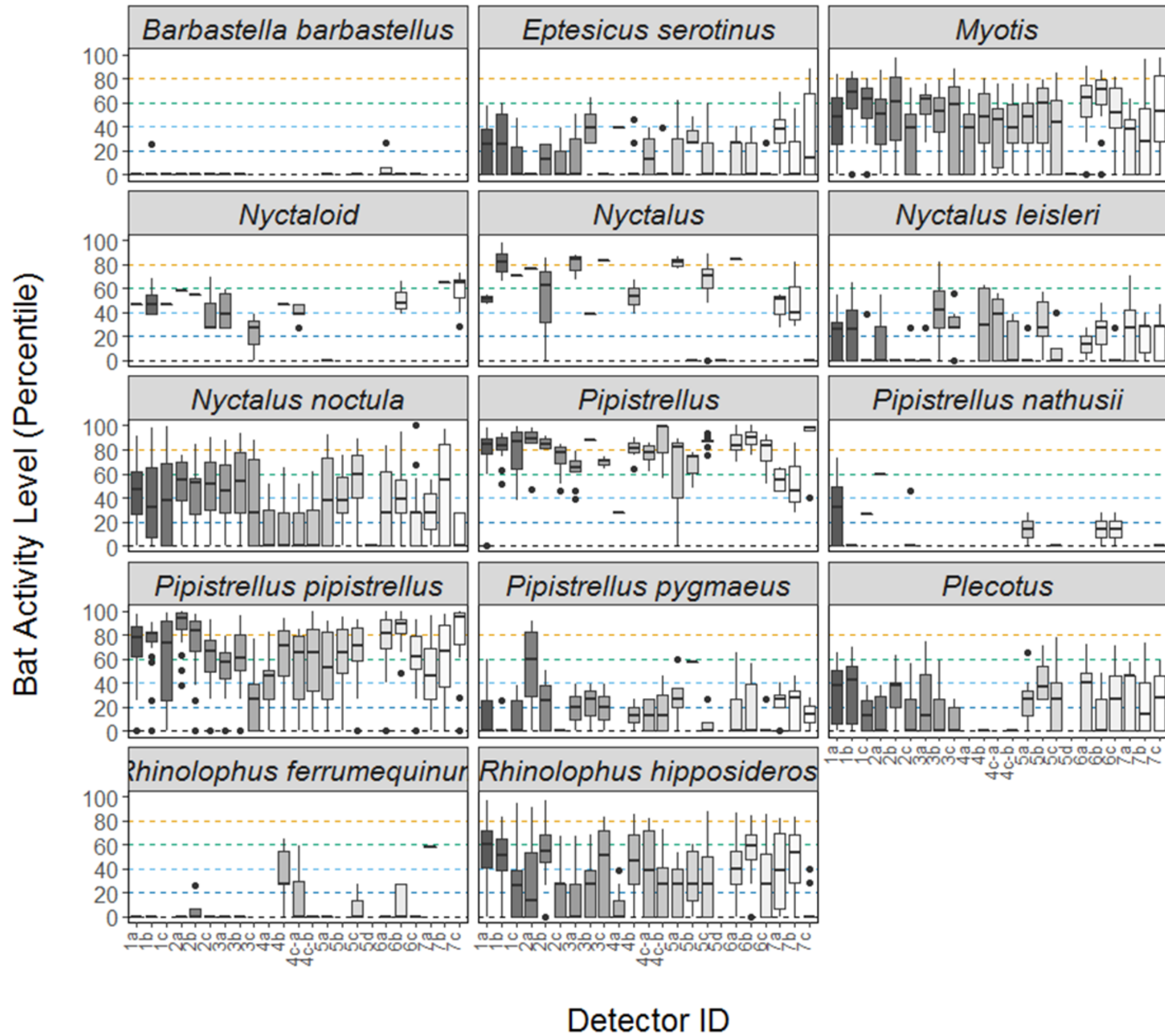
- low activity: 0-20th percentiles;
- low to moderate activity: 21st-40th percentiles;
- moderate activity: 41st-60th percentiles;

⁶ <https://nbnatlas.org/>

- moderate to high activity: 61st-80th percentiles; and
- high activity: 81st-100th percentiles

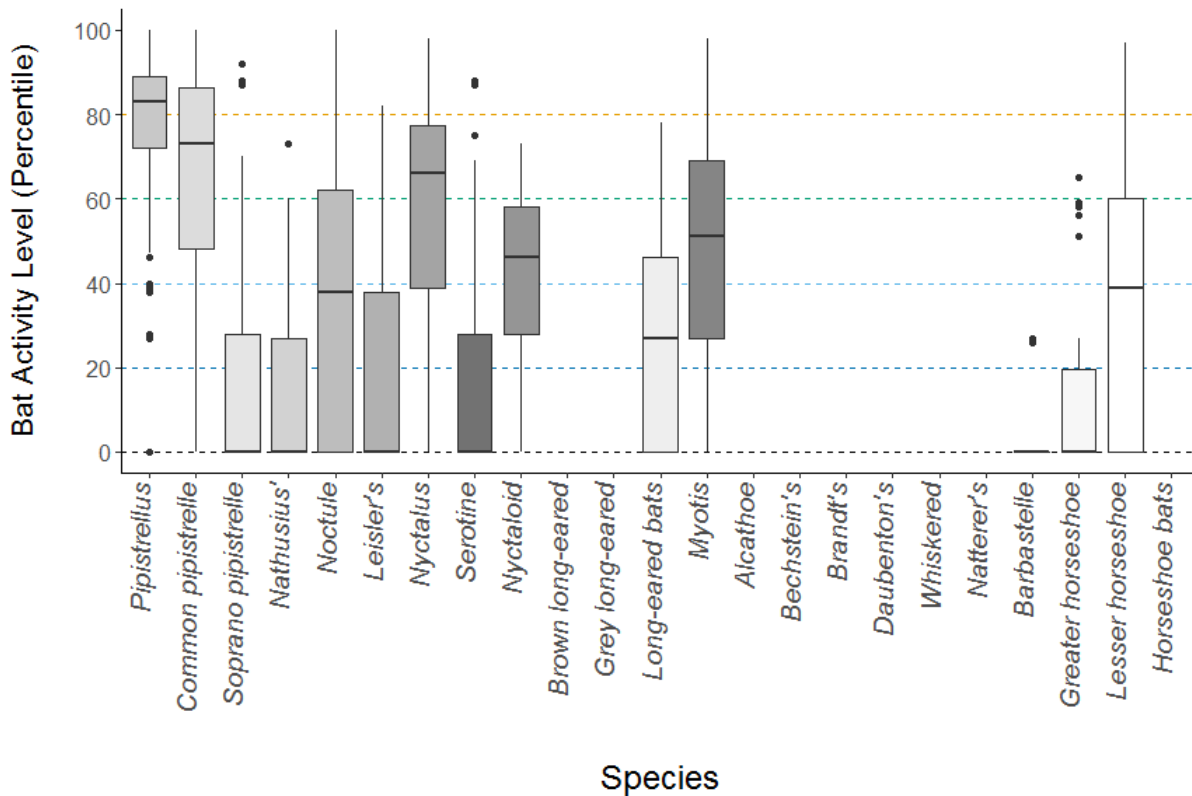
3.2.32. Figure 4 illustrates differences in activity between static detector locations, split by species and location. The centre line indicates the median activity level whereas the box represents the interquartile range (the spread of the middle 50% of nights of activity).

Figure 4: Percentile bat activity per species at each static location.



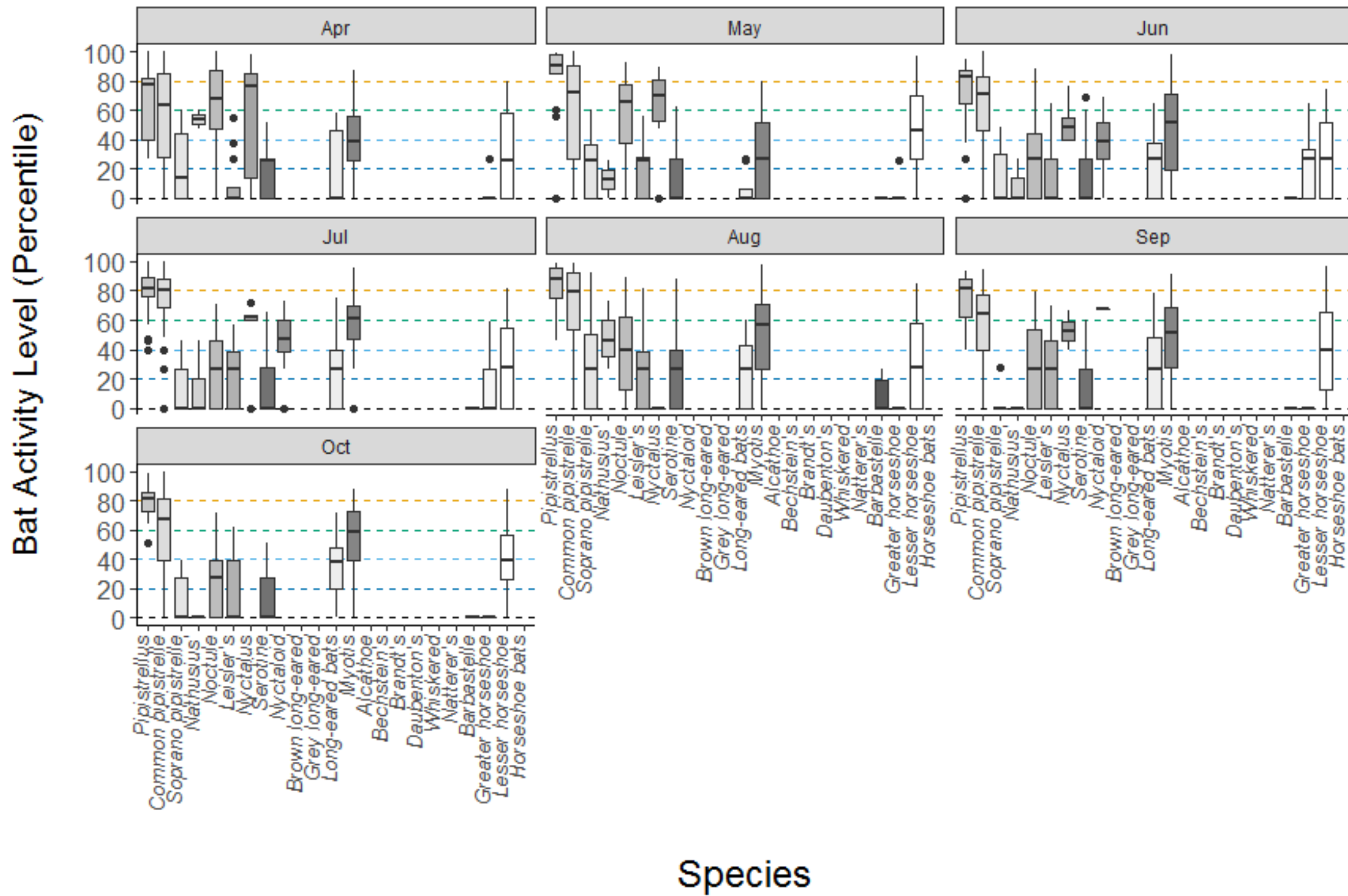
- 3.2.33. Figure 4 illustrates that high levels of bat activity were most frequently recorded for common pipistrelle, with nights of high levels of activity recorded across all static locations with the exception of 3A and 3C. The interquartile range was within the high activity range for the following static sites: 1A, 1B, 1C, 2A, 2B, 4B, 4Cb, 5A, 5B, 5C, 6A, 6B, 7B and 7C. The highest percentile activity for common pipistrelle was recorded at static 2A, which may reflect the proximity of the common pipistrelle maternity roost at Stockwell Farm.
- 3.2.34. Moderate to high levels of *Myotis* species activity were recorded across around a third of the static locations, with the interquartile activity range in the moderate to high activity category for sites 1A, 1B, 1C, 2A, 2B, 3A, 3B, 3C, 4B, 5B, 6A, 6B, 6C and 7A. The majority of the other static locations recorded moderate levels of *Myotis* activity.
- 3.2.35. Of the Annex II species, lesser horseshoe were the most frequently recorded with bats recorded across all of the static locations. Key locations where the interquartile range of activity was within the moderate to high activity range were statics 1A, 1B, 2B, 3C, 4B, 4Ca, 6B, 7A and 7B. Greater horseshoe activity levels were significantly lower than lesser horseshoe, with this species detected at 1A, 1B, 2A, 2B, 2C, 3A, 3B, 4B, 4Ca, 4Cb, 5A, 5C, 6A, 6B, 6C and 7A. The highest levels of greater horseshoe activity were associated with static 4B with the interquartile range within the moderate activity range. Activity was within the low range for all the other sites where this species was recorded, except for 4Ca and 6B, which were just into the moderate activity range. Barbastelle activity was very low across the scheme, but this species was recorded at sites 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, 5A, 5C, 6A, 6B and 6C.
- 3.2.36. Figure 5 below illustrates the results of the percentile activity levels recorded across each night of the bat survey for the entire site. This shows that in combination, high activity levels were recorded for common pipistrelle across the site, with the interquartile range covering the high activity band and the median activity level within the high activity band. The interquartile range for lesser horseshoe ranged between low and moderate activity, with peaks of high activity. Greater horseshoe activity levels were low and barbastelle activity very low. *Myotis* species activity ranged between low, to moderate to high, with peaks of high activity and a median within the moderate range.

Figure 5: Percentile bat activity per species across entire site



3.2.37. A comparison of bat activity across each night of the bat survey for the entire site split between months is illustrated in Figure 6 below. This illustrates that percentile bat activity was fairly consistent throughout the season. Peaks in lesser horseshoe activity were recorded in May. Peaks in barbastelle activity were recorded in August (although activity levels remained low). Peaks in noctule activity were recorded in April and May. *Myotis* species activity was fairly consistent with a slight increase in summer/autumn activity compared to spring activity levels.

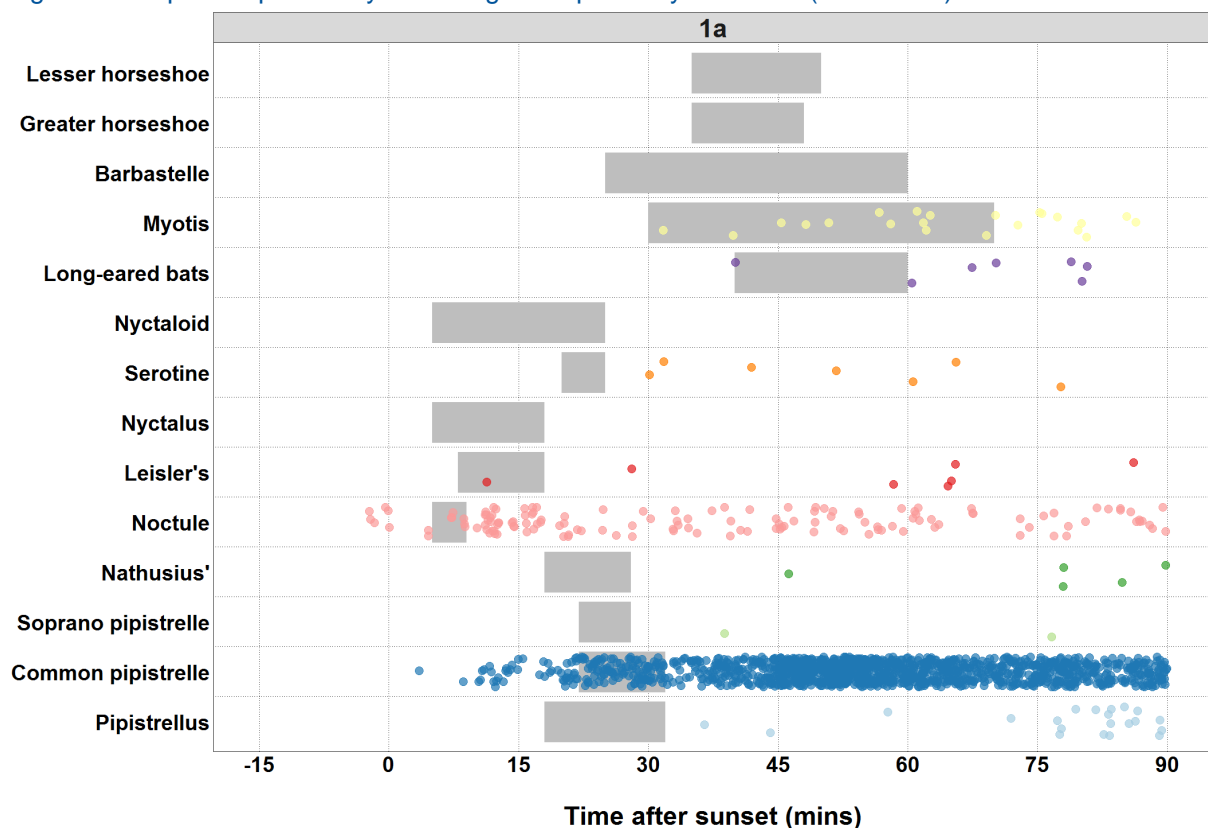
Figure 6: Percentile bat activity per species across entire site



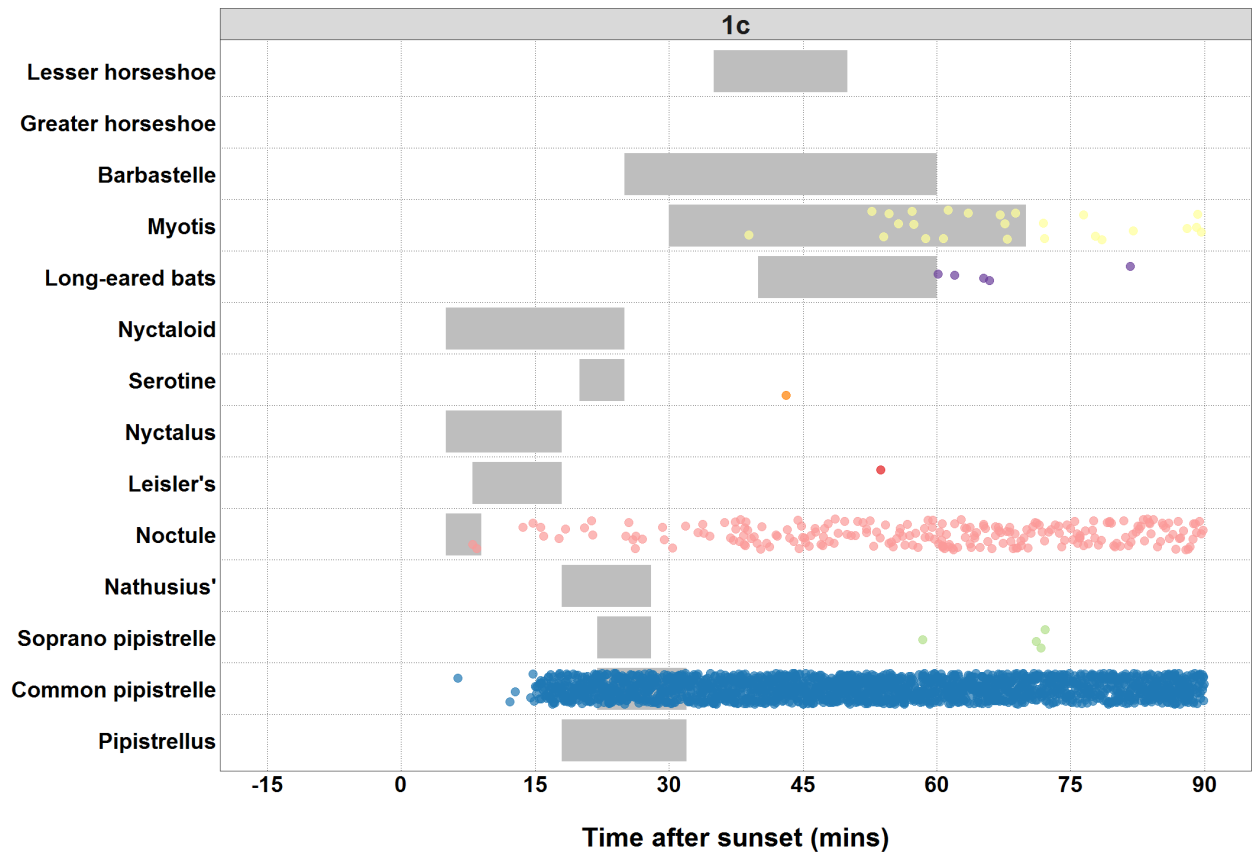
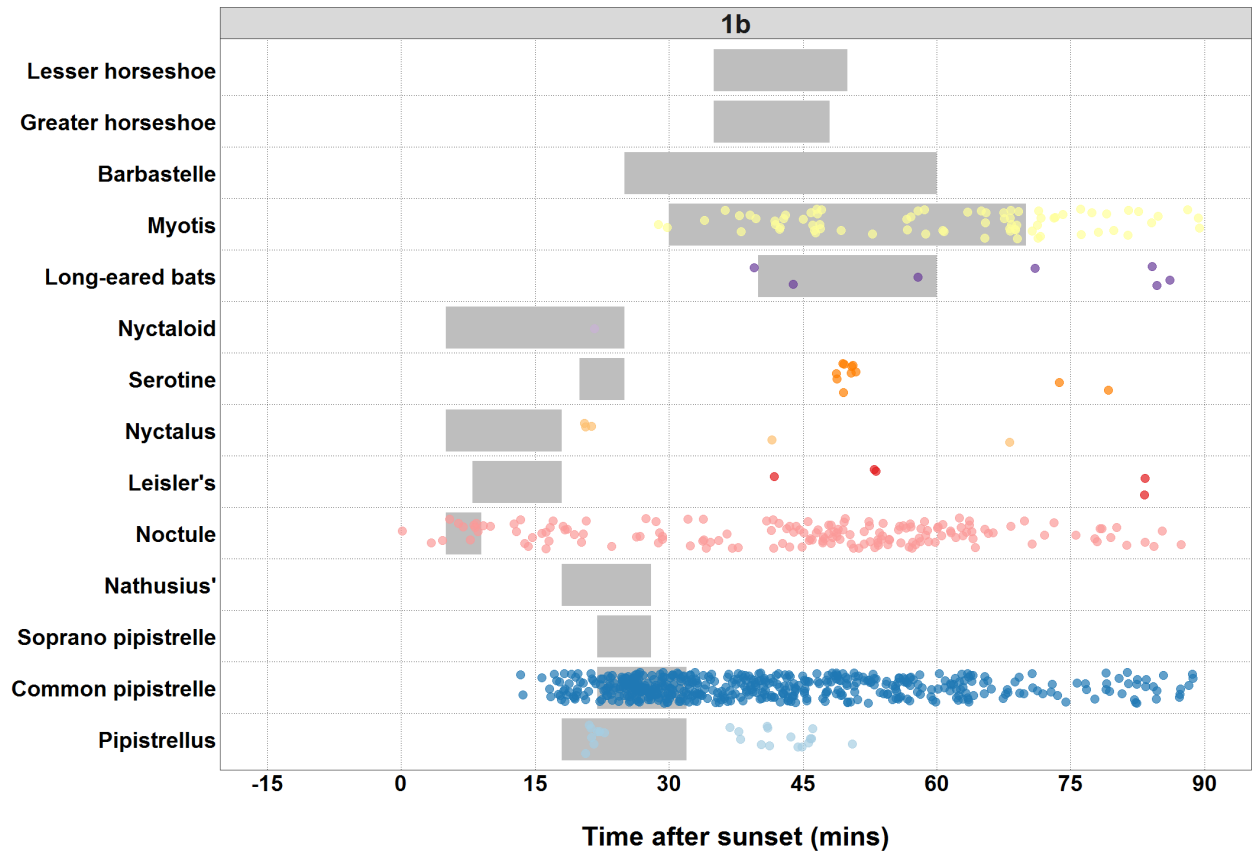
Analysis of static data to identify likely proximity of roosts

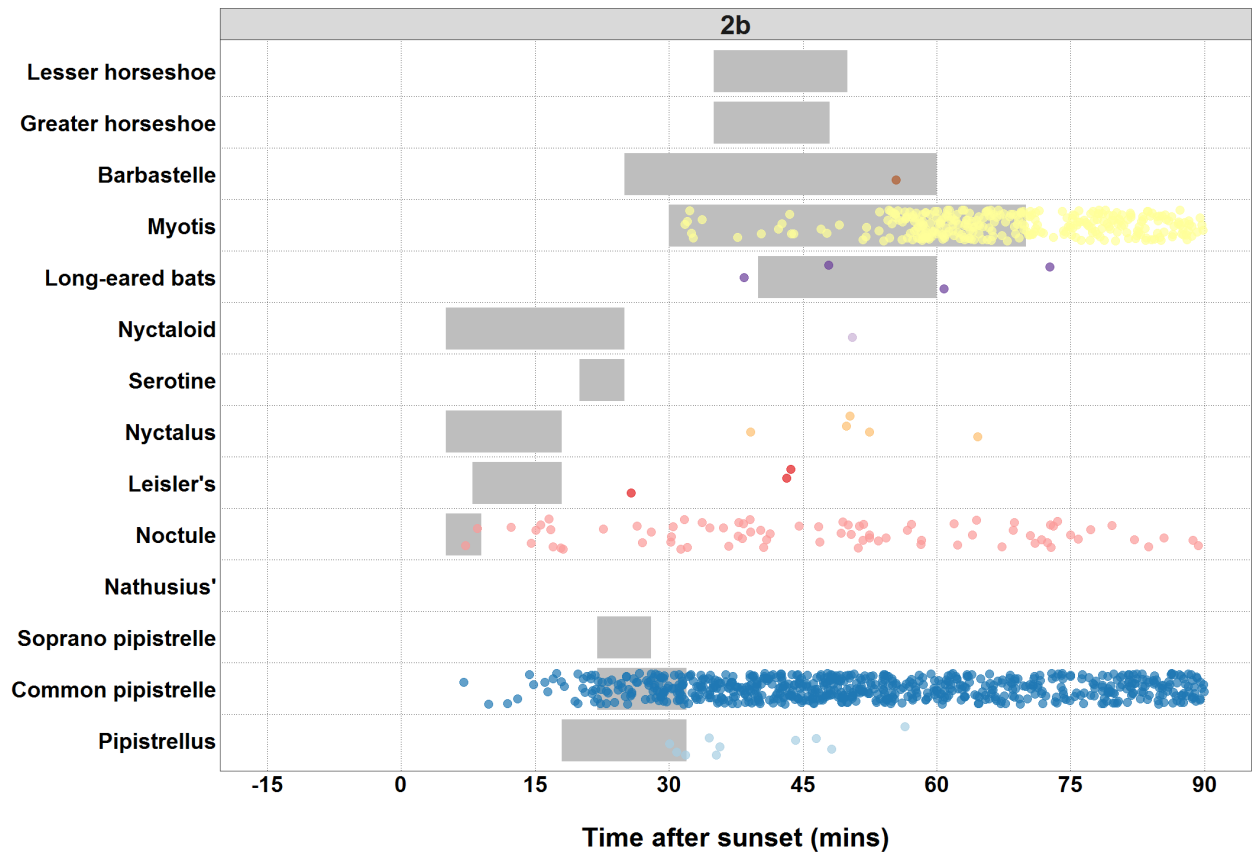
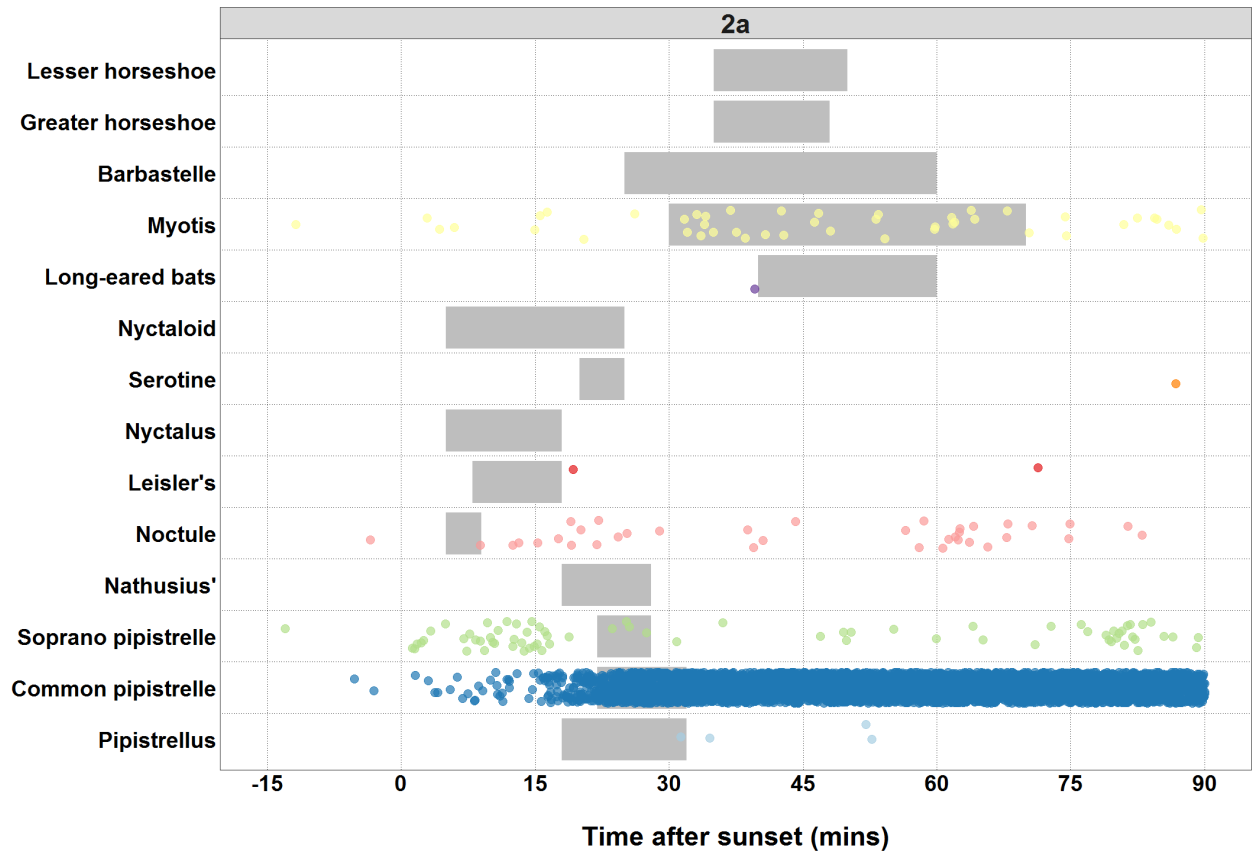
3.2.38. Using the Ecobat tool, an analysis was made of the timings of bat passes compared with typical emergence times (based on Russ 2012⁷) for each bat species. Within the Ecobat tool, a pass was defined as a single registration of up to 15 seconds. Figure 7 below shows for each static location all bat passes between 15 minutes before sunset and 90 minutes after sunset, with emergence times for each species shown as a grey bar. Where there is an overlap in bat passes and emergence times (or where bat passes are recorded earlier than typical emergence times) this may indicate the close proximity of a roost.

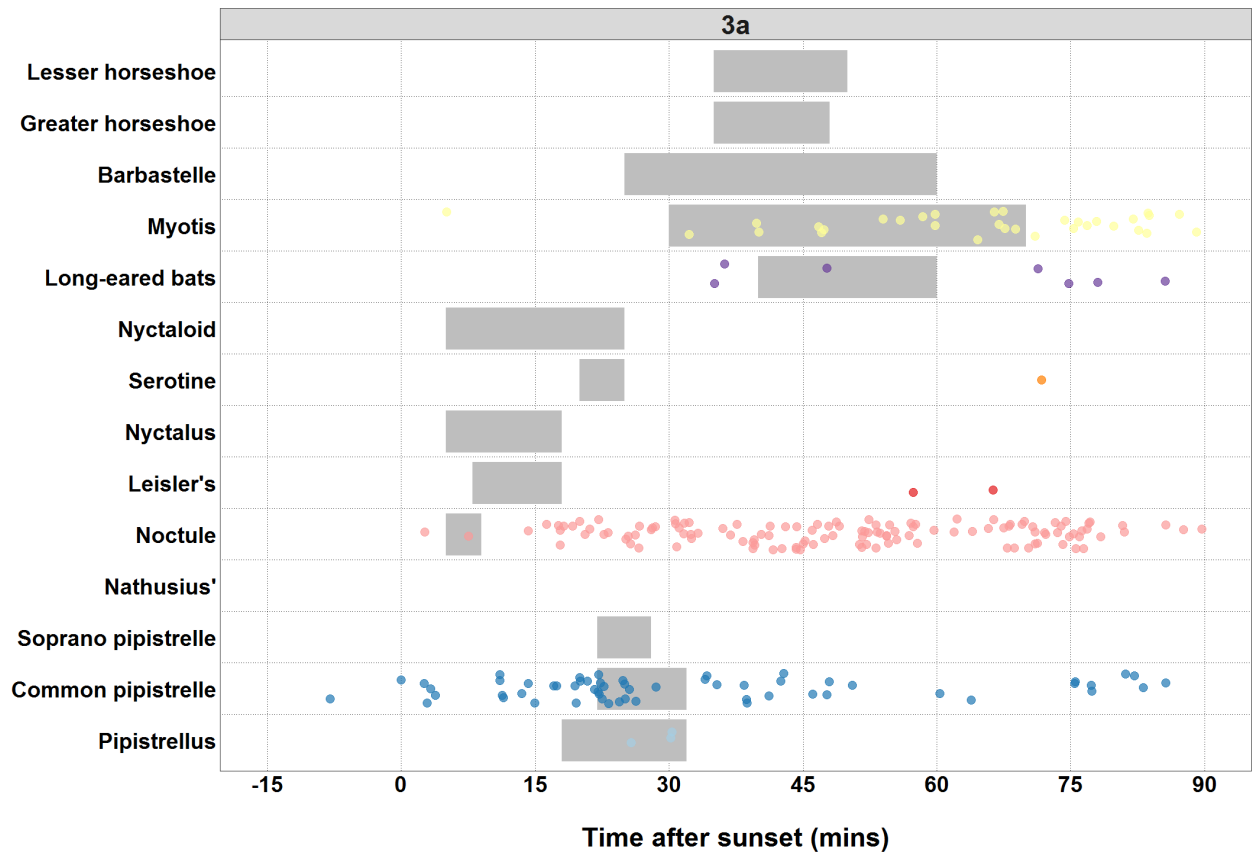
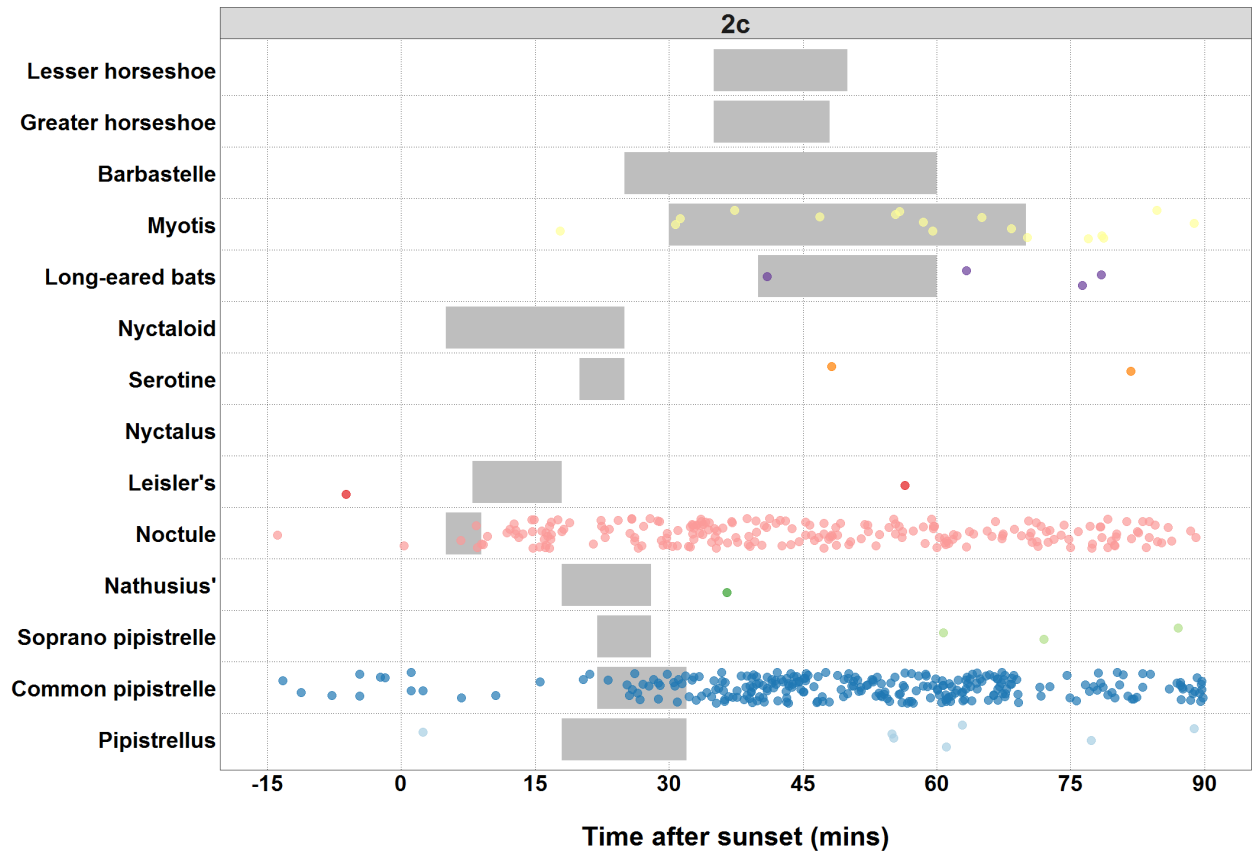
Figure 7: Bat passes potentially indicating close proximity to a roost (Russ 2012)

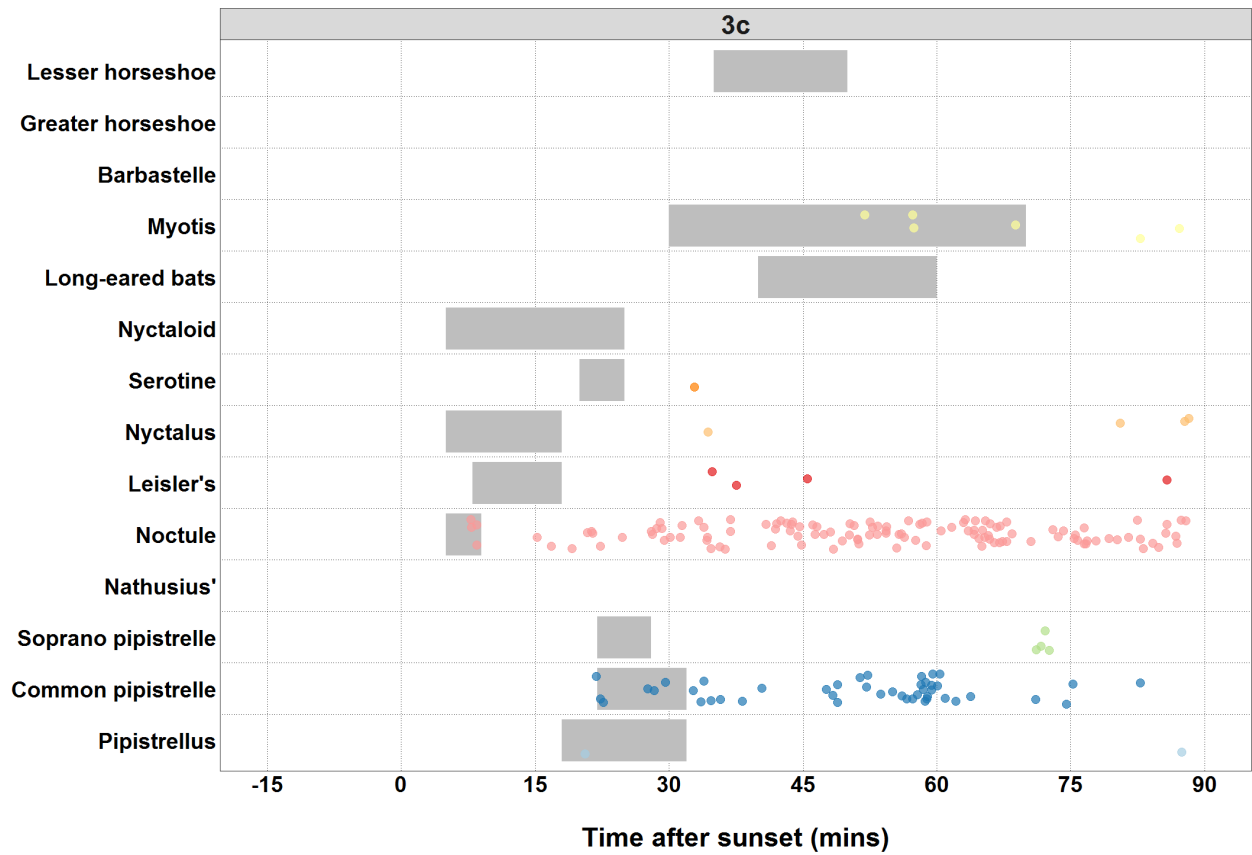
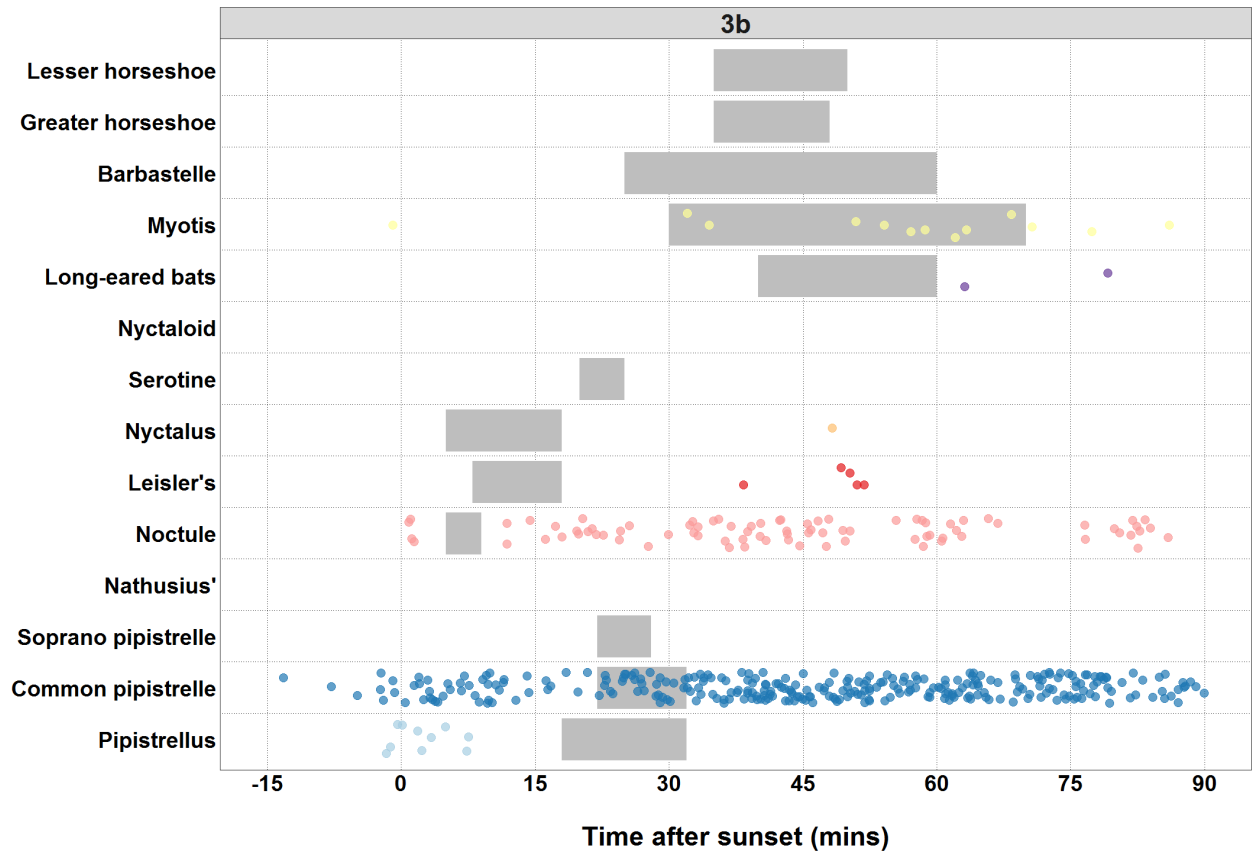


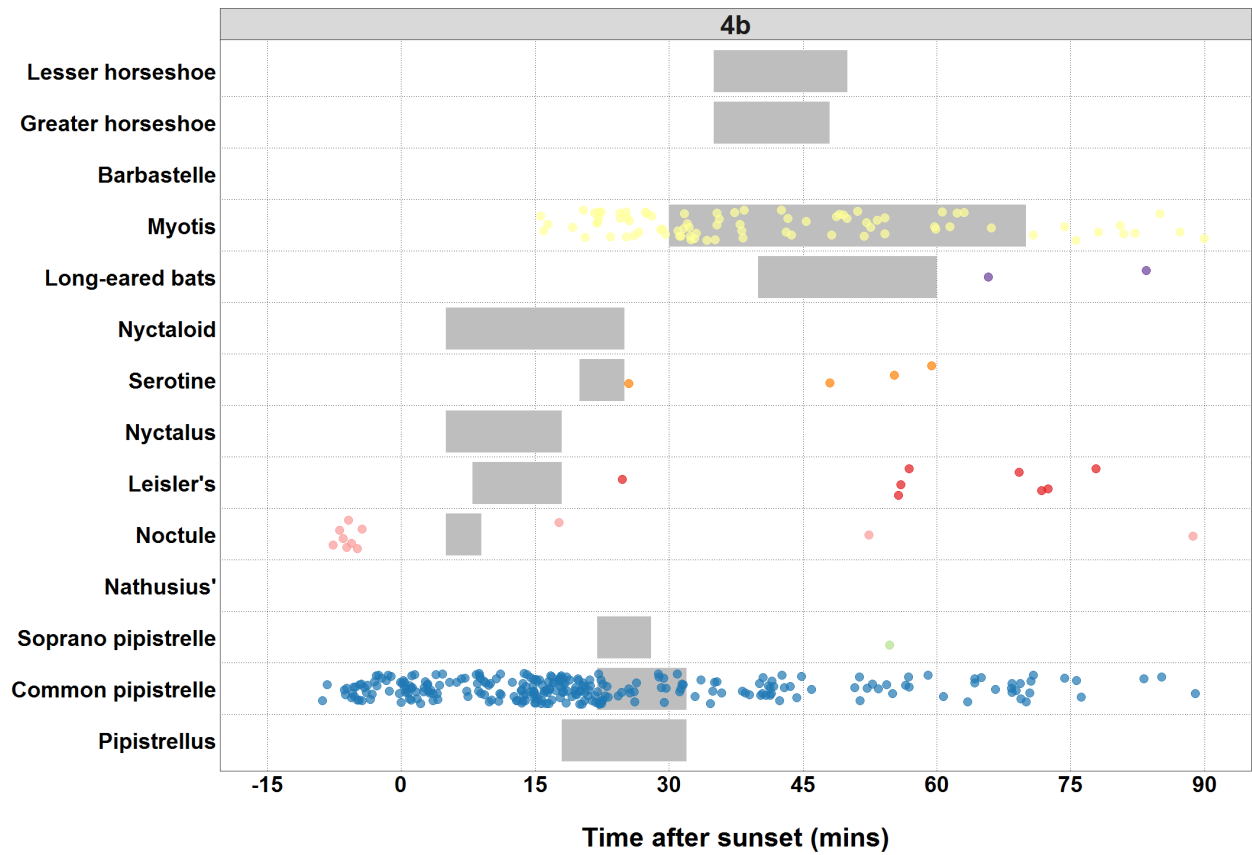
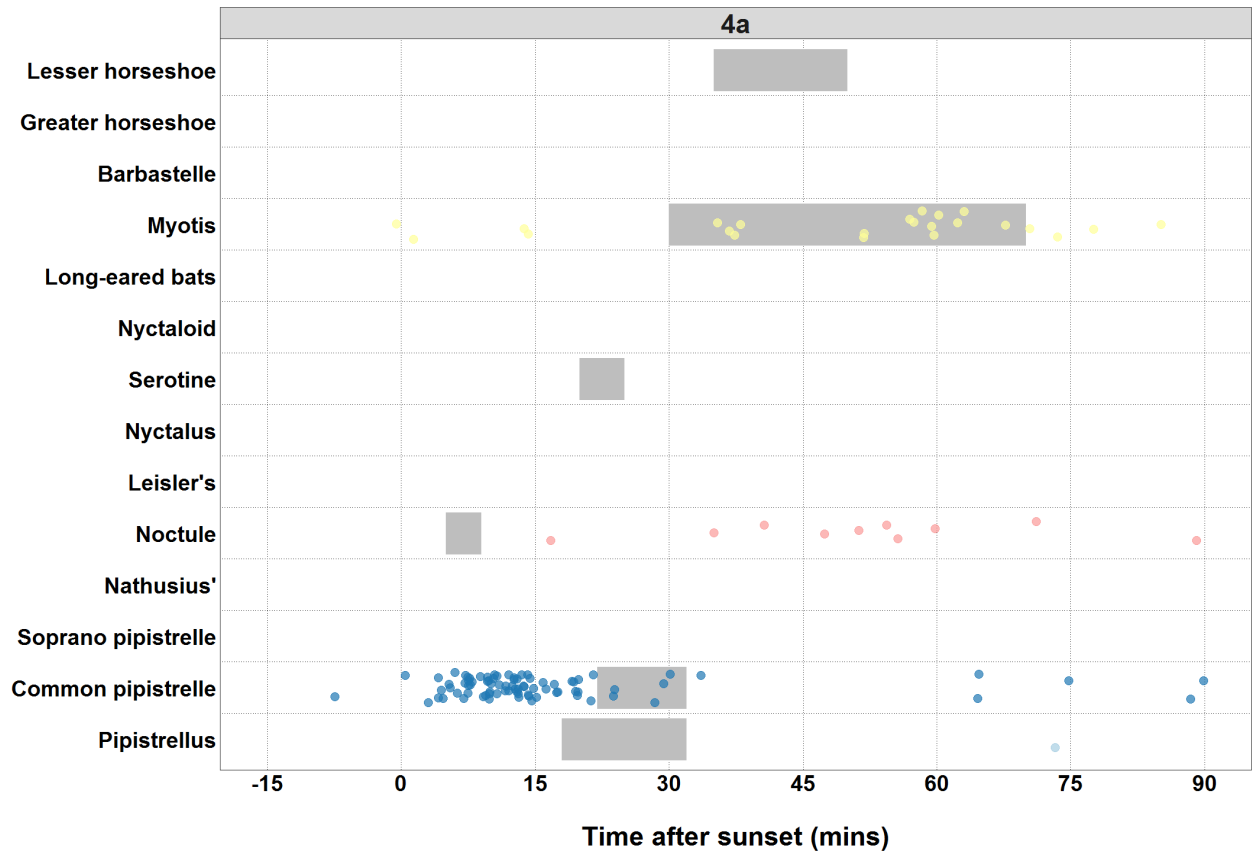
⁷ Russ, J.M. (2012) British Bat Calls: A Guide to Species Identification. Pelagic Publishing, Exeter.

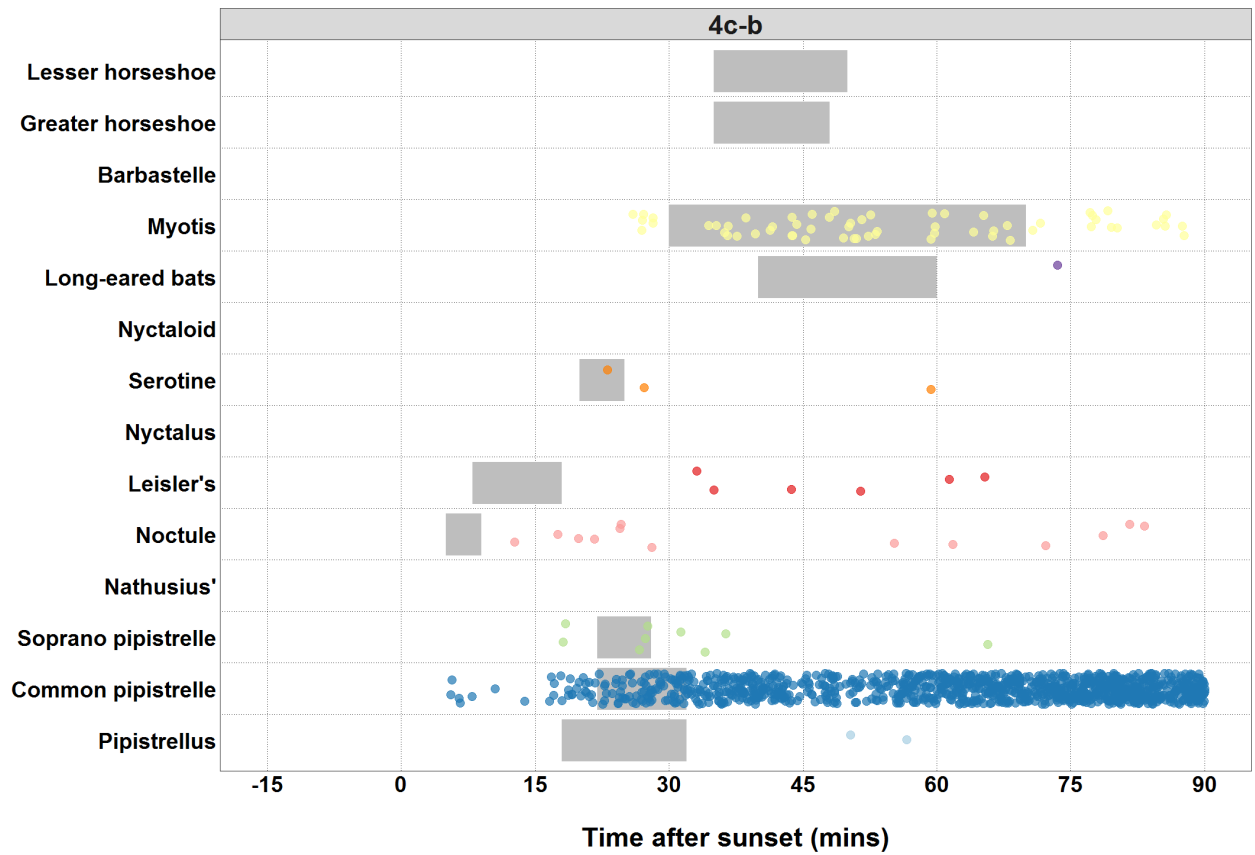
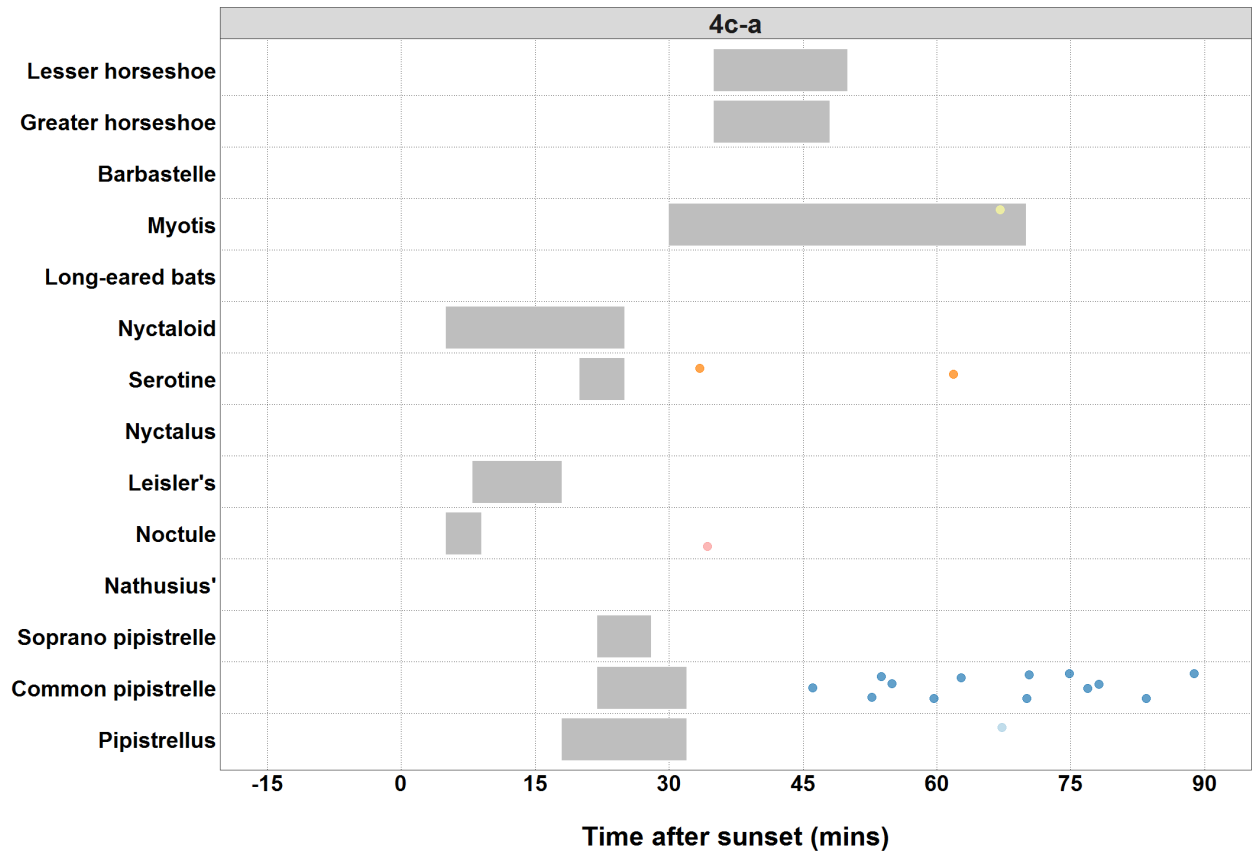


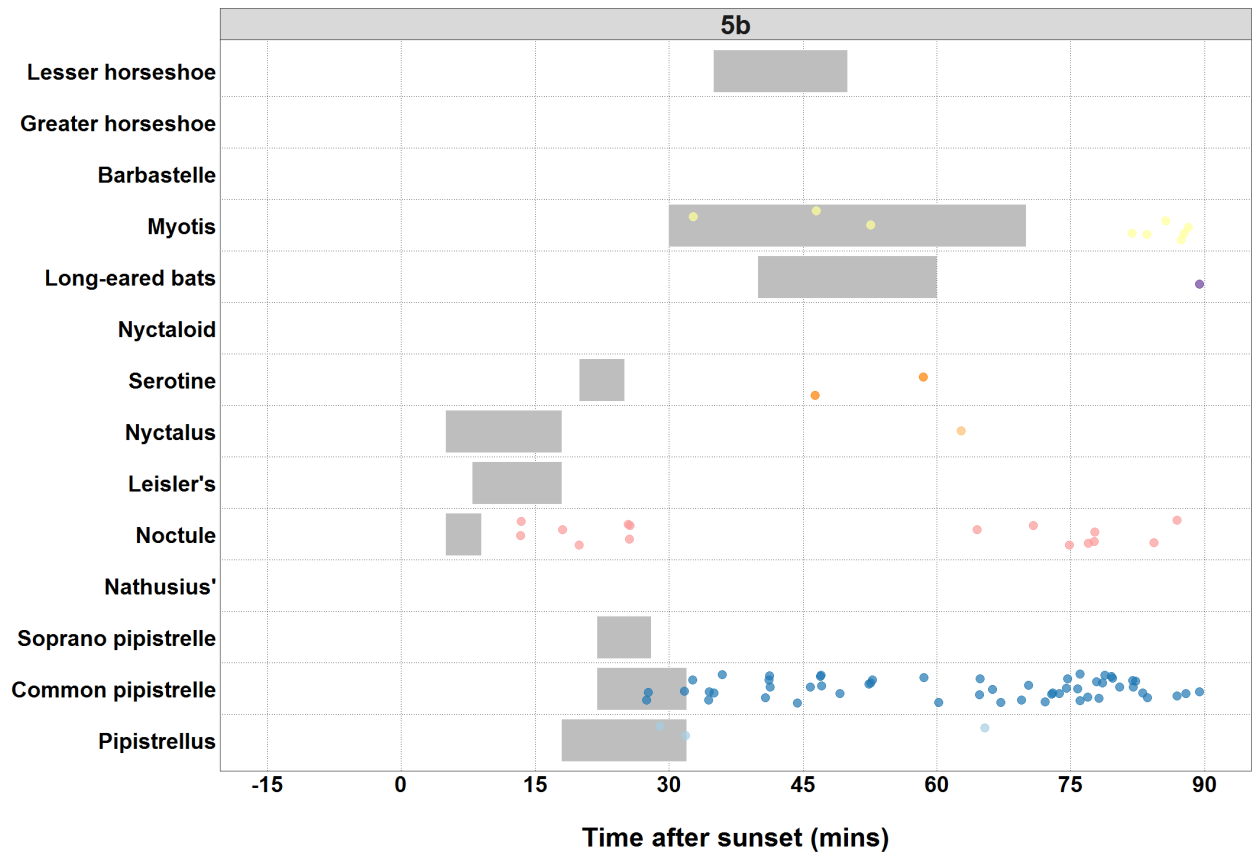
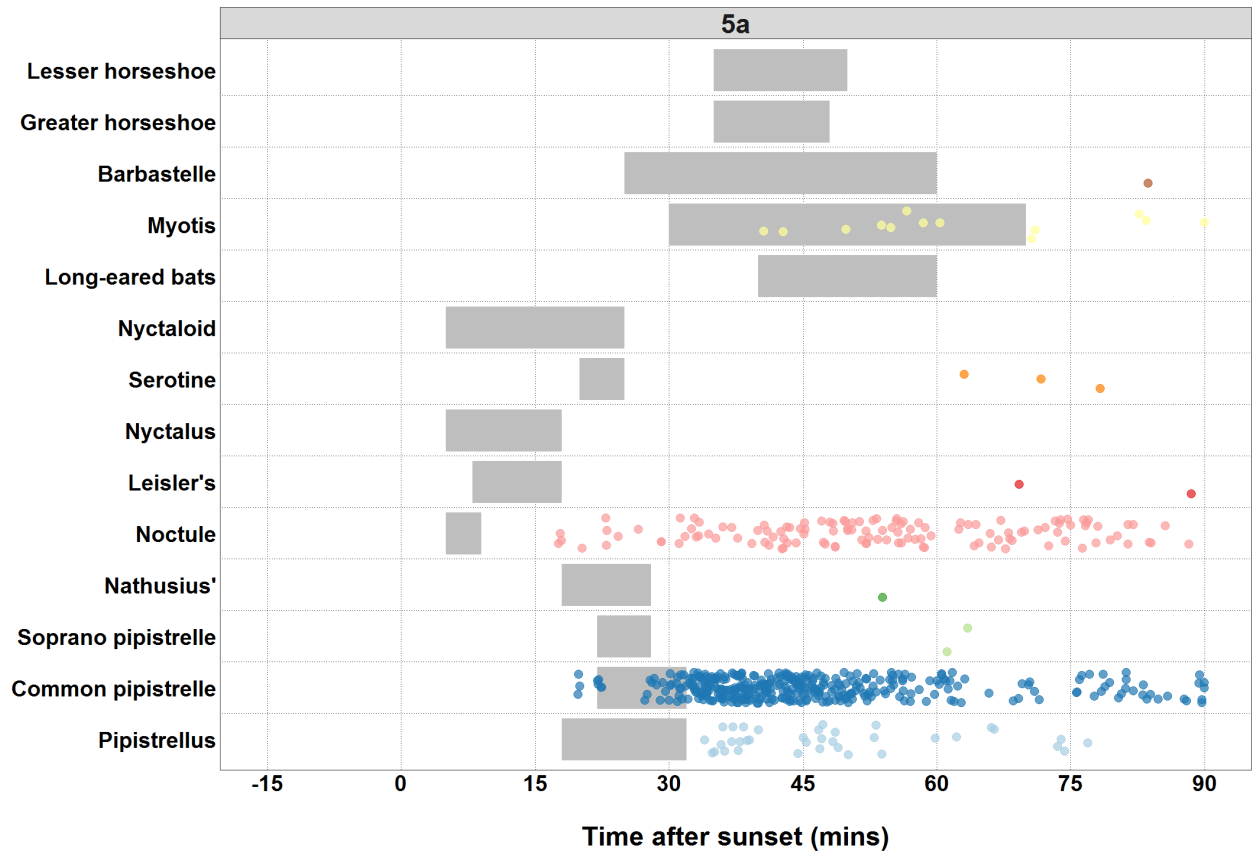


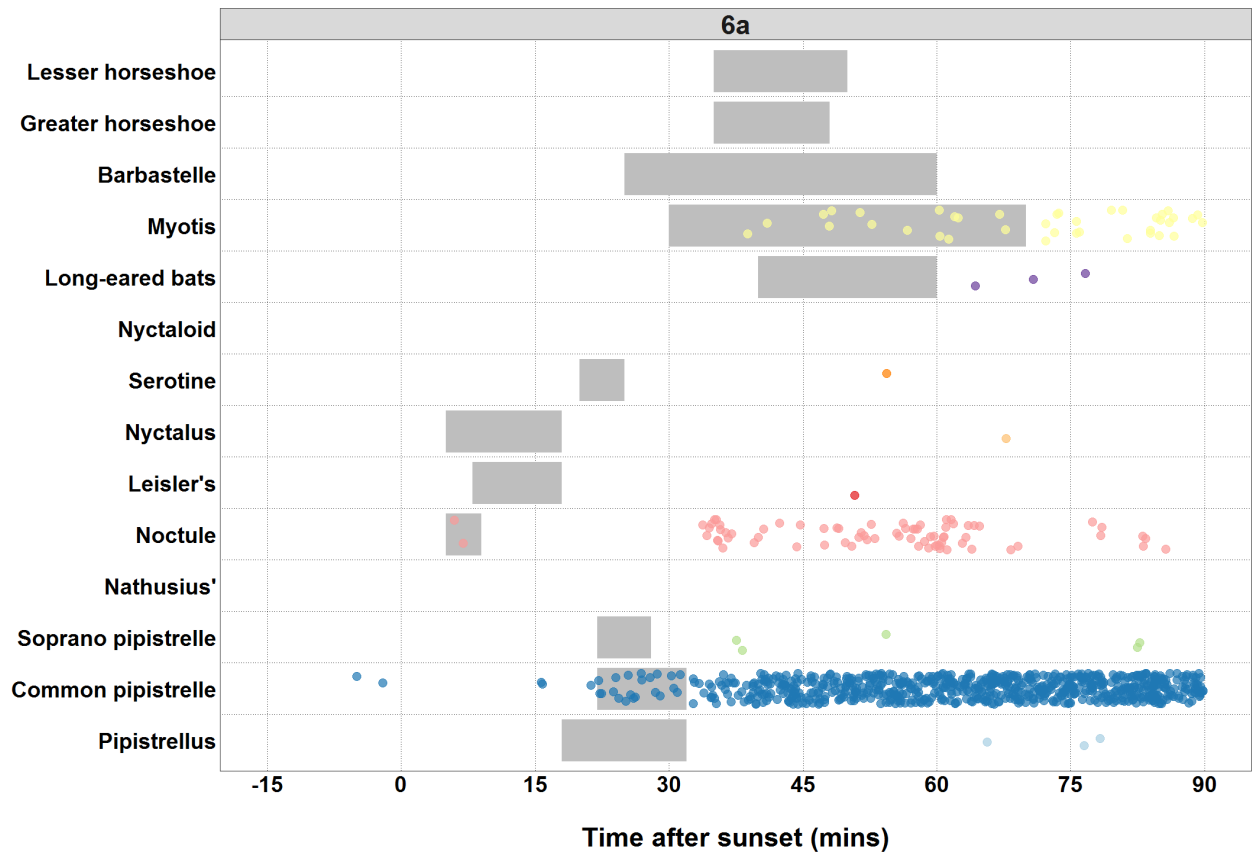
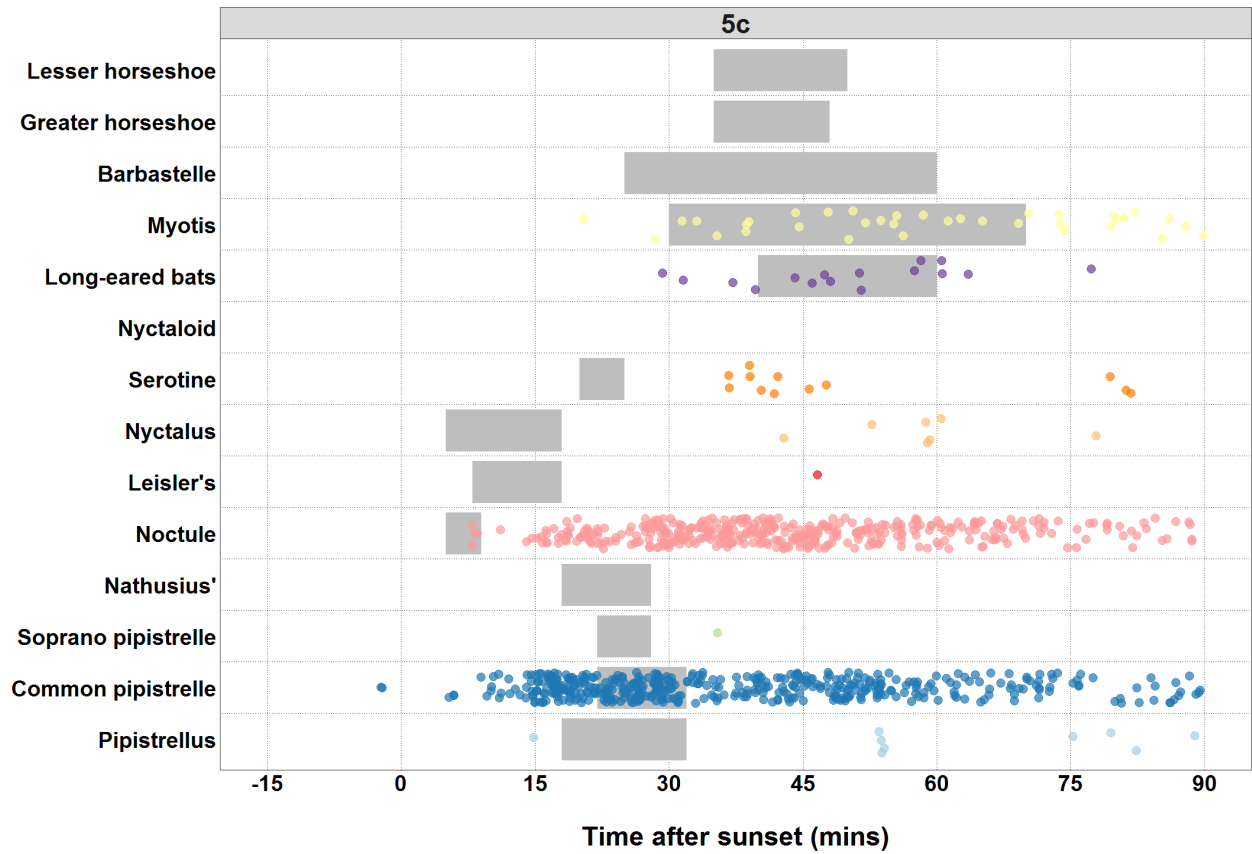


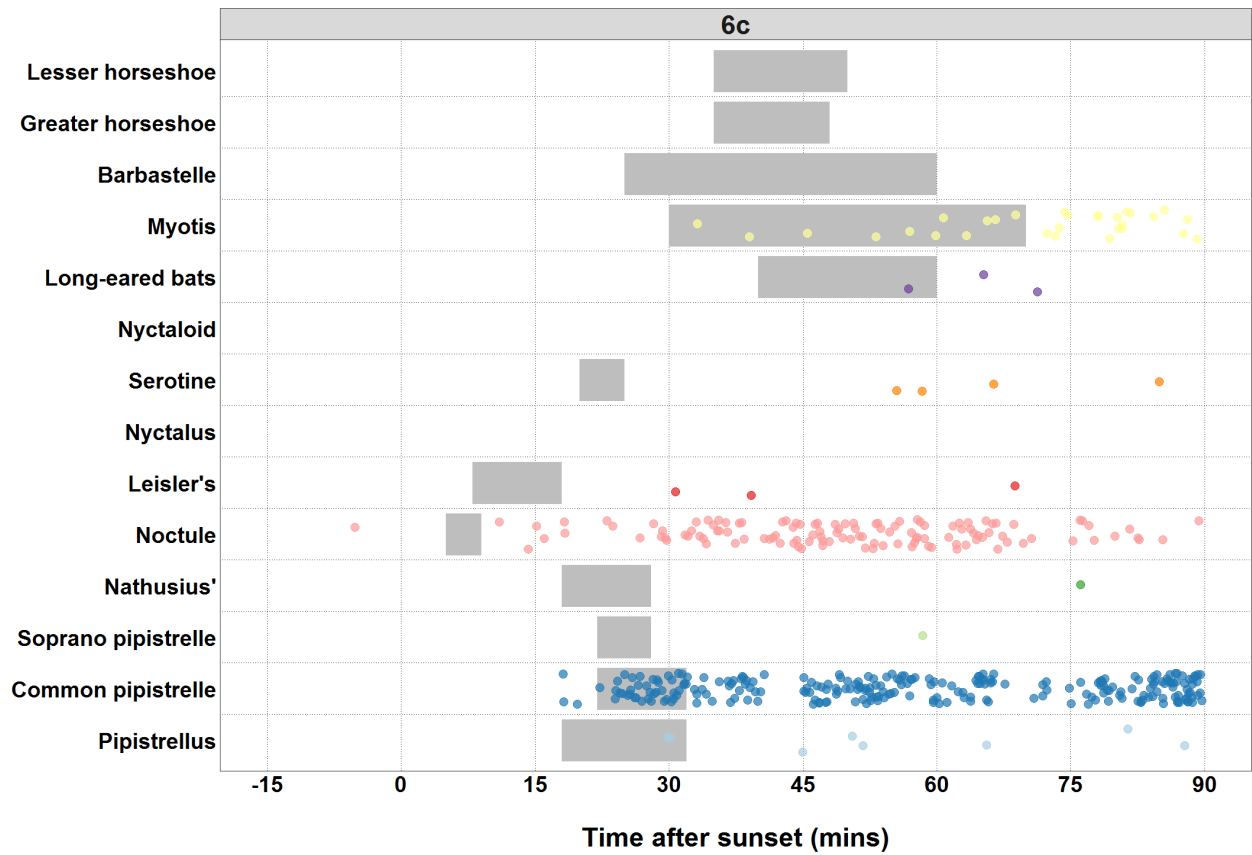
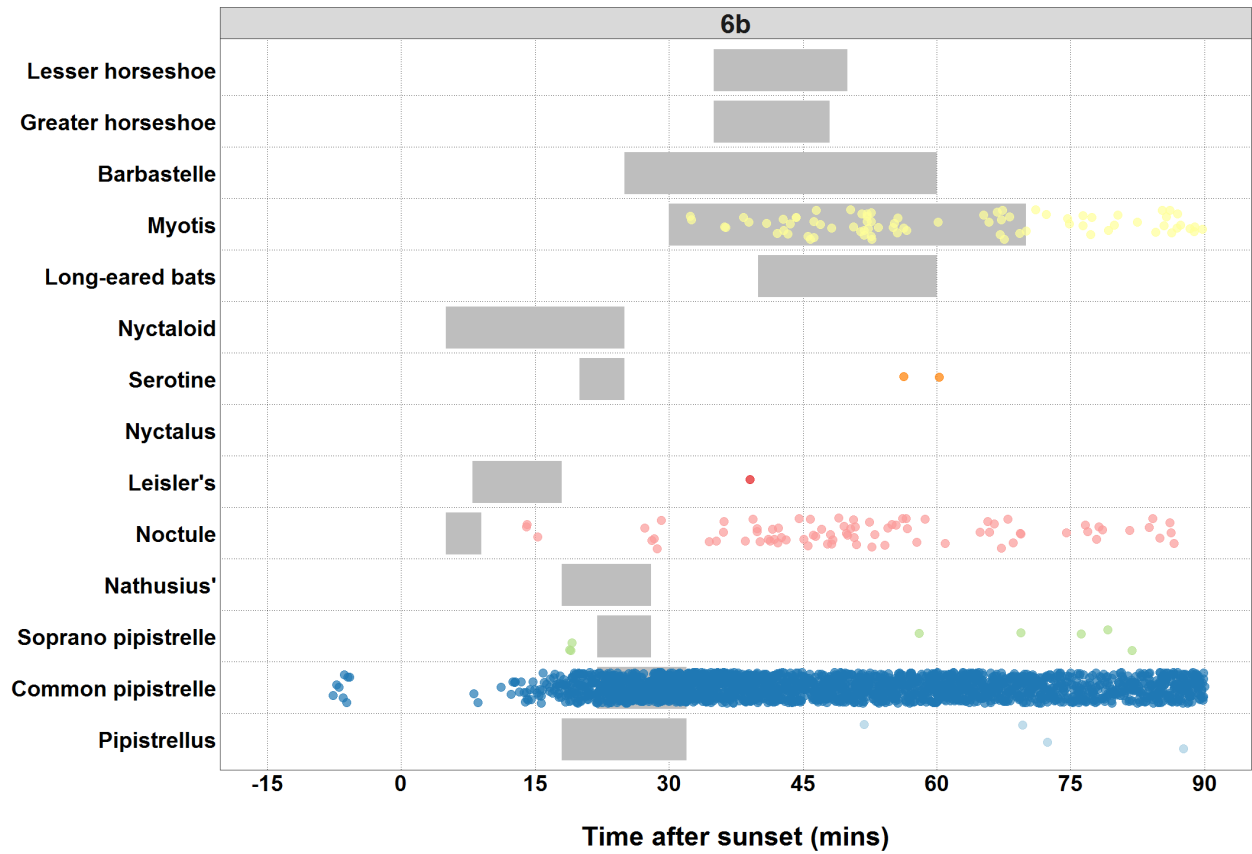


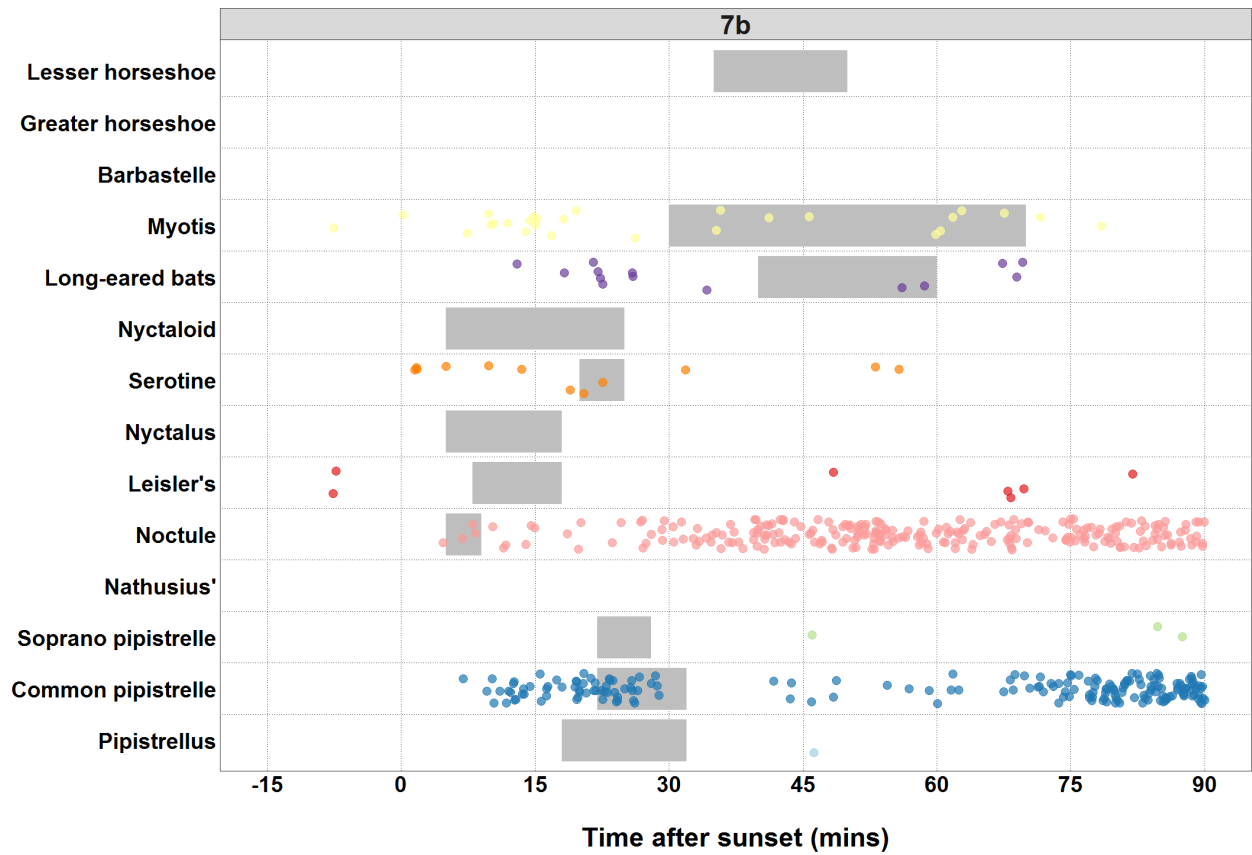
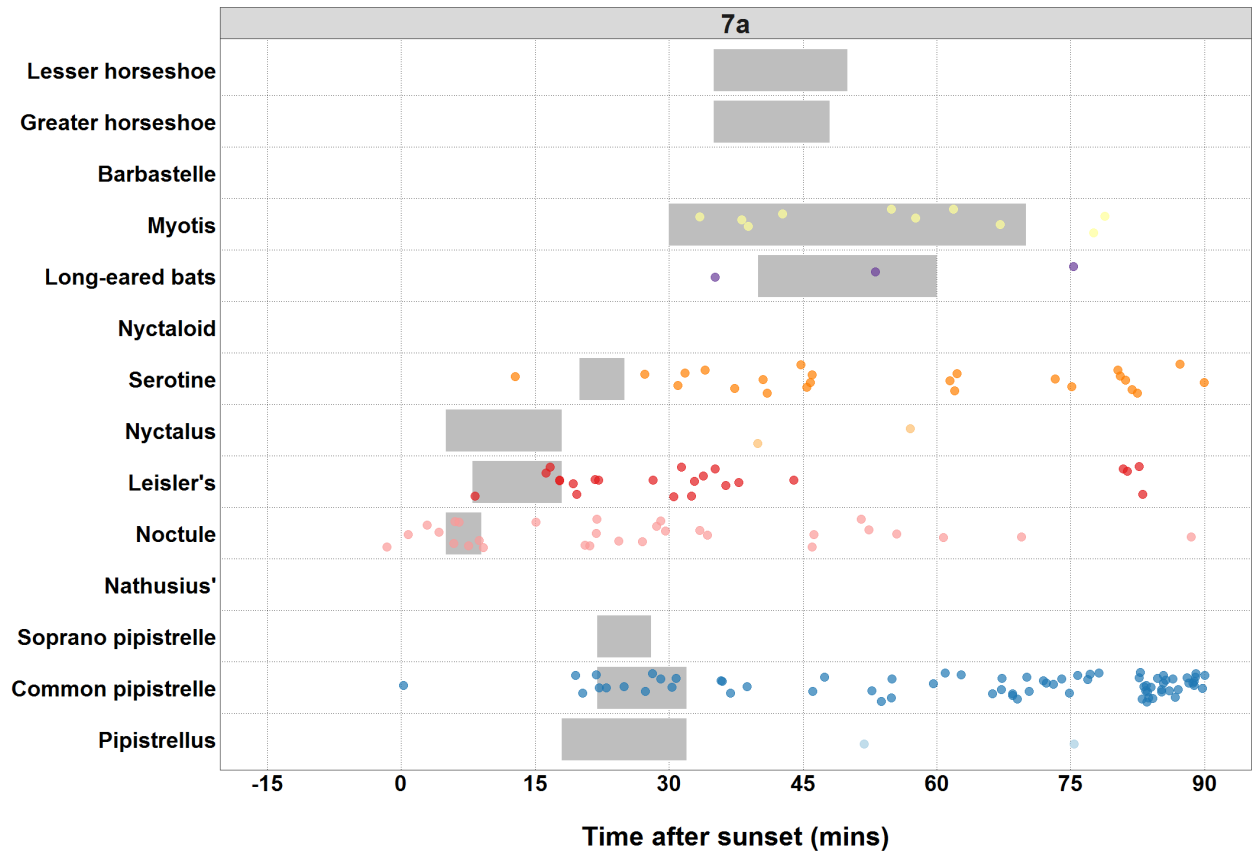


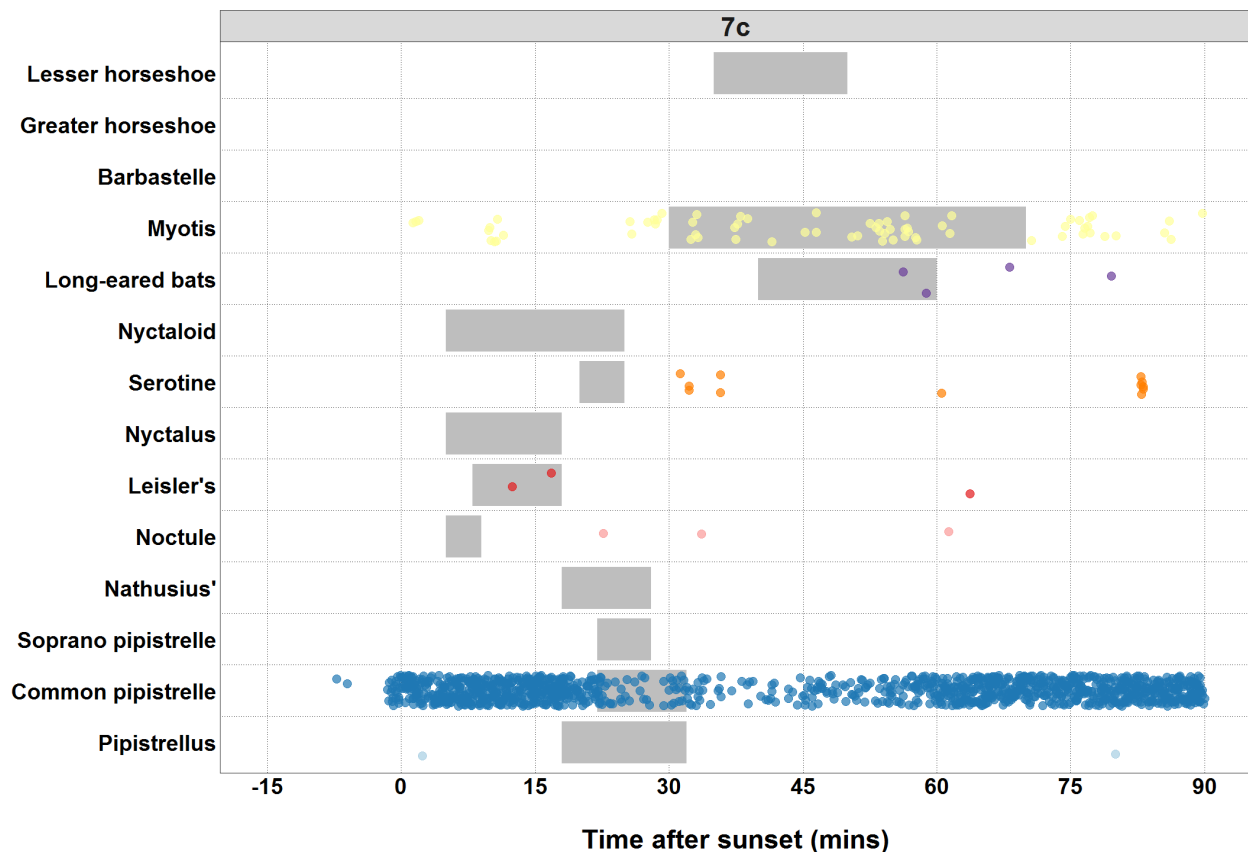












- 3.2.39. High levels of common pipistrelle activity were recorded around emergence time (or before) at statics 1A, 1B, 1C, 2A, 2B, 2C, 3B, 4A, 4B, 4Cb, 5C, 6B, 6C, 7B and 7C, indicating the likely presence of roosts within proximity of these static locations.
- 3.2.40. There was no indication of the presence of lesser horseshoe or greater horseshoe roosts within proximity of the static locations.
- 3.2.41. Soprano pipistrelle activity was recorded before typical emergence times at static 2A, indicating the likely presence of a roost within proximity of this static.
- 3.2.42. Activity indicates the likely presence of a *Myotis* species roost within proximity of the following static locations: 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, 4A, 4B, 4Cb, 5A, 5C, 6A, 6B, 6C, 7A, 7B and 7C.
- 3.2.43. Activity indicates the likely presence of noctule roosts within proximity of the following static locations: 1A, 1, 2C, 3B, 3C, 4B, 5C, 7A and 7B.
- 3.2.44. Long-eared and serotine activity at static site 7B indicate the potential presence of roosts for these species within proximity of this static location.

Count of bat passes

3.2.45. Table 8 provides a summary of the total number of bat passes recorded across all of the detectors throughout the survey season.

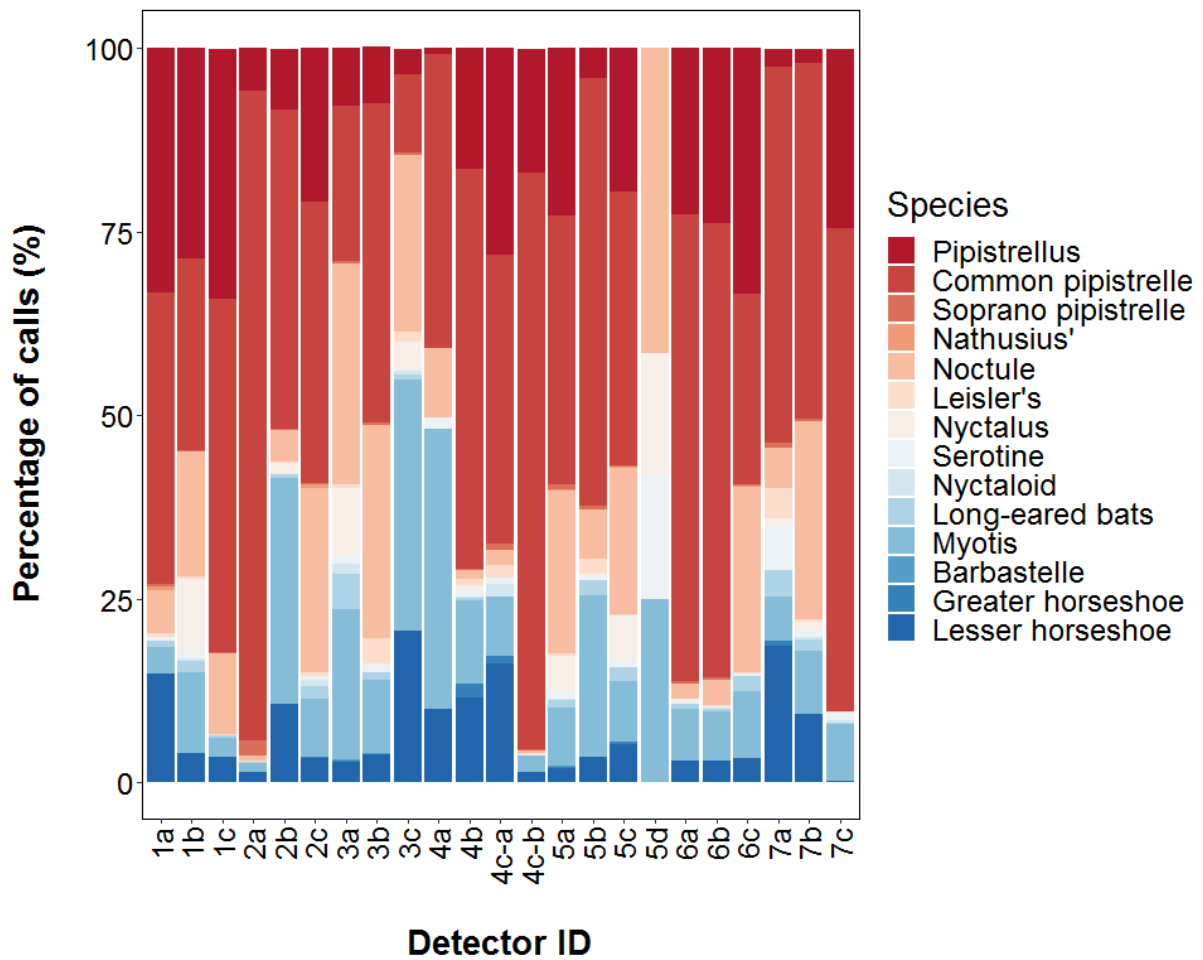
Table 8: Sum of bat activity per species across all static locations

Species	Count	Percentage of total (%)
<i>Pipistrellus</i>	25276	20.1
Common pipistrelle	72467	57.5
Soprano pipistrelle	650	0.5
Nathusius'	68	0.1
Noctule	9151	7.3
Leisler's	377	0.3
<i>Nyctalus</i>	1402	1.1
Serotine	557	0.4
Nyctaloid	209	0.2
Long-eared bats	795	0.6
<i>Myotis</i>	9356	7.4
Barbastelle	25	0.0
Greater horseshoe	103	0.1
Lesser horseshoe	5545	4.4
Total	125981	100.0

3.2.46. Common pipistrelle and pipistrelle species activity accounted for 77.6% of all activity across the sites. Soprano activity was generally very low, with only 0.5% of the total calls from this species. *Myotis* species and Noctule were the next most frequently recorded species, with 7.4% and 7.3% of the overall passes. Significantly, lesser horseshoe was the next most frequently recorded species with 4.4% of the total calls. Greater horseshoe calls were very infrequent, representing 0.1% of all calls and barbastelle accounted for the fewest number of passes with less than 0.1% of all activity.

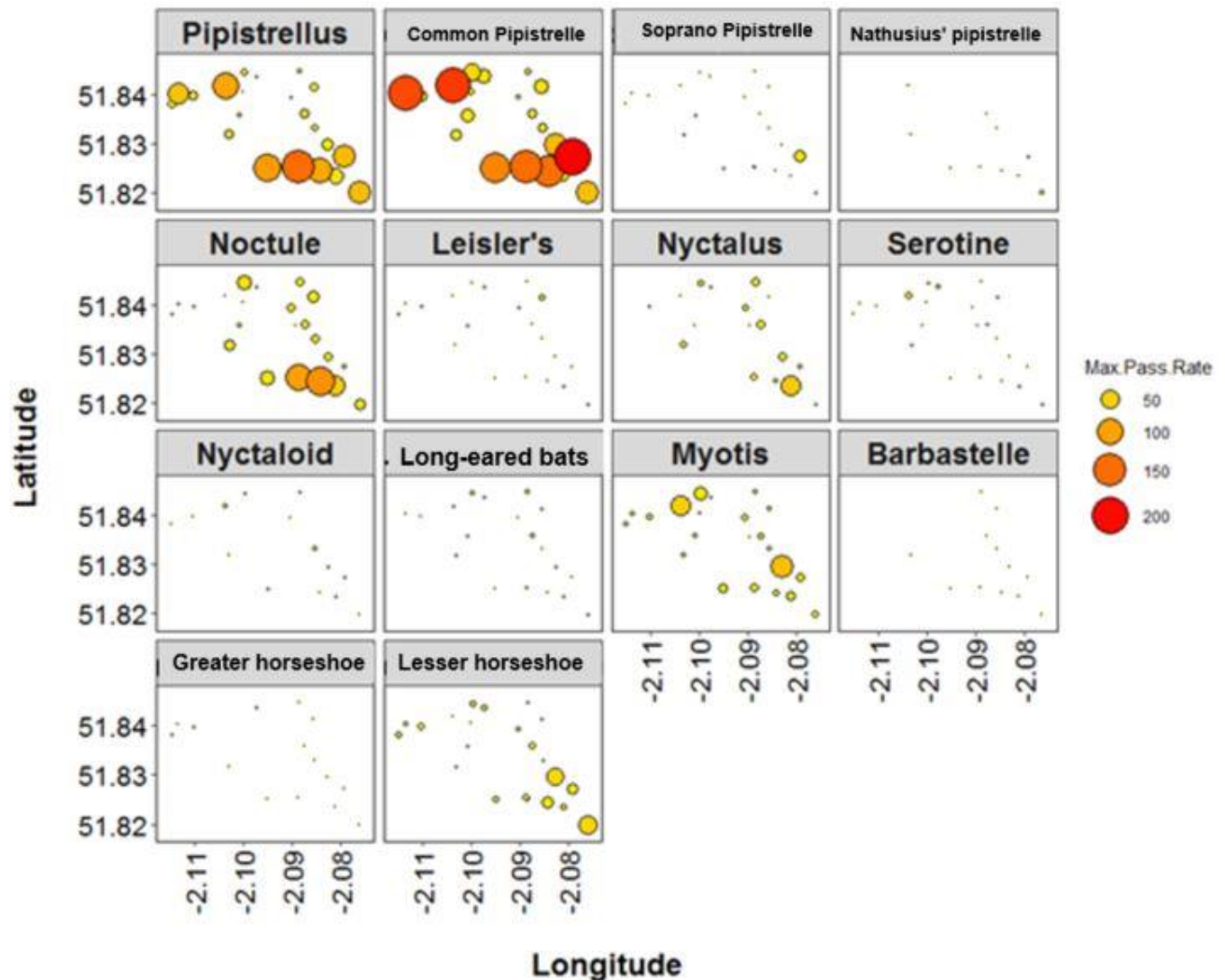
3.2.47. Figure 8 below illustrates the breakdown of percentage species composition across all of the individual static locations based on total number of passes throughout the survey. The species composition was broadly similar across the static locations. However, certain static locations had a smaller percentage of calls attributed to pipistrelle species, notably 3A, 3C and 5D. Statics with the highest percentage of lesser horseshoe calls were 1A, 2B, 3C, 4A, 4B, 4Ca, 7A and 7B.

Figure 8: Species composition of passes at each static location



3.2.48. Figure 9 below illustrates the maximum nightly pass rate (bat passes/hour/night) recorded in a single night throughout the survey period. This illustrates peaks of common pipistrelle activity around 2A, 4Cb and 7C, peaks of noctule activity around 6A and 1C, peaks of *Myotis* activity around 2B and 7C.

Figure 9: Maximum Nightly Pass Rate (bat passes/hr/night) recorded in a single night throughout the survey period



3.2.49. Additional extracts from the Ecobat analysis are provided in Appendix H.

Summary of bat activity per detector

3.2.50. A summary of bat activity at each static location is provided below.

Static 1a

3.2.51. Eleven species were recorded with the main species recorded was common pipistrelle making up 57.09% of calls. Lesser horseshoe were the next most frequently recorded species with 21.03% of the calls. Very low numbers of greater horseshoe (0.09%) and barbastelle (0.03%) were recorded. There were also occasional recordings of Nathusius' s pipistrelle (0.53%). *Myotis* sp. made up 5.13% of the calls.

- 3.2.52. Peak activity was observed during May, when there was a very large count of lesser horseshoe recordings (1314). Lesser horseshoes were recorded each month, with the greater horseshoe being recorded only in May. Barbastelles were only recorded once in August and October.

Static 1b

- 3.2.53. Eleven species were recorded with the main species being that of common pipistrelle making up 37.73% of calls, with noctules second with 24.48%, lesser horseshoe had 5.64%, greater horseshoes 0.04% and barbastelle 0.13%. The large number of noctule calls could be due to the static being in a pasture field providing high quality habitat for this species. *Myotis* also form a significant portion of the calls with 15.77%. There was a single call of a Nathusius's pipistrelle made in June. Nathusius's pipistrelle was recorded in May with 2 recordings.
- 3.2.54. Peak activity occurred in April (1335) but only with 30 more calls than June. Common pipistrelles were dominant across the majority of the recordings. The majority of the noctule calls came in April (1065 out of 1197 call total), potentially indicating a nearby transitional roost for this species.
- 3.2.55. Lesser horseshoe were recorded each of the months (excluding May), with greater horseshoe being recorded in April only. Barbastelle were only recorded from June to August in very low numbers.

Static 1c

- 3.2.56. Ten species were recorded with the main species being that of common pipistrelle making up a high percentage of calls with 69.03%, with noctule second with 15.92%, lesser horseshoe had 4.95% and barbastelle with 0.01% (One single call recorded). Just like static 1b there was a large number of noctule calls in the same month of April, which could have been picking up the same bats if they are flying over the pasture field too which both static 1b and 1c are placed either side of.
- 3.2.57. Peak activity occurred in May, of which common pipistrelles made up the majority of activity with 3485 calls. Common pipistrelles were dominant across the majority of the recordings.
- 3.2.58. Lesser horseshoes were recorded each of the months, with a peak in activity in September with 379 calls.

Static 2a

- 3.2.59. Nine species were recorded with the main species being that of common pipistrelle making up the majority of the calls with 91.50%, with soprano

pipistrelle with 2.13% second and *Pipistrellus* sp. third with 1.65%, lesser horseshoe had 1.33% and greater horseshoe 0.01%.

- 3.2.60. Peak activity occurred in April which was dominated by common pipistrelle. Common pipistrelle were the dominant species across the majority of the of recordings, with large amounts of recordings in April (8302), May (3007), August (4232) and October (2083). This static was placed at the end of a tree line which is close to the maternity common pipistrelle roost at Stockwell Farm, where high activity levels were also picked up in the transect surveys. This is likely to attribute to the high number of bats call registered.
- 3.2.61. Lesser horseshoes were recorded across all periods except August, with a surge in calls in September with 233 passes. The only greater horseshoe recordings were 1 in April and 1 in June. Only 1 barbastelle call was recorded in August.

Static 2b

- 3.2.62. Ten species were recorded with the main species recorded was that of common pipistrelle with nearly half the calls, 47.87%. *Myotis* sp. came second 33.85%, lesser horseshoe was third with 11.71%. Greater horseshoe were rare with 0.09% and barbastelle were also rarely recorded with 0.04% of recordings.
- 3.2.63. The highest activity was seen in August, with 9 species detected. The majority of these were *Myotis* sp. (1,741) and common pipistrelle (1,563).
- 3.2.64. Lesser horseshoes were recorded across all the months, with an increase in calls in September with 528 passes. This is similar to activity levels at 2a with higher activity levels later in the season. A number of these calls could be from the same bat(s), as the 2 statics are effectively at the end of a woodland edge, so they could either be foraging or commuting along this feature. There were 5 greater horseshoe recordings, with none in June, July and October. Only 2 barbastelles calls were recorded, 1 in August and 1 in October.

Static 2c

- 3.2.65. Eleven species were recorded with the main species being that of common pipistrelle with 46% of calls. Noctule were second most frequent with 30.38%, *Myotis* sp. third with 9.64%. Lesser horseshoe had 3.97%, greater horseshoe 0.16% and barbastelle had 0.05%. Nathusius's pipistrelle were recorded 8 times during July.

- 3.2.66. The highest activity was seen in July, which the majority again coming from common pipistrelle. There was a slight increase in noctule recordings in April with 298 calls, which dropped to 140 in June and then below 50 for all other months.
- 3.2.67. Lesser horseshoe were recorded in every month except for May, with reasonable call spread across the rest of the months. Only 1 barbastelle call was recorded in July, 1 in August and 1 in October.

Static 3a

- 3.2.68. Ten species were recorded with a very spread out composition, with 35.15% of calls being noctule, common pipistrelle second with 24.73%, *Myotis* sp. just third with 23.90%. Lesser horseshoe had 3.23%, greater horseshoe 0.25% and barbastelle 0.17%. The large number of noctule calls could be due to the static being in a pasture field providing good quality foraging habitat for this species.
- 3.2.69. Lesser horseshoes were recorded in all months except for April, with a peak in October with 21, with the greater horseshoe only being recorded in April (2 calls) and June (1 calls). Barbastelles were only recorded once each in May and October.

Static 3b

- 3.2.70. Ten species were recorded with the main species recorded being common pipistrelle (46.75%) and noctule (31.13%), with *Myotis* sp. coming third with 10.76%. Lesser horseshoe had 3.99%, greater horseshoes 0.05% and barbastelle 0.05%. As the static was placed in an Ancient Semi Natural Woodland (ASNW) the *Myotis* sp. could potentially be from Bechstein's bat due to the high quality of the habitat.
- 3.2.71. Peak activity occurred in August, with common pipistrelles dominant across the majority of the recordings, with only October where *Myotis* sp. had a higher tally of 62 against common pipistrelle's 49 passes.
- 3.2.72. Lesser horseshoes were recorded in all months, with peaking in September (26) and October (28), with greater horseshoe only being recorded once in May. Barbastelles were also only recorded once in October.

Static 3c

- 3.2.73. Eight species were recorded with the main species recorded being *Myotis* sp., 36.53%, noctule second with 25.74% and lesser horseshoe coming third with 11.44%. There were no greater horseshoe or barbastelle recorded. As the static was placed in an Ancient Semi Natural Woodland (ASNW) the *Myotis* sp. could be potentially from Bechstein's bat due to the

suitability of habitat. The lesser horseshoes recorded on static 3c and likely 3b and 3a may be associated with roosts around Crickley Hill, as there is a lot of activity recorded in the transect surveys as well as high numbers of recordings in the hibernation surveys 2018/2019 from the automated statics placed by the large rock face at Crickley Hill.

- 3.2.74. Peak activity occurred in October which could be due to potential swarming site, especially for *Myotis* sp. and lesser horseshoes as both their numbers peaked in this month.

Static 4a

- 3.2.75. Only five species were recorded, with the main species recorded being common pipistrelle (41.88%) and *Myotis* sp. (36.32%). Lesser horseshoe had 9.4%. Greater horseshoe and barbastelle were not recorded.
- 3.2.76. Generally activity is low across the entire season, with peak activity occurring in June (87 totals calls).
- 3.2.77. Lesser horseshoes were recorded in all months except May, peaking in October with only 11 recordings.

Static 4b

- 3.2.78. Nine species were recorded with the main dominant species recorded being common pipistrelle with 62.91%. Lesser horseshoe represented 13.43% and *Myotis* sp. 13.1%. Static 4b has the single highest count of greater horseshoe calls (38) with nearly all the calls, 35 being recorded in June. There were no barbastelle recorded.
- 3.2.79. The lesser horseshoes were recorded in reasonable numbers across the season, with a general peak in July and August.

Static 4c-a

- 3.2.80. Though only deployed for two months June and July before being moved due to access issues, 8 species were recorded with the main dominant species recorded being common pipistrelle with 51.84%, second highest was lesser horseshoe with 21.29% (with a high count in July of 126 recordings) and then *Myotis* sp. 10.43%. Greater horseshoe had 1.32% of calls.

Static 4c-b

- 3.2.81. Nine species were recorded across the 5 months deployment with common pipistrelle dominating nearly all the calls species recorded with 94.32%. Greater horseshoe was recorded only in July (2 calls) and October (1 call).

There were no barbastelles recorded. Activity from the other species was generally low with common pipistrelle recordings mainly coming in July and October. There are two common pipistrelle day roosts within the Flyup Ltd structures on Crickley Hill Farm which could contribute to the calls.

- 3.2.82. There was a reasonable number of lesser horseshoes recorded, peaking in September and October. If you combine both 4c-a and 4c-b together then it shows there is generally a high level of activity in the area surrounding Crickley Hill Farm.

Static 5a

- 3.2.83. Eleven species were recorded with the main dominant species being that of common pipistrelle with 45.55%, noctule was second with 27.56%. The remaining species had a low percentage composition. This static was placed very near to an underpass. It is not possible to determine which species were recorded flying under the A417 from this static data, but is likely that noctule, Leisler's and serotine recorded would be flying high above the moving traffic if crossing. The rest of the other species recorded could well be utilising this feature, as well as foraging in the scrub/tree line. Nathusius's pipistrelle were recorded in July (2 times) and October (once).
- 3.2.84. Activity peaked in July with 311 common pipistrelles recorded as well as highest count of lesser horseshoes with 14.

Static 5b

- 3.2.85. Eight species were recorded with the main species being common pipistrelle (59.89%) and *Myotis* sp. Second most frequent (22.67%). Lesser horseshoe had 3.45%. Greater horseshoe and barbastelle were not recorded. There was not a large amount of calls recorded, which is probably due to the static being located near to the A417 and the disturbance associated with the moving traffic. Activity peaked in July, with 528 common pipistrelles recorded.

Static 5c

- 3.2.86. Eleven species were recorded with the main dominant species being common pipistrelle with 49.46%, second was noctule with 26.35% and third was *Myotis* sp. with 11.01%. Lesser horseshoes had 6.93%, with a peak activity in October with 118 calls. Common pipistrelle also peak with their calls in October (365) which could indicate a possible swarming area/mating site nearby. Barbastelle were only recorded once in October.

- 3.2.87. The high number of noctule calls along with the lesser horseshoe calls could be associated with the semi-improved pasture fields which offer suitable prey items.

Static 5d

- 3.2.88. This was an incidental deployment to monitor lesser horseshoe activity after the emergence of the ammo bunker at Shab Hill noted a number of lesser horseshoes calls being detected around the surveyors. The October deployment recorded 1395 lesser horseshoe passes (over a 16 night deployment). There were none recorded in April but during the May deployment there were 672 lesser horseshoe passes. This indicates that the Shab Hill woodland is frequently used by lesser horseshoe.

Static 6a

- 3.2.89. Ten species were recorded with the main dominant species being common pipistrelle with 81.20% of passes. *Myotis* sp. were second most frequent with 8.9% and lesser horseshoe third with 3.57%. Greater horseshoes were recorded once a month in May, June and September. Barbastelle were only recorded in August (3 passes) and September (2 passes).
- 3.2.90. Peak activity occurred in July with 3677 recordings, of which common pipistrelle made 3618 of the recordings.

Static 6b

- 3.2.91. Eleven species were recorded with activity dominated by common pipistrelle with 76.98%, *Myotis* sp. second with 8.32% and Pipistrelle sp. 5.16%. Greater horseshoes were recorded in April, July and August, with a peak count of 5 passes in July. Lesser horseshoes were recorded across all months. Only one recording of a barbastelle was made in May. Nathusius's was recorded 3 times in June.
- 3.2.92. Activity peaked in May with 3151 calls (2932 being common pipistrelle) the next being the month before in April (1611). Lesser horseshoe activity was fairly consistent throughout the season, peaking in October with 153 passes.

Static 6c

- 3.2.93. Eleven species were recorded with the highest proportion of calls from common pipistrelle with 30.85%, noctule had the second highest proportion with 30.27% and Pipistrelle sp. 17.07%. A single recording of a greater horseshoe was made in July. Lesser horseshoes were recorded across all months except May. Only 1 recording of a barbastelle was made in July.

- 3.2.94. Activity peaked in April with 1060 calls (mainly being that of noctule, 958) the next being June (813). Lesser horseshoe activity was fairly consistent, peaking in August with 75 passes.
- 3.2.95. The high level of noctule calls might be related due to static being located next to two pasture fields providing good quality foraging habitat for this species.

Static 7a

- 3.2.96. Nine species were recorded with the highest proportion of recordings from common pipistrelle with 52.45% and lesser horseshoes second with 18.91% and *Myotis* sp. just coming third with 6.22% of passes. Greater horseshoe were only recorded July with 7 passes recorded. No barbastelle were recorded.
- 3.2.97. Activity peaked in June with 503 calls (435 being common pipistrelle) the next being July (292), when lesser horseshoe passes recorded the highest count of 123.
- 3.2.98. Due to the quality of the woodland supporting mature deciduous trees in The Scrubbs woodland at Crickley Hill, the *Myotis* sp. recorded at 7a, b and c statics have potential to be Bechstein's Bat.

Static 7b

- 3.2.99. Eight species were recorded with the most frequent species being common pipistrelle with 50% of passes. Noctule were second most frequent with 27.92% and lesser horseshoes third with 9.63%. No greater horseshoe or barbastelles were recorded.
- 3.2.100. Activity peaked in July with 1024 calls which common pipistrelles contribute the majority. Lesser horseshoes activity was primarily at the beginning of the season, tailing off after July, with 2 calls in August none in September and 13 in October.

Static 7c

- 3.2.101. Nine species were recorded with common pipistrelle making up the majority of passes with 85.99% and second was *Myotis* sp. with 10.26%. Lesser horseshoes had just 0.16% of the calls. No greater horseshoe or barbastelle were recorded.
- 3.2.102. Activity periods peaked June (5186) and July (4134), with the vast majority being common pipistrelle. *Myotis* calls followed the same path in terms of levels of activity, with their calls peaking at June (477) and July (633).

4. Potential Impacts

- 4.1.1. The impact assessment will be covered within the ecology and biodiversity chapter of the Environmental Statement for the project. At the time of writing, the scheme is still being designed and firm conclusions on impacts will be detailed in the aforementioned document.

5. Mitigation and enhancement recommendations

- 5.1.1. Full details of ecological mitigation and enhancement measures will be included within the ecology and nature conservation chapter of the Environmental Statement for the project.

6. Conclusion

- 6.1.1. Bat activity surveys have confirmed the presence of at least 11 species of bat within and around the footprint of the scheme. The majority of bats recorded both during transects and static surveys were common pipistrelle, with high activity levels recorded across the majority of the site for this species. Key areas of activity identified during the transect surveys included along the convergence of a number of linear features along the track to the northeast of Birdlip Radio station, with next highest levels of activity south of Crickley Hill along the lane to Cold Slad.
- 6.1.2. Transect and static surveys confirmed the presence of Annex II bat species including lesser horseshoe, greater horseshoe and barbastelle, as well as potential for Bechstein's due to the recording of *Myotis* species and availability of suitable habitat for this species. Lesser horseshoe were the most frequently recorded across the scheme, with moderate to high levels of activity recorded at a number of static locations including 1A, 1B, 2B, 3C, 4B, 4Ca, 6B, 7A and 7B. Activity for the other Annex II species was generally low, however, percentile activity levels for greater horseshoe were in the moderate band for sites 4B, 4Ca and 6B.
- 6.1.3. This report should be read in conjunction with the A417 Missing Link Bat Roost report and A417 Missing link Radiotracking and Crossing Point reports to provide a full assessment of bat activity within the zone of influence of the A417 Missing Link scheme.

Appendix A - NERC Act 2006 Schedule 41 bat species

Table 9: Bat species listed under NERC Act 2006 Schedule 41 and their specific species actions

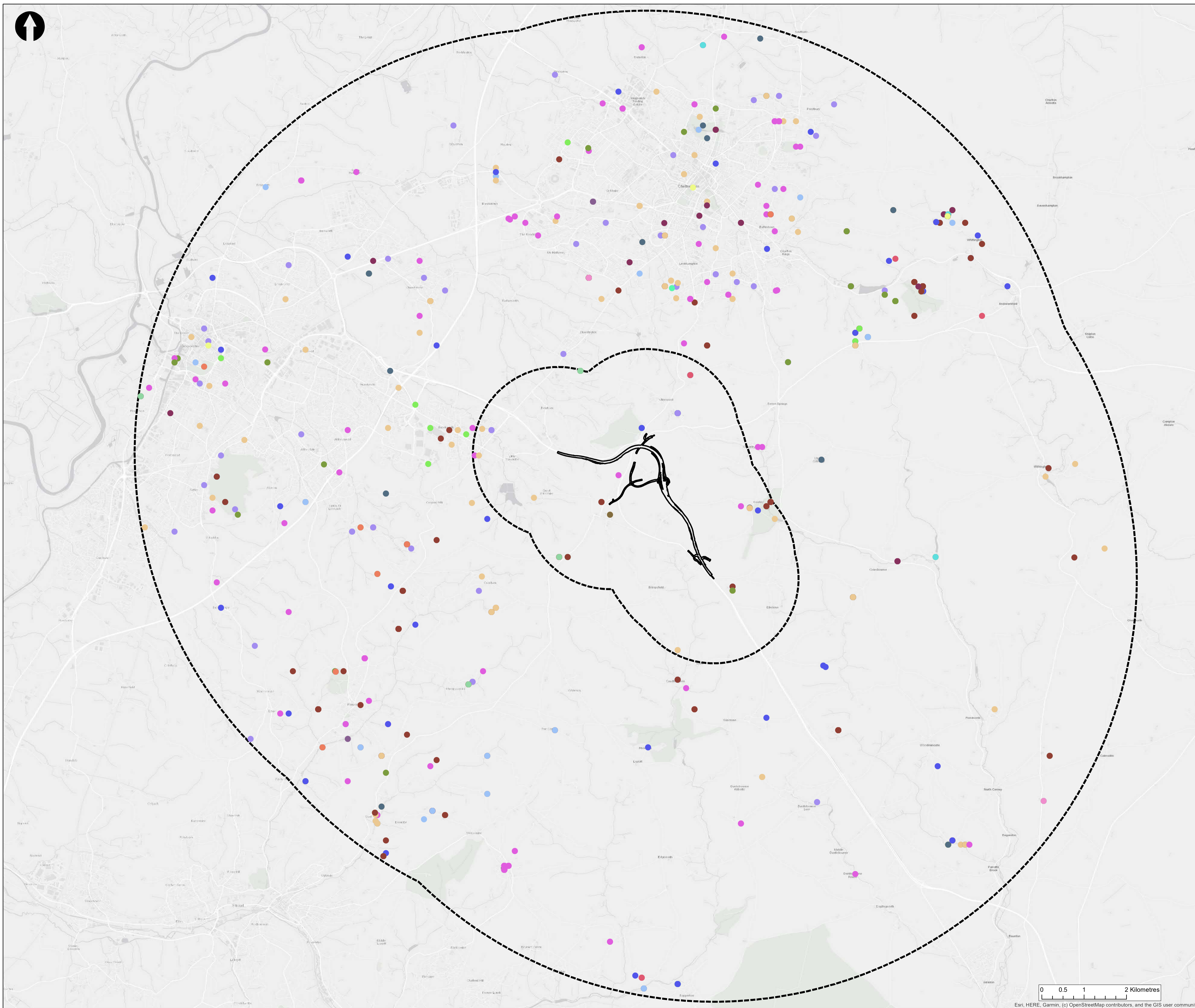
Species	Priority Group	Action Priority	Action
Barbastelle	1 – global concern	High	Ensure species is considered in agri-environment, assisting at a farm scale to ensure hedgerow, small linear wood and field margin creation, persisting in the landscape and maintaining landscape level connectivity and insect biodiversity. Improvements to small farm woodlands and wet meadows, blocking land drains may also encourage retention of trees used for roosting.
			Continuation and expansion of research into more detailed habitat requirements by this species, including the impact of regional differences and management needs.
			Continued monitoring through the National Bat Monitoring Programme (NBMP) to monitor population trends of this species.
			Protect the condition of priority wetland and woodland habitats, to contribute towards provision of sufficient good quality trees for roosting and insect rich foraging grounds. Ensure the protection and preservation of mature woodland and improve the conditions of young woodland specifically for this species.
			Help buffer core woodland areas with the encouragement of woodland expansion, increasing flight-line connectivity between woodland areas and other foraging habitats at a landscape level.
Bechstein's bat	1 – global concern	High	Ensure sufficient roosting and foraging habitats are available through woodland habitat management meeting the requirements of this species, such as encouragement of continuous cover canopy and a well-developed understorey.
			Ensure the protection and monitoring of maternity colonies, hibernation sites and swarming sites, and designation of appropriate woodland and underground sites identified through survey.
			Continuation and expansion of research into more detailed habitat requirements by this species, including the impact of regional differences and management needs.
			Expand woodlands around their core areas, reconnecting fragmented woodlands with treeline and hedgerow planting, to allow recolonisation of previously populated areas and aid seasonal dispersal for mating and hibernating.
		Medium	Provide advice to woodland managers and arboriculturalists regarding the retention of roost trees, and management of areas suitable for foraging. Discouragement of felling and where necessary mitigating through staged felling.
			Wider woodland policy such as requirement for bat surveys and mitigation agreement prior to the granting of felling licences in certain woodland types, identified as having the potential to support Bechstein's bat, has been identified as potentially assisting this species.
			Ensure the improvement and retention of the condition of woodlands. This is also likely to benefit other bat species which roost in trees and woodlands.
Brown long-eared bat	3 – national concern	High	Continued monitoring through NBMP to monitor population trends of this species. In addition to this the recording of roost used by species should be promoted by local bat groups, local record centres and consultants through appropriate information sharing, and by species conservation plans.
			The best roosts (identified as those supporting the largest colonies) should be considered for designation as Sites of Special Scientific Interest (SSSIs).

			<p>Critical resources should be protected at landscape level, including all types of roost and important foraging grounds and commuting routes. For this the provision of appropriate landscape features are required, including habitats not classified as UK priority habitats but are important foraging resources and for connectivity.</p> <p>Improvement of mitigation in barns and lofts targeting brown long eared bat, by developing designs specifically for this species previously found to be successful (e.g. incorporation of adequate roof space/use of the correct roofing material to provide an environment with the desired thermal characteristics).</p>
		Medium	<p>Ensure this species is considered in agri-environment schemes and woodland policy, with improvements in farmland, woodland edges, hedgerow, small farm woodlands and mixed woodland. In addition to retaining and protecting older trees for roosts as part of land-use policies></p> <p>Consider the impacts of light pollution on this species.</p> <p>Consideration of the effectiveness of different conservation management on brown long-eared bat, with detailed understanding of priority habitats. Better guidance should be produced for land managers particularly on habitat structures and features.</p> <p>Improve planning policy in relation to bat roosts in buildings, particularly for this species, reducing levels of exclusion and roost destruction through tighter planning control and legal enforcement. In addition to ensuring building regulations to consider bats which roost in buildings.</p> <p>Reducing habitats fragmentation and increasing habitat connectivity between foraging grounds and roosts, particularly between woodlands, tree lines and high hedgerows.</p>
Greater horseshoe bat	2 – European concern	High	<p>Continue with monitoring through the NBMP activity count and hibernation survey. This should focus on male to female ratios within roosts, and consider new colonies will form with small numbers of bats which are often overlooked.</p> <p>Continue the protection of designated sites and known roosts (i.e. building and underground) notifying local authorities and other relevant bodies of records. Ensuring the management of sites is appropriate to the species needs, with the designation of new sites where appropriate.</p> <p>Encouragement of appropriate habitat management particularly within 4km of maternity roosts of woodlands, wood pasture, pasture and connecting hedgerows, with these habitats representing critical foraging areas for pregnant and lactating bats, and their offspring. Landscape suitable for the survival of this species throughout its range should be protected through woodland policy, agri-environment schemes and planning policy in respect to building and underground sites.</p>
		Medium	<p>Research into climate change adjustments in the phenology of invertebrate prey populations and the impact of the decline of these populations, particularly moths, dung beetles cockchafers and tipulids.</p> <p>Ensure advice and good practice information is offered on habitat management and relevant grants schemes.</p> <p>Expand priority habitats used for foraging and commuting, and close to maternity colonise, enhancing these to increase insect prey populations. Increase the extent of suitably managed woodland and connective hedgerows, particularly those linking foraging areas and maternity sites. It should be noted as a landscape species greater horseshoe may use habitats not classified with priority status, so action should not be restricted to priority habitats.</p>
Lesser horseshoe bat	2 - European concern	High	<p>Research to improve understanding of which priority and non-priority habitats are used by lesser horseshoe bat. This should aim to provide Habitat Groups with suggested targets for increase in area and condition of habitats of importance for this species, considering conservation at a landscape level. This should also contribute towards future success criteria for lesser horseshoe.</p> <p>Maintain monitoring of designated sites and known roosts through the NBMP and provision of records to appropriate authorities.</p>

			<p>Consideration of this species in planning, woodland and agri-environment policy to protect roosts and retain and create suitable habitat and landscape features throughout the range of this species.</p> <p>Ensure protection of all known roosts via implementation of legislation and policy and implementation of appropriate mitigation and monitoring of effectiveness and compliance.</p> <p>Ensure a landscape approach is undertaken when considering the conservation of this species and ensuring that habitat such as woodland foraging habitat, old hedgerows and treelines, and roosting sites are increased and managed appropriately for the needs of lesser horseshoe, improving connectivity between these.</p>
		Medium	<p>Priority and other important habitats close to roosts (including maternity, hibernation mating and transitory roosts), used for commuting and foraging should be improved and expanded to maximise insect prey density. Non-priority habitats should be managed in addition to priority habitats as this species utilised many habitats.</p> <p>Ensure that site management is appropriate to the needs of lesser horseshoe and there is consideration of the importance of a landscape approach to the conservation of this species. Cross-sector conservation should be implemented to address issues such as habitat fragmentation, for example, with the adoption of the Batscapes concept.</p>
Noctule	3 – national concern	High	<p>Avoid conflict with the requirements of H&S policy with regard to mature trees and noctule roosts, through collaborative working between bat workers, H&S inspectors and arboriculturalists.</p> <p>Enhance existing monitoring schemes via the NBMP to provide long term roost population trends. Surveys for roosts throughout the noctule range are also required to better understand the distribution of this species.</p> <p>All roosts must be proactively protected through measures such as accurate recording on local and national schemes and local authority tree records so they are flagged up during planning searches and tree safety routines. Mitigation for loss of roosts needs to be effective to maintain populations. Surveys should also be undertaken before tree-felling, to look for roosts and potential roosts.</p> <p>High flying species such as noctule should be considered in policy relating to wind turbine developments.</p> <p>Ensure that the requirements of this species are considered in woodland, windfarm, agri-environment, water quality, tree protection (including H&S considerations) policy. Older trees should be retained and protected for noctule roosts, with this included in land-use policies (particularly planning and woodland).</p>
		Medium	<p>There should be a focus on woodland and lowland agricultural habitats at the landscape level when considering habitat improvements. Although noctule are a mosaic species, increasing the quality of existing habitats such as insect-rich wetlands may also help noctule.</p> <p>Improve the management of urban, suburban, rural, woodland and riverine landscapes for insect populations and roost protection.</p> <p>Consider how climate change may results in a range shift for noctule in relevant policy.</p> <p>Further research should be conducted into understanding how this species uses priority habitats and what ones are imperative to them, the effects of climate change, and impacts of windfarms. A greater understanding is also required of types of roost used by this species.</p> <p>The designation of woodlands which encompass several tree roosts used by a colony should be considered. Good foraging areas which could be subject to specific action for improvements should also be identified.</p>
Soprano pipistrelle	3 – national concern	High	<p>Ensure the provision of on-going free advice, with this species often roosting in houses, and forming the largest colonies in buildings in the UK. Appropriate advice and support are required to find solutions for people living and using buildings where roost exist to protect this species and manage issues associated with large roosts such as noise and smell.</p>

		<p>Continuation of population monitoring via field survey and colony count surveys with the NBMP, ensuring on-going national co-ordination, regional training and local volunteer engagement.</p> <p>Ensure the protection of known roosts through the implementation of legislation and policy. Surveys should be undertaken to identify new roosts and advice on proposed works and development should be provided through education and volunteer networks in addition to the private consultancy sector. Proportionate and appropriate mitigation must be implemented where required, accompanied by monitoring of effectiveness and compliance.</p> <p>Undertake research to understand the effectiveness of mitigation proposed on specific management recommendations. This should aim to provide habitat groups with target suggestions to increase the extend and quality of habitat for this species and contribute towards future success criteria for soprano pipistrelle.</p> <p>Promote the improvement, expansions and creation of key habitats for this species, including wetlands, and features such as hedgerows and woodland edges, ensuring the provision of maximal foraging opportunities. The landscape approach to conservation of this species should be considered, with this species using additional habitats to those listed previously and the delivery of conservation actions for soprano pipistrelle only likely to be achieved when considering other habitats.</p> <p>Ensure the needs of this species are considered in agri-environment schemes, planning, wetland creation, wind farm and water quality policy. The impacts of climate change on this species should also be considered in policy making, such as how the drying up of wetlands could impact this riparian associated species.</p>
	Medium	<p>Consider designating larger roosts as SSSI's.</p> <p>Consider ensuring the biggest roosts are notified and protected.</p>

Appendix B - Biological Records



Notes

Key to symbols:

Desk data record

Species

- *Barbastella barbastellus*
- Chiroptera
- *Eptesicus serotinus*
- *Myotis*
- *Myotis bechsteinii*
- *Myotis brandtii*
- *Myotis daubentonii*
- *Myotis mystacinus*
- *Myotis mystacinus/brandtii*
- *Myotis nattereri*
- *Nyctalus*
- *Nyctalus leisleri*
- *Nyctalus noctula*
- *Pipistrellus*
- *Pipistrellus nathusii*
- *Pipistrellus pipistrellus*
- *Pipistrellus pygmaeus*
- *Plecotus*
- *Plecotus auritus*
- *Rhinolophus ferrumequinum*
- *Rhinolophus hipposideros*
- *Vespertilionidae*

2km buffer
 10km buffer
 Option 30

P02	10/10/2019	Second Revision	TP	SW	SM
P01	01/10/2019	First Revision	ER	SW	SM
Rev	Date	Amendment Details	Drawn	Chk'd	App'd

**Mott MacDonald
Sweco**



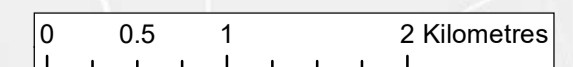
Drawing Status	Suitability
For Information	S2

Project Title
A417 Missing Link

Drawing Title
Bat Desk Study Data

Scale	Designed	Drawn	Checked	Approved
1:42,000	ER	ER	SW	SM
Original Size	Date	Date	Date	Date
A1	01/10/2019	01/10/2019	10/10/2019	10/10/2019

Drawing Number	Originator	Volume	Project Ref. No.
551505 - MMSJV	- VOL	- EBD	551505
000 - DR	- LB	- 0060	Revision
Location	Type	Role	Number
			P01



Appendix C - Natural England Consultation

Date: 26 June 2017
Our ref: DAS/217407
Your ref: No ref



BY EMAIL ONLY

Customer
Services
Hornbeam
House
Crewe Business
Park
Electra Way
Crewe
Cheshire
CW1 6GJ

0300 060 3900

Dear Julia Barrett,

Discretionary Advice Service (Charged Advice)

DAS/12235/217407

Development proposal and location: A417 'Missing Link' at Air Balloon

Thank you for your coming to meet with Natural England at our Worcester offices. As a follow up to this meeting please see below a summary of the headline points discussed at the meeting.

This advice is being provided as part of Natural England's Discretionary Advice Service. Mott MacDonald Sweco has asked Natural England to provide advice and comment upon a range of issues at this meeting, including:

- Feedback on the current status of the scheme and issues to consider moving forward in relation to species, SSSI impacts and mitigation and wider planning conversations
- Review and feedback at meeting on species survey methodology

The advice is provided in the meeting and the summary of this below are in accordance with the Quotation and Agreement dated 07 June 2017.

The advice is based upon the information within the Bat Survey Memorandum and maps prepared to inform the scheme as provided on the day.

Protected sites

On the basis of the information so far provided Natural England is has highlighted the following key messages to take forward on work for this scheme.

- The area is of very high importance to Natural England, both as an Area Of Natural Beauty (AONB) and as a focus area due to its high biodiversity value.
- Ensuring connectivity of landscape and habitat in relation to existing and new roads schemes should be a major objective for this scheme, in particular limestone grassland.

- Tunnel options are likely to be beneficial for this whilst green bridges would benefit open cut and existing road schemes.
- Species-rich grassland creation does work well on the thin nutrient soils of the Cotswold scarp. These can also be manipulated to benefit target species such as butterflies and pollinators. Further information on schemes in the area such as 'Back from the Brink' can be shared to support delivery through the eventual design and delivery of the scheme.
- The new scheme will be a good opportunity for Highways England to sort out the management of their (albeit small) sections of SSSI that they own both at Crickley Hill and Barrow Wake. We will expect to see this as a part of the delivery of the scheme.
- Bore hole locations discussed did not appear to be a concern. However the southernmost location was discussed as a potential issue should it need to move further south of the outlined location at the meeting. Assent will be required if this needs to happen.

Protected species – Bat Memorandum and wider species issues (planning discussions)

- Provided the methodology proposed is adhered to Natural England can foresee no problems with the survey effort proposed
- Natural England would have preferred two seasons of transect surveys to inform the baseline the scheme will work from. However, we appreciate that the deadlines are very tight making it challenging to achieve this before submission of the Development Consent Order, therefore this will have to be done after this deadline in 2019.
- The time-table is extremely tight and sheer volume of potential license applications could have a severe impact on natural England resources. It will be important to develop an informed timetable and shared agreement for scheduling of work and advice moving forward.
- Licenses cannot be issued more than three months in advance and survey data has to be from the current or previous survey season so surveys will have to continue throughout the construction phase. Natural England can offer support through our Pre Submission Screening (PSS) process that could be beneficial with getting applications processed quicker
- Careful thought needs to be given to potential crossing points on the chosen route and how to mitigate against road kill and severance etc. Green/grey bridges are preferred to underpasses or gantry type crossings.

The advice on this proposal, and the guidance contained within Natural England's standing advice relates to this case only and does not represent confirmation that a species licence (should one be sought) will be issued. Please see **Annex 1** for information regarding licensing for the following European Protected Species:

Further information can also be obtained from [The Institute of Ecology and Environmental Management](#), [The Bat Conservation Trust](#) and [Biodiversity Planning Toolkit](#) for more guidance.

Yours Faithfully

Stephanie Matthews
Senior Adviser - West Midlands Area Team
Cc commercialservices@naturalengland.org.uk

The advice provided within the Discretionary Advice Service is the professional advice of the Natural England adviser named below. It is the best advice that can be given based on the information provided so far. Its quality and detail is dependent upon the quality and depth of the information which has been provided. It does not constitute a statutory response or decision, which will be made by Natural England acting corporately in its role as statutory consultee to the competent authority after an application has been submitted. The advice given is therefore not binding in any way and is provided without prejudice to the consideration of any statutory consultation response or decision which may be made by Natural England in due course. The final judgement on any proposals by Natural England is reserved until an application is made and will be made on the information then available, including any modifications to the proposal made after receipt of discretionary advice. All pre-application advice is subject to review and revision in the light of changes in relevant considerations, including changes in relation to the facts, scientific knowledge/evidence, policy, guidance or law. Natural England will not

Annex 1

European Protected Species

A licence is required in order to carry out any works that involve certain activities such as capturing the animals, disturbance, or damaging or destroying their resting or breeding places. Note that damage or destruction of a breeding site or resting place is an absolute offence and unless the offences can be avoided (e.g. by timing the works appropriately), it should be licensed. In the first instance it is for the developer to decide whether a species licence will be needed. The developer may need to engage specialist advice in making this decision. A licence may be needed to carry out mitigation work as well as for impacts directly connected with a development. Further information can be found in Natural England's ['How to get a licence'](#) publication.

If the application requires planning permission, it is for the local planning authority to consider whether the permission would offend against Article 12(1) of the Habitats Directive, and if so, whether the application would be likely to receive a licence. This should be based on the advice Natural England provides at formal consultation on the likely impacts on favourable conservation status and Natural England's [guidance](#) on how the three tests (no alternative solutions, imperative reasons of overriding public interest and maintenance of favourable conservation status) are applied when considering licence applications.

Natural England's pre-submission Screening Service can screen application drafts prior to formal submission, whether or not the relevant planning permission is already in place. Screening will help applicants by making an assessment of whether the draft application is likely to meet licensing requirements, and, if necessary, provide specific guidance on how to address any shortfalls. The advice should help developers and ecological consultants to better manage the risks or costs they may face in having to wait until the formal submission stage after planning permission is secured, or in responding to requests for further information following an initial formal application.

The service will be available for new applications, resubmissions or modifications – depending on customer requirements. More information can be found on [Natural England's website](#).

Subject Ecology Surveys
To Julia Barrett
From Simon Mason
Our reference Bat Survey Methods
Office Southampton
Date 06.06.2017
Your reference A417 Air Ballon

Memorandum

This memo outlines the proposed bat survey approach for the A417 Air Balloon Highways England Road Improvement Scheme (RIS). The assessment of this scheme is being undertaken under a Development Consent Order (DCO), which is due to be submitted in early 2019. Several route options are currently under consideration for the scheme.

The aim of this memo is to provide a platform for agreeing an approach to survey, which is acceptable to all parties involved, and which can be included in a Statement of Common Ground to facilitate the Development Consent Order (DCO) application process.

Background

Highways England are currently proposing to undertake a number of major Road Improvement Schemes of which the A417 Air Balloon is one of a number of schemes which Mott MacDonald are currently working on. Mott MacDonald are currently in consultation with Natural England regarding the ecological surveys being undertaken for the A358 Taunton to Southfields and the A303 Sparkford to Ilchester RIS Schemes in Somerset. WSP/Parsons Brinkerhoff consulted Natural England regarding the A30 Chiverton to Carland Cross dualling scheme in Cornwall. To ensure a consistent approach is undertaken, Mott MacDonald are seeking to align the proposed survey effort with the agreed approach with other HE RIS Schemes of a similar scale.

As part of the WSP/Parsons Brinkerhoff consultation they produced a memo¹ which outlined their proposed approach to undertaking bat surveys to assess the impacts of the scheme. The A30 Chiverton to Carland Cross memo provided an assessment of various survey methods including standard methods outlined within the Bat Conservation Trust 2016 survey guidelines², together with the consideration of methods outlined within recently published research funded by Defra³. This memo was sent to Natural England (NE) on the 13th December 2016. Katherine Walsh, Natural England Senior Specialist Mammals, provided a response to this memo on the 26th January 2017. A copy of this response is included in **Appendix A** of this memo.

Summary of Natural England's Response to A30 Bat Survey Memo

WSP/Parsons Brinkerhoff (WSP/PB) had proposed to omit the Landscape Scale transects as outlined within the 2015 DEFRA study from the proposed A30 survey approach. However, NE confirmed (having consulted John Altringham) that the landscape scale transects were required and important for enabling monitoring of future impacts on the bat population.

¹ WSP | Parsons Brinckerhoff 1st September 2016 - A30 Chiverton to Carland Cross Bat Survey Approach, v2

² Collins, J. (ed.) (2016) Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edn). The Bat Conservation Trust, London.

³ Berthinussen & Altringham (2015) 'Development of a cost-effective method for monitoring the effectiveness of mitigation for bats crossing linear transport infrastructure'

'by not including the transect methodology, the proposed survey design does not allow for a methodology that is repeatable i.e. it does not establish a baseline by which the bat population can be assessed. At a landscape scale the proposed survey design will not be able to statistically assess whether bat populations have remained stable, increased, decreased or if bat diversity has been altered to any degree by this scheme. Whilst, the methodology should be suitable for identifying crossing points, it won't provide a baseline by which to effectively measure the success or otherwise of any mitigation.'

Natural England's response confirmed that they are happy with WSP/PB's approach to standard roost and activity surveys which are based on the methods outlined within the BCT survey guidelines.

'Your existing survey methodology has/is addressing the 'other survey' requirements which are desirable for this scheme, which we welcome.'

Proposed Bat Survey Methods for the A417

Following the consultation with Natural England on the proposed survey methodology for the A30 along with initial consultation responses from Natural England on the A358 and A303, the proposed methods outlined below for the A417 are based on the standard survey methods and effort proposed by WSP/PB which were deemed as acceptable by Natural England, together with crossing point surveys and landscape scale transects broadly in line with the methods outlined in Berthinussen & Altringham (2015). Details of the proposed survey methods are outlined below.

Preliminary Ecological Appraisal for Bats – Desk Study

The desk study will involve the collation of data from the Gloucestershire Centre for Environmental Records (GCER) and MAGIC together with a review of aerial photography and ordnance survey mapping.

The following search areas will be used for the desk study:

- 30 km from the scheme options for SACs designated for bats (specifically in relation to the Assessment of Implications on European Sites);
- 10 km from the scheme options for bat records;
- 10 km from the scheme options for bat licensing information (obtained from MAGIC); and
- Historic mapping will be used to help identify the presence of any underground sites (e.g. mine shafts) within 100 m of the scheme options .

These search areas are based on published guidance, consideration of core sustenance zones (CSZ's) for bats likely to be impacted, and initial consideration of the scheme's zone of influence (ZoI) on bats. The wider 10 km search area will be used to provide context to the data obtained in closer proximity to the scheme.

The desk study will provide context in the EclA regarding the species of conservation importance recorded in the zone of influence for the scheme and identify any significant habitats of note for focussing survey effort.

Preliminary Ecological Appraisal for Bats – Scoping Walkover

An extended phase 1 habitat survey is being undertaken along the proposed route options for the A417 between April and June 2017. This walkover survey will cover the various route options, undertaking an initial assessment of potential roosting, commuting and foraging habitats. The extended phase 1 survey covers a broad area up to 250-500m from the proposed route options. The aim of the initial scoping walkover is to determine the suitability of the site for bats, to assess what further bat surveys will be needed and how those surveys should safely be carried out.

Preliminary Roost Inspection Surveys

In accordance with IAN 116/08⁴, both mature trees and structures within 100 m of the proposed construction footprint will be assessed for their potential to support bat roosts. Given the potential presence of rare woodland bat species including barbastelle and Bechstein’s, the presence of tree roosting bats is considered as important a consideration as roosts within buildings and structures. Preliminary roost inspection surveys will be undertaken in early 2018.

Building and Structure Surveys

Building and structure (bridge) surveys will initially comprise external surveys. The surveys will conform to the methodology outlined within the BCT survey guidelines and buildings and bridges will be assessed for their suitability to support roosting bats in accordance with BCT Guidelines as summarised in Table 1. Internal inspections will be undertaken on suitable buildings following the preferred route option selection. This will minimise any unnecessary disruption to homeowners who are located outside of the preferred route option. Prior to the internal inspections, a precautionary assessment of roost suitability will be made, based on the external inspection survey results.

Table 1 – Bat Roost Suitability Assessment

Potential to support roosting bats	Description
Confirmed	A feature / structure within which bats are seen to be present (either live bats, or bat carcasses) or heard ‘chattering’ inside will be classified as a confirmed roost. In addition any feature/structure found to contain droppings during inspections will in the first instance be considered as a confirmed roost. N.B. In some cases it may be appropriate to revise this assessment following further survey (e.g. for buildings containing low numbers of old droppings and showing no evidence of use during emergence surveys).
High	A structure or tree with one or more potential roost sites that are obviously suitable for use by larger numbers of bats on a more regular basis and potentially for longer periods of time due to their size, shelter, protection, conditions and surrounding habitat.
Moderate	A structure or tree with one or more potential roost sites that could be used by bats due to their size, shelter, protection, conditions and surrounding habitat but unlikely to support a roost of high conservation status (with respect to roost type only – the

⁴ Highways Agency (2008) Interim Advice Note 116/08: Nature conservation advice in relation to bats
Page 3 of 10

Potential to support roosting bats

Description

	assessments in this table are made irrespective of species conservation status, which is established after presence is confirmed).
Low	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 or by larger numbers of bats (i.e. unlikely to be suitable for maternity or hibernation). A tree of sufficient size and age to contain PRFs but with none seen from the ground or features seen with only very limited roosting potential.
Negligible	Negligible habitat features on site likely to be used by roosting bats.

Tree Surveys – Ground Level Roost Assessment

The tree survey will include a ground level roost assessment using binoculars, a torch and endoscope to identify Potential Roosting Features (PRFs). An assessment of a trees suitability to support roosting bats will be made in accordance with BCT guidelines outlined in **Table 1**.

Tree Surveys - PRF Inspection Surveys

Following the ground level tree roost assessment, at-height Potential Roost Feature (PRF) inspection surveys will be undertaken on trees identified as having moderate or high roosting potential during the ground level tree assessment. The at-height survey will enable a more detailed inspection of PRF’s to assess in more detail their likely suitability for bats and to look for evidence of bats such as live or dead bats, droppings, staining or odour. These surveys will help prevent unnecessary emergence/dawn work where features appear to be of high suitability from the ground but are actually of limited or no suitability.

Emergence/Re-entry Surveys

Buildings/Structures

The spatial extent of the building roost emergence and re-entry surveys will be based on Mott MacDonald’s professional opinion and will be proportionate to the roost suitability, likely ecological importance and potential impacts. This is based on the approach being proposed on the A30 by WSP/PB. As a guide, the building roost surveys will include all structures with low, moderate, and high roosting suitability which are within the construction footprint, structures with moderate suitability which are within 20 m of the construction footprint, and structures with high suitability which are within 100 m of the construction footprint. These spatial extents may be extended if there are any features of potential high conservation significance, such as potential maternity roosts of Annex II species, within the core sustenance zones of these species. Structures with negligible suitability will not be surveyed further.

The survey effort for bat emergence surveys will be based on BCT guidelines as outlined in **Table 2**.

Table 2: Minimum number of emergence & re-entry survey visits for high, moderate and low potential buildings and high and moderate potential trees

High bat roosting potential	Moderate bat roosting potential	Low bat roosting potential
Three separate survey visits. At least one dusk emergence and a separate dawn re-entry survey. The third visit could be either dusk or dawn. May to September ⁵	Two separate survey visits. One dusk emergence and a separate dawn re-entry survey. May to September ⁶ .	One survey visit. One dusk emergence or dawn re-entry survey (structures). May to August. No further surveys required (trees).

Source: Bat Surveys – Good Practice Guidelines 3rd Edition (Collins, 2016).

Surveyors are to be positioned in sufficient numbers so that all potential roost features can be seen by at least one surveyor during each survey. Evening emergence surveys are to be undertaken from 15 minutes before sunset until 1.5 to 2 hours after sunset; and dawn re-entry surveys undertaken from 1.5 to 2 hours before sunrise until 15 minutes after sunrise.

Trees

As outlined above for structure surveys, the spatial extent of the tree roost emergence and re-entry surveys will be based on Mott MacDonald’s professional opinion and will be proportionate to the roost suitability, likely ecological importance and potential impacts. In accordance with BCT guidelines, trees assessed as having low roost potential will not be subject to further surveys, but where they are directly impacted will be subject to avoidance measures such as supervised soft felling. Trees with moderate suitability which are within 20 m of the construction footprint, and trees with high suitability which are within 100 m of the construction footprint will be subject to dusk emergence surveys and/or dawn re-entry surveys.

The survey effort for bat emergence surveys will be based on BCT guidelines as outlined in **Table 2**. Surveyors will be positioned in sufficient numbers so that all potential roost features (PRF) can be seen by at least one surveyor during each survey. Evening emergence surveys are to be undertaken from 15 minutes before sunset until 1.5 to 2 hours after sunset; and dawn re-entry surveys undertaken from 1.5 to 2 hours before sunrise until 15 minutes after sunrise.

Hibernation Surveys

If the preliminary surveys identify buildings/structures/caves with the potential to act as bat hibernation sites, these will be surveyed by an ecologist with a Natural England licence to disturb hibernating bats. A minimum of two visits will be undertaken, one in mid-December 2018 and one in mid-January 2019. These surveys will entail the systematic search of the sites from the entrance, with the locations of any bats seen marked on a plan of the site. In addition, static detectors will be placed within potential hibernation sites for a period of 2 weeks between December 2018 and February 2019 to monitor species present.

Bat Activity Surveys – Transects

The transect surveys are designed to identify species composition and general distribution along the length of the schemes, and to inform the locations of crossing point surveys. Transects will be circular or linear routes of between 3-5 km (in accordance with BCT guidelines) each largely following the liner route of the scheme options and the habitats likely to be impacted in the construction footprints. The number of transects will depend on the options being considered but it is anticipated that a minimum of five transects will be undertaken.

⁵ At least two of the surveys should be undertaken between May and August

⁶ At least one of the surveys should be undertaken between May and August

Each transect will be surveyed at dusk once per month for 7 months April to October 2018 inclusive. In addition, each transect will be subject to a single follow-up dawn transect surveys within the same 24h period between July and August 2018. Approximately 10 point counts will be included per transect, with each transect taking approximately 3 hours to complete. The transect routes will be reversed on each visit and where possible, start points will be randomised to produce more robust data. Dusk transect surveys are to be undertaken from sunset until 2-3 hours after sunset. Dawn transects will be undertaken from 2-3 hours before sunrise until sunrise.

Due to the length of the schemes, the suitability of the foraging and commuting habitat is variable, ranging from low to high. Low value habitats include intensively farmed areas containing large arable/pastoral fields divided by heavily managed hedgerows. High value habitats include areas of broadleaved woodland and smaller less intensively managed fields bordered by mature species-rich hedgerows with trees.

To ensure survey effort is cost effective and proportional, the proposed survey effort of one survey per month (April to October) is based on the 'moderate' survey effort outlined in the BCT survey guidelines (2016)⁷. This effort is considered adequate for the assessment due to the mix of habitats present across the schemes, and given that the surveys will be supplemented by crossing point surveys which will be targeted on the higher quality habitats, and Landscape Scale Transects. Additionally, where areas of high quality broadleaved woodland are likely to be impacted, advanced survey techniques will be considered, including mist netting and radiotracking. These survey techniques will provide robust survey data to enable the assessment of the impacts of the schemes on bats.

Bat Activity Surveys – Static Automated

A total of three static detectors are to be installed for each transect route, in accordance with the specifications within the BCT guidelines (Collins 2016). Each detector will be deployed for five consecutive nights per month between April and October.

The automated detector sampling strategy will be stratified, which will allow the statistical comparison of data between paired locations. Static detectors will be deployed within a range of suitable habitats which may be directly or indirectly affected (fragmented) by the scheme options including hedgerows, riparian corridors, woodland, parkland, orchards and scrub. A random or systematic sampling strategy is not considered practical for the scheme due to landowner constraints and risk of damage to equipment if set up in the middle of arable/pastoral fields which make up much of the sites. A random or systematic sampling strategy would also be less useful in informing the crossing point surveys, which will be concentrated on linear features bisected by the scheme (as described below).

⁷ The scale of transect surveys is comparable to the A30 proposal which Natural England commented '*The long transects along the length of the scheme does seem onerous and could be scaled down.*' Therefore, any increased survey effort is considered unnecessary.

Advanced Survey Techniques

Due to the potential impacts on areas of mature broadleaved woodland, including areas of ancient woodland, targeted mist netting surveys are proposed within key habitats to provide more detailed information on the status of bat species, in particular Annex II species, within the survey area. Mist netting surveys will only be used where sufficient information cannot be determined from non-intrusive methods. Surveys will only be undertaken by appropriately licenced and experienced surveyors. A detailed methodology will be produced for each mist netting site once these targeted sites have been identified following completion of the preliminary bat assessments. An assessment of the need for more detailed radiotracking studies will be made following the results of the initial surveys.

Crossing Point Surveys

A series of crossing point surveys will be undertaken in line with the methods described in Berthinussen and Altringham 2015. The surveys will be static, visual surveys designed to inform the impact assessment in relation to the fragmentation of bat foraging/ commuting habitat and direct mortality. This data will be used to inform the nature and location of required bat crossing structures and will facilitate the future monitoring of the effectiveness of any mitigation.

The crossing point survey method described in Berthinussen and Altringham 2015 requires at least six visits per location to provide a robust baseline from which to monitor the effectiveness of crossing structures. Berthinussen and Altringham conducted their surveys between June and August. Due to the southerly location of the site and the potential for hibernation / transitional / swarming sites in the surrounding landscape, it is considered appropriate to undertake surveys between July and September 2018. Repeated surveys will be at least 1 week apart.

The crossing point survey locations will be informed by the first three months of transect and automated survey data, and also by the results of the preliminary surveys of buildings and trees with roost potential. It is estimated that 10 crossing point surveys will be required, however, this will be dependent on the options taken forward for consideration. This is based on a visual assessment of the habitats being severed by the scheme which are likely to be important for commuting and foraging bats, focusing on mature hedgerows with good connectivity, woodland blocks and riparian habitats which the schemes will impact.

The surveys will record bat species, numbers, flight height, direction, location, time of crossing, and any other general behaviour. The surveys will commence at sunset and will be undertaken for a minimum of 60 minutes. After 60 minutes, it is usually too dark to record visual bat movements accurately. However, if late emerging species are recorded, surveys will be extended by an additional 30 minutes.

Landscape Scale Transect Surveys

Landscape scale surveys will be undertaken in line with the methods described in Berthinussen and Altringham 2015. The survey will consist of walked transects 1 km either side of and perpendicular to the proposed routes, with bat activity recorded using full spectrum bat detectors during 10 min stationary spot checks at 100 m intervals from the route centrelines. Weather and habitat variables will also be recorded at each spot check. Ten transects

will be carried to ensure sufficient data to detect changes in overall bat activity. This will include 10 independent transects (with five walked towards the road, and five walked away). Each transect will be at least 500m apart. Each of the ten transects will be repeated once during the season. Surveys will commence 30 minutes after sunset, and be completed within approximately two hours. Surveys will be undertaken between July and August 2018, following the selection of the preferred routes for both schemes. An equal number of transects will be selected on each side of the road and equal numbers walked towards and away from the road. Transects will be located along minor roads, bridleways or public footpaths so that they will be repeatable for future monitoring. In accordance with the survey method, data will be subject to auto species analysis using BatClassify or comparable software. Data will then be statistically analysed using the methodology outlined in Berthinussen and Altringham (2015).

Berthinussen and Altringham recommend that baseline data is collected over two survey season where possible. It is therefore proposed to repeat the surveys between June and August 2019. These 2019 surveys will not inform the Environmental Statement as they will be undertaken following the DCO submission, but will be used to provide a robust baseline pre-construction.

Conclusion

The above methodology is considered to provide a robust approach for assessing the impacts of the A417 scheme on bats and will provide a baseline to monitor the impacts and success of mitigation. The recommended methods are in line with both the BCT Guidelines (2016) and Berthinussen and Altringham (2015).

Appendix A – Natural England Response to WSP/PB A30 Survey Approach

Response to WSP/Parsons Brinckerhoff on Meeting Notes and Memo

Thank you for the opportunity to comment on the WSP/PB memo dated 1st September and meeting notes dated 3rd September describing the bat survey approach for the A30, sent to us on 13th December.

In preparing this response I have spoken to both Jean Matthews (NRW) and Professor John Altringham (Leeds University –retired) All three of us were members on the Steering Group for the Defra commissioned ‘WC1060 – Development of a Cost-Effective method for monitoring the effectiveness of mitigation for bats crossing linear transport infrastructure’. Professor John Altringham was the lead researcher on the project. John does not agree with the meeting notes, which state that the landscape methodology was not to be taken forward, so maybe there was a misunderstanding, as different methodologies and research proposals were discussed at the workshop.

As noted in our previous discussions, the Defra report makes it clear that the methodology should be used in combination with existing methodology for identifying bat roosts, important foraging habitats and species which are not easy to detect, for example through use of acoustic detectors only.

Your existing survey methodology has/is addressing the ‘other survey’ requirements which are desirable for this scheme, which we welcome. However, by not including the transect methodology, the proposed survey design does not allow for a methodology that is repeatable i.e. it does not establish a baseline by which the bat population can be assessed. At a landscape scale the proposed survey design will not be able to statistically assess whether bat populations have remained stable, increased, decreased or if bat diversity has been altered to any degree by this scheme. Whilst, the methodology should be suitable for identifying crossing points, it won’t provide a baseline by which to effectively measure the success or otherwise of any mitigation.

We would suggest that a combination of the proposed WSP/PB methodology with that stated in the WC1060 report would be advisable for this scheme. The long transect(s) along the length of the scheme does seem onerous and could be scaled down. This could then allow for the transect methodology to be incorporated in a cost-effective way.

A couple of final points of detail,:

- if statics were to be used as a replacement for people walking the transects with detectors, which is acceptable as an alternate methodology, this would require statics being placed at each of those spot check points. Collins et al (2016) states on P8 that ‘this edition of the guidelines does not include specific advice in relation to road and rail schemes, although the principles of survey design and execution do apply. Berthinussen and Altringham (2015) provide information on pre and post construction surveys of linear infrastructure schemes, designed specifically to assess the effectiveness of mitigation for bats crossing them’.

We would be happy to discuss further the above points to agree a proportionate and cost effective way forward for replicable bat surveys for pre and post construction for this important road scheme, so that any measures



required to address and monitor the impacts of the scheme are based on a robust evidence base and are proportionate and cost effective.

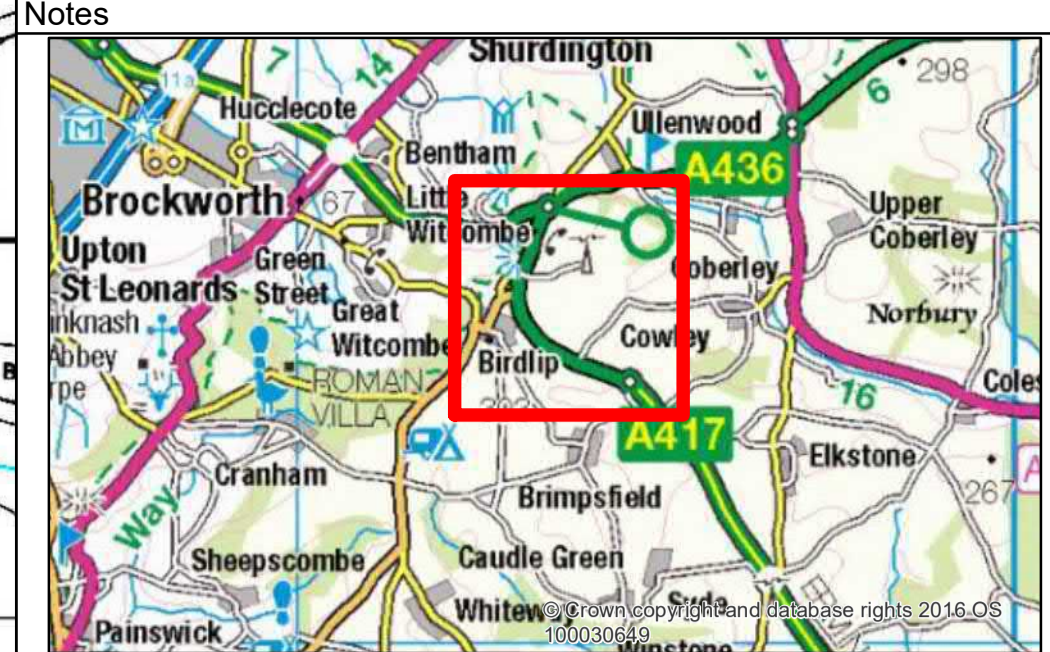
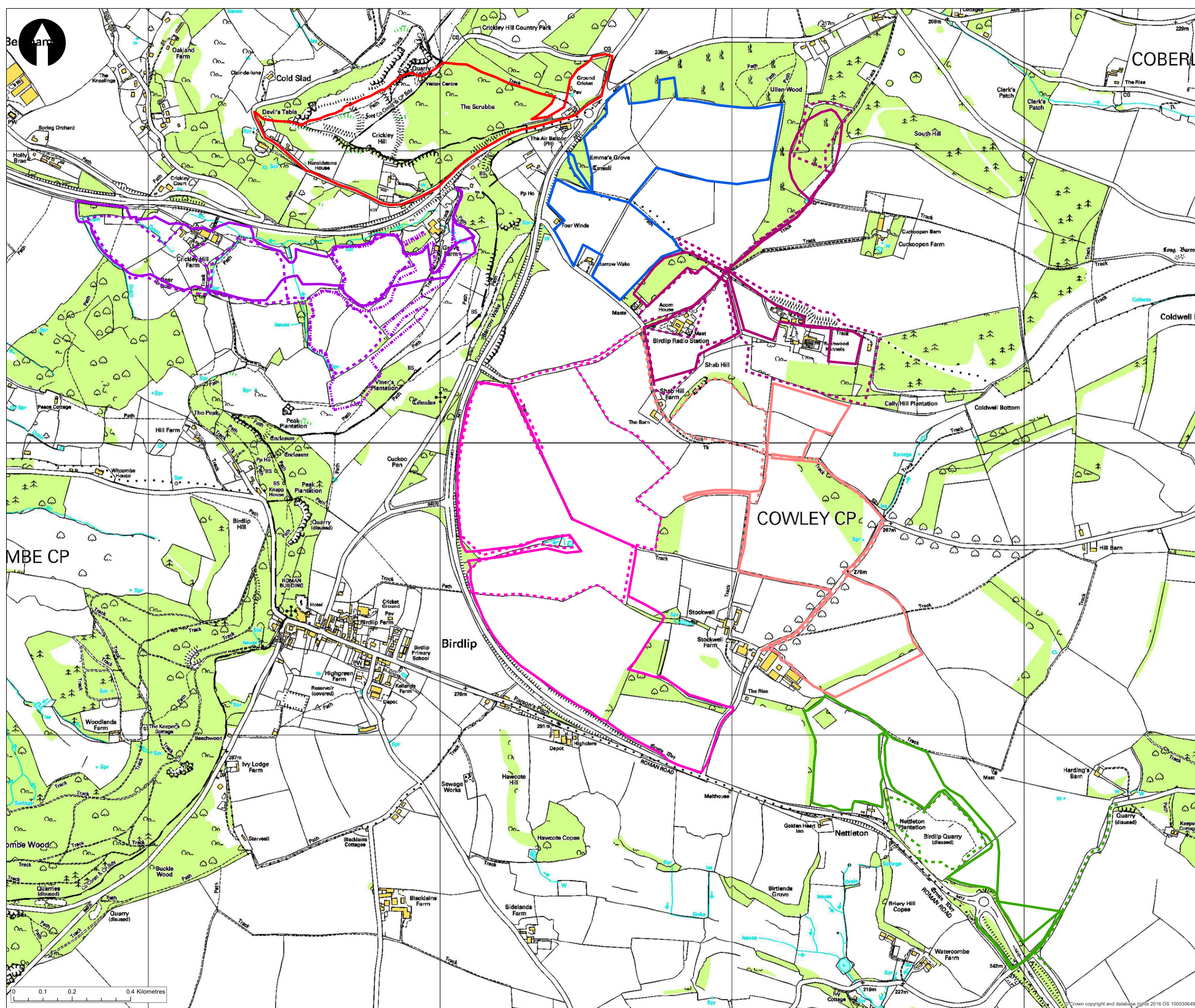
I am free morning of 31st Jan to discuss further. I will then be on leave for 4 weeks. I look forward to hearing from you.

Yours Sincerely,

K, Walsh

Katherine Walsh (Senior Specialist – Mammals)

Appendix D - Activity Transect Routes



- Legend**
- Transect 1 2018
 - - - Transect 1 2019
 - Transect 2 2018
 - - - Transect 2 2019
 - Transect 3 2018
 - - - Transect 3 2019
 - Transect 4 2018
 - - - Transect 4 Sept 2018
 - - - Transect 4 2019
 - Transect 5 (No access)
 - Transect 6 2018
 - - - Transect 6 2019
 - Transect 7 2018/19

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P01	31/10/19	First Revision	DBY	SM	KA

Mott MacDonald Sweco

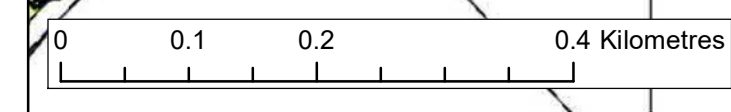


Client: For Information

Project Title: A417 Missing Link

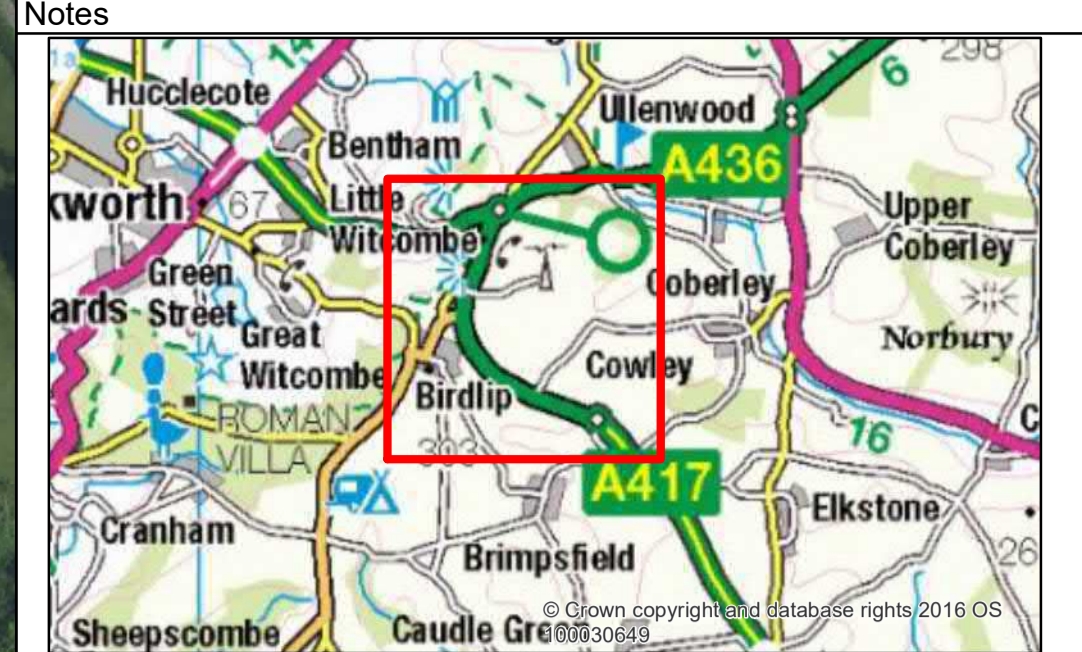
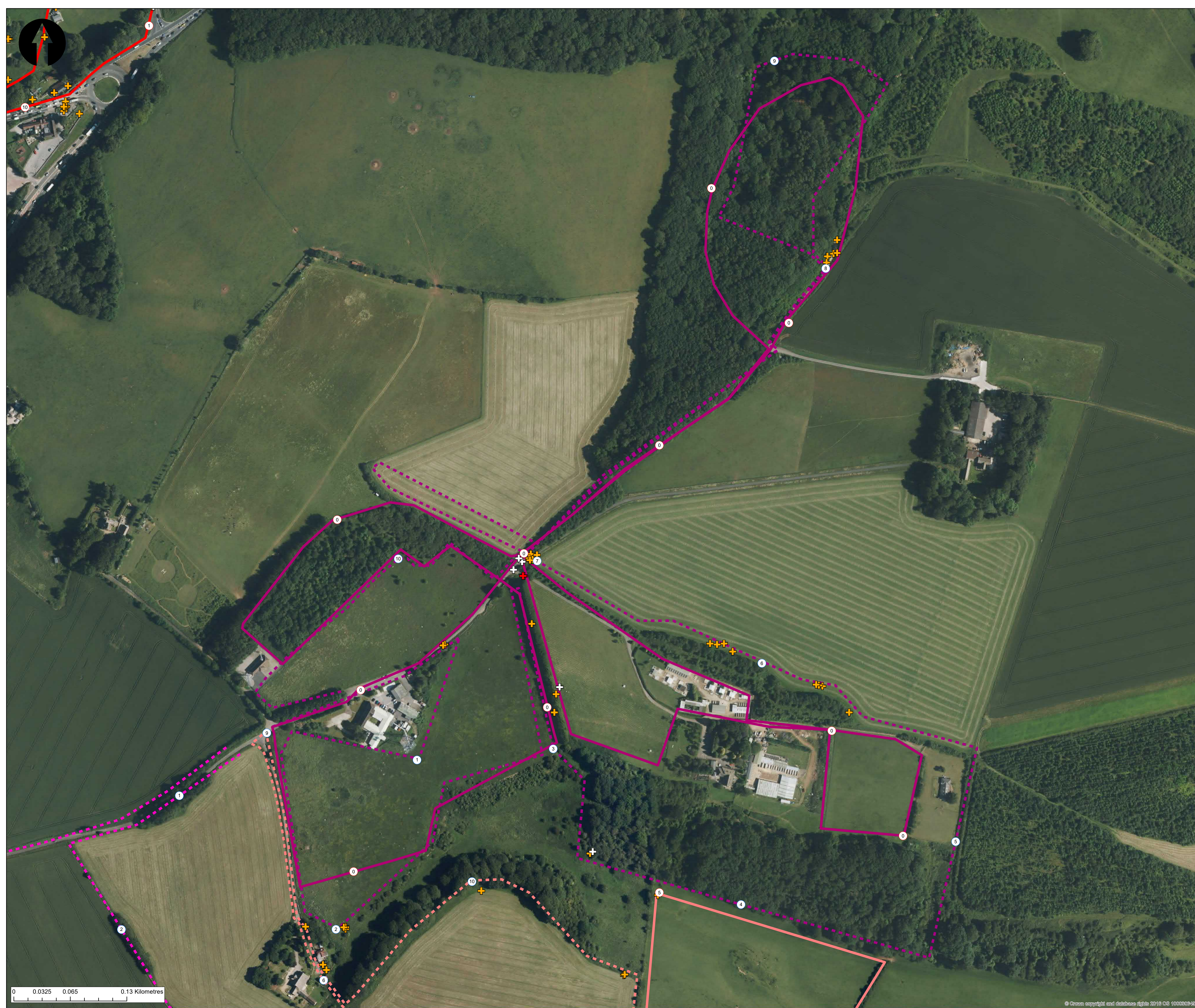
Drawing Title: Bat Survey - Activity Transect Routes

Scale	Designed	Drawn	Checked	Approved
1:5,900	DBY	DBY	SM	KA
Original Size	Date	Date	Date	Date
A1	25/09/19	31/10/19	31/10/19	31/10/19
Drawing Number	Originator	Volume	Project Ref. No.	
551505 - MMSJV - EBD -			398700	
Location	Type	Role	Number	
000 - DR - LB -			00065	
			P01	



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Appendix E - Activity Transect Species Maps



Legend

- Stopping points 2018
- Stopping points 2019
- ✚ Noctule
- ✚ Leisler's bat
- ✚ Serotine
- ✚ Nyctalus spp.
- Transect 1 2018
- - - Transect 1 2019
- Transect 2 2018
- - - Transect 2 2019
- Transect 3 2018
- - - Transect 3 2019
- Transect 4 2018
- - - Transect 4 Sept 2018
- - - Transect 4 2019
- Transect 6 2018
- - - Transect 6 2019
- Transect 7 2018/19

P01	31/10/19	First Revision		DBy	SM	KA
Rev	Date	Amendment Details		Drawn	Chk'd	App'd

Mott MacDonald Sweco

Client **highways england**

Drawing Status	For Information	Suitability	S02
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Project Title
A17 Missing Link

Drawing Title
Bat Survey - Activity Transects
Transect Results Nyctaloid Species
Transect Route 3

Scale	1:1,980	Designed	DBy	Drawn	DBy	Checked	SM	Approved	KA
Original Size	A1	Date	25/09/19	Date	31/10/19	Date	31/10/19	Date	31/10/19

Drawing Number	551505 - MMSJV - EBD	Originator	Volume	Project Ref. No.
000	DR	LB	00071	398700
Location		Type	Number	Revision
				P01

0 0.0325 0.065 0.13 Kilometres

Appendix F - Automated Static Point Locations

Appendix G - Automated Static Detector Results

Table 10. Automated static bat detector results, showing each location and species for each month, with a species count over the whole deployment and their overall percentage of calls

Static ID	Species	Deployment Month							Species Total	%
		Apr	May	Jun	Jul	Aug	Sep	Oct		
1a	Barbastelle					1		1	2	0.03
	Common pipistrelle	29	1973	270	258	1069	168	217	3984	57.09
	Greater horseshoe		6						6	0.09
	Leisler's		7	2	8	8	2	18	45	0.64
	Lesser horseshoe	21	1314	55	9	10	15	44	1468	21.03
	<i>Myotis.sp</i>	3	21	2	40	60	50	18 2	358	5.13
	Nathusius's pipistrelle	4	1		1	30		1	37	0.53
	Nathusius's pipistrelle poss	19	5	13					37	0.53
	Noctule	240	202	13	14	29	51	49	598	8.57
	Nyctaloid				1				1	0.01
	<i>Nyctalus.sp</i>		3						3	0.04
	Pipistrelle.sp		25	1	13 7	3	31	59	256	3.67
	<i>Plecotus.sp</i>	4	4		13	14	31	23	89	1.28
	Serotine	1	11	2		14	3	8	39	0.56
	Soprano pipistrelle		20	1	1	10		2	34	0.49
	UNKNOWN				3	19			22	0.32
	Total Count		321	3592	359	485	1267	351	604	
1b	Barbastelle			1	3	2			6	0.13
	Common pipistrelle	238		453	426	210	31	422	1780	37.73
	Greater horseshoe	2							2	0.04
	Leisler's			18	8	6		1	33	0.70
	Lesser horseshoe	17		74	38	32	15	90	266	5.64
	<i>Myotis.sp</i>	3		365	55	128	7	186	744	15.77
	Nathusius's pipistrelle			1					1	0.02
	Noctule	106 5		39	8	18	8	17	1155	24.48
	Nyctaloid				5		1		6	0.13
	<i>Nyctalus.sp</i>	3					4		7	0.15
	Pipistrelle.sp	1		27 1	19 8	3		32	505	10.70
	<i>Plecotus.sp</i>	1		24	7	24	6	40	102	2.16
	Serotine	5		13	1	23			42	0.89
	Soprano pipistrelle			2	1	3			6	0.13

	UNKNOWN			44	6	13			63	1.34	
	Total Count	1335		1305	756	462	72	788			
1c	Barbastelle				1				1	0.01	
	Common pipistrelle	273	3024	38	640	1914	34	43	5966	69.03	
	Leisler's	3	1	1	2	1			8	0.09	
	Lesser horseshoe	2	13	6	9	2	379	17	428	4.95	
	<i>Myotis.sp</i>	3	107	4	150	57	8	12	341	3.95	
	Nathusius's pipistrelle		2						2	0.02	
	Nathusius's pipistrelle poss		89						89	1.03	
	Noctule	1108	243	3	1	7	10	4	1376	15.92	
	Nyctaloid				3				3	0.03	
	<i>Nyctalus.sp</i>		1						1	0.01	
	Pipistrelle.sp	20	1	19	34 0					380	4.40
	<i>Plecotus.sp</i>		2	1	5	1	6	4	19	0.22	
	Serotine	4				1	1		6	0.07	
	Soprano pipistrelle		2		4	4		3	13	0.15	
	UNKNOWN	1		5	3				9	0.10	
	Total Count	1414	3485	77	1158	1987	438	83			
2a	Barbastelle					1			1	0.00	
	Common pipistrelle	8302	3007	552	378	4232	273	2083	18827	91.50	
	Greater horseshoe	1		1					2	0.01	
	Leisler's	9			3			1	13	0.06	
	Lesser horseshoe	3	4	11	2		23 3	20	273	1.33	
	<i>Myotis.sp</i>	126	10	17	7		54	72	286	1.39	
	Nathusius's pipistrelle	8							8	0.04	
	Noctule	49	57	17	1	1	5	14	144	0.70	
	Nyctaloid				2				2	0.01	
	<i>Nyctalus.sp</i>	6							6	0.03	
	Pipistrelle.sp				33 2	1	6			339	1.65
	<i>Plecotus.sp</i>	4		3	1	1	3	1	13	0.06	
	Serotine	1		1	1			1	4	0.02	
	Soprano pipistrelle	19	1	2		41 6		1	439	2.13	
	UNKNOWN			24	19 4				218	1.06	
	Total Count	8528	3079	628	921	4652	574	2193			
2b	Barbastelle					1		1	2	0.04	
	Common pipistrelle	10	4	334	271	1563	218	314	2714	47.87	
	Greater horseshoe	1	2	1			1		5	0.09	
	Leisler's			1	1	1		2	5	0.09	

	Lesser horseshoe	23	50	2	8	35	528	18	664	11.71
	<i>Myotis.sp</i>	2	7	13	5	1741	75	76	1919	33.85
	Noctule	108	120	2	11	9	6	13	269	4.75
	Nyctaloid				1				1	0.02
	<i>Nyctalus.sp</i>	2			4				6	0.11
	Pipistrelle.sp			4			4	8	16	0.28
	<i>Plecotus.sp</i>			3		1	5	18	27	0.48
	Serotine	2				1	1	2	6	0.11
	Soprano pipistrelle			4		8			12	0.21
	UNKNOWN		5	14		3		1	23	0.41
	Total Count	148	188	378	301	3363	838	453		
2c	Barbastelle				1				1	0.05
	Common pipistrelle	129	46	61	335	71	176	27	845	46.00
	Greater horseshoe	1			1	1			3	0.16
	Leisler's	7		1	1				9	0.49
	Lesser horseshoe	3		10	15	27	10	8	73	3.97
	<i>Myotis.sp</i>	18	5	7	88	6	23	30	177	9.64
	Nathusius's pipistrelle				8				8	0.44
	Noctule	298	140	48	30	15	19	8	558	30.38
	Nyctaloid			3					3	0.16
	Pipistrelle.sp			2	88	3		4	97	5.28
	<i>Plecotus.sp</i>	1			8	3	9	16	37	2.01
	Serotine	2			10	2			14	0.76
	Soprano pipistrelle	2	1		2	1			6	0.33
	UNKNOWN	3		3					6	0.33
	Total Count	464	192	135	587	129	237	93		
3a	Barbastelle		1					1	2	0.17
	Common pipistrelle	28	53	34	95	34	7	48	299	24.73
	Greater horseshoe	2		1					3	0.25
	Leisler's		1	1	4		1		7	0.58
	Lesser horseshoe		5	1	5	2	5	21	39	3.23
	<i>Myotis.sp</i>		4	56	106	34	31	58	289	23.90
	Noctule	102	196	8	7	10 7	2	3	425	35.15
	Nyctaloid			7	2				9	0.74
	<i>Nyctalus.sp</i>	2	2						4	0.33
	Pipistrelle.sp	2		9	9				20	1.65
	<i>Plecotus.sp</i>		3	6	43	15	2		69	5.71
	Serotine	1	1	1	2	10			15	1.24
	Soprano pipistrelle			3	1				4	0.33
UNKNOWN			14	5	4		1	24	1.99	

	Total Count	137	266	141	279	206	48	132		
3b	Barbastelle							1	1	0.05
	Common pipistrelle	210	217			276	104	49	856	46.75
	Greater horseshoe		1						1	0.05
	Leisler's		2			50	14		66	3.60
	Lesser horseshoe	1	3	3	3	9	26	28	73	3.99
	<i>Myotis.sp</i>	8	8	2		77	40	62	197	10.76
	Noctule	109	175	6		272	3	5	570	31.13
	<i>Nyctalus.sp</i>			1					1	0.05
	Pipistrelle.sp					11			11	0.60
	<i>Plecotus.sp</i>	2				15	2		19	1.04
	Serotine	1	1			20			22	1.20
	Soprano pipistrelle	1	1			4			6	0.33
	UNKNOWN			2		5		1	8	0.44
	Total Count	332	408	14	3	739	189	146		
3c	Common pipistrelle		18	2	3	5	21	75	124	11.44
	Leisler's		9	2		2	3		16	1.48
	Lesser horseshoe	1	3				60	174	238	21.96
	<i>Myotis.sp</i>	12			1	1	72	310	396	36.53
	Noctule		221	2	2	38	4	12	279	25.74
	Nyctaloid			1	3				4	0.37
	<i>Nyctalus.sp</i>		4						4	0.37
	Pipistrelle.sp						2	4	6	0.55
	<i>Plecotus.sp</i>						1	7	8	0.74
	Serotine		1					1	2	0.18
	Soprano pipistrelle							4	4	0.37
	UNKNOWN			1	1			1	3	0.28
	Total Count	13	256	8	10	46	163	588		
4a	Common pipistrelle	1		80	1	6	1	9	98	41.88
	Lesser horseshoe	2	2	2		2	3	11	22	9.40
	<i>Myotis.sp</i>	44	1	2	1	15	14	8	85	36.32
	Noctule	3	7	2		2		7	21	8.97
	Pipistrelle.sp	1							1	0.43
	Serotine	3							3	1.28
	UNKNOWN	1		1				2	4	1.71
Total Count	55	10	87	2	25	18	37			
4b	Common pipistrelle	70	72	307	357	201	90	60	1157	62.91
	Greater horseshoe	1	1	35				1	38	2.07
	Leisler's			1				16	17	0.92
	Lesser horseshoe	10	36	5	74	109	1	12	247	13.43

	<i>Myotis.sp</i>	79	13	94	38	7	9	1	241	13.10
	Noctule	9	4	8	2		3	1	27	1.47
	Nyctaloid			1					1	0.05
	<i>Nyctalus.sp</i>	1					1		2	0.11
	Pipistrelle.sp			43					43	2.34
	<i>Plecotus.sp</i>	1	2	2		1			6	0.33
	Serotine	5	1	5	1	1		5	18	0.98
	Soprano pipistrelle	1						2	3	0.16
	UNKNOWN			39					39	2.12
	Total Count	177	129	540	472	319	104	98		
4c-a	Common pipistrelle			202	151				353	51.84
	Greater horseshoe			1	8				9	1.32
	Leisler's			1	15				16	2.35
	Lesser horseshoe			19	126				145	21.29
	<i>Myotis.sp</i>			49	22				71	10.43
	Noctule			9	10				19	2.79
	Nyctaloid			7					7	1.03
	Pipistrelle.sp			9	10				19	2.79
	Serotine			2	5				7	1.03
	Soprano pipistrelle			1	5				6	0.88
	UNKNOWN			29					29	4.26
Total Count			329	352						
4c-b	Common pipistrelle	32	13			19 92	56	39 40	6033	94.32
	Greater horseshoe					2		1	3	0.05
	Leisler's					3		9	12	0.19
	Lesser horseshoe	16	16			3	46	22	103	1.61
	<i>Myotis.sp</i>	39	17			43	6	74	179	2.80
	Noctule	5	7			9	2	10	33	0.52
	Pipistrelle.sp		1			1		4	6	0.09
	<i>Plecotus.sp</i>	1				1			2	0.03
	Serotine	3	1			2		2	8	0.13
	Soprano pipistrelle	1				11		3	15	0.23
	UNKNOWN	1						1	2	0.03
Total Count	98	55			2067	110	4066			
5a	Barbastelle		1						1	0.07
	Common pipistrelle	59	43	145	311	112	4	7	681	45.55
	Greater horseshoe	1			1	1	1		4	0.27
	Leisler's		1		5		1		7	0.47
	Lesser horseshoe	4	11	2	14	4	1		36	2.41
	<i>Myotis.sp</i>	6		20	43	54	23	2	148	9.90

	Nathusius's pipistrelle			2			1	3	0.20	
	Noctule	66	316	1	3	20	5	1	412	27.56
	Nyctaloid			1	2				3	0.20
	<i>Nyctalus.sp</i>	2	1						3	0.20
	Pipistrelle.sp		5	4	66		2		77	5.15
	<i>Plecotus.sp</i>					6	13	2	21	1.40
	Serotine		14		1	2	1		18	1.20
	Soprano pipistrelle			1		11			12	0.80
	UNKNOWN		15	27	26		1		69	4.62
	Total Count	138	407	201	474	210	52	13		
5b	Common pipistrelle	5		9	528	48	2	50	642	59.89
	Leisler's			5	18				23	2.15
	Lesser horseshoe			3	18		4	12	37	3.45
	<i>Myotis.sp</i>	26		5	90	16	48	58	243	22.67
	Noctule			2	14	26	24	8	74	6.90
	<i>Nyctalus.sp</i>	1							1	0.09
	Pipistrelle.sp			2				6	8	0.75
	<i>Plecotus.sp</i>						2	20	22	2.05
	Serotine	2				6			8	0.75
	Soprano pipistrelle					6			6	0.56
	UNKNOWN			4	4				8	0.75
Total Count	34		30	672	102	80	154			
5c	Barbastelle							1	1	0.04
	Common pipistrelle	2	17	137	359	187	146	365	1213	49.47
	Greater horseshoe	1	1	4	2		1		9	0.37
	Leisler's		1			4		1	6	0.24
	Lesser horseshoe	2	13	13	1	1	22	11 8	170	6.93
	<i>Myotis.sp</i>	29	6	9	37	6	26	15 7	270	11.01
	Nathusius's pipistrelle				1		1		2	0.08
	Nathusius's pipistrelle poss				5				5	0.20
	Noctule		242	236	48	31	71	18	646	26.35
	<i>Nyctalus.sp</i>	1	5	3	4				13	0.53
	Pipistrelle.sp			1	4	1	1	5	12	0.49
	<i>Plecotus.sp</i>	4	6	7	6	1	25	13	62	2.53
	Serotine	4	4	3	3	5	7	3	29	1.18
	Soprano pipistrelle			2	2	1			5	0.20
UNKNOWN	1			8				9	0.37	
Total Count	44	295	415	480	237	300	681			
5d	Common pipistrelle	21	65					19 63	2049	46.71
	Lesser horseshoe		672					13 95	2067	47.17

	<i>Myotis.sp</i>	4	13					9	26	0.59
	Noctule	95	106					3	204	4.65
	<i>Nyctalus.sp</i>	1	3						4	0.09
	Pipistrelle.sp		2					1	3	0.07
	<i>Plecotus.sp</i>	1	9					8	18	0.41
	Serotine	1	3						4	0.09
	UNKNOWN	12							12	0.27
	Total Count	135	873						4387	
6a	Barbastelle					3	2		5	0.07
	Common pipistrelle	2	867	388	3618	542	486	54	5957	81.21
	Greater horseshoe		1	1			1		3	0.04
	Leisler's			1		2			3	0.04
	Lesser horseshoe		9	20	10	15	194	14	262	3.57
	<i>Myotis.sp</i>	13	60	50	37	104	331	58	653	8.90
	Noctule	13	153	3	4	4	6	7	190	2.59
	<i>Nyctalus.sp</i>		1						1	0.01
	Pipistrelle.sp			145	1	1	1	3	151	2.06
	<i>Plecotus.sp</i>			2		14	26	24	66	0.90
	Serotine				6	3	3	3	15	0.20
	Soprano pipistrelle		2	6	1	12	2		23	0.31
	UNKNOWN			6					6	0.08
Total Count	28	1093	622	3677	700	1052	163			
6b	Barbastelle		1						1	0.01
	Common pipistrelle	1309	2932	387	635	1111	411	173	6958	76.98
	Greater horseshoe	1			5	1			7	0.08
	Leisler's	2		8	4	1			15	0.17
	Lesser horseshoe	8	37	53	3	31	44	153	329	3.64
	<i>Myotis.sp</i>	13	74	260	13	165	126	101	752	8.32
	Nathusius's pipistrelle			3					3	0.03
	Noctule	274	96	9	9	3	4	5	400	4.43
	Nyctaloid			4					4	0.04
	Pipistrelle.sp	1		452	1	9		3	466	5.16
	<i>Plecotus.sp</i>	3	2	3		5	2	5	20	0.22
	Serotine		1	5	7	6	1		20	0.22
	Soprano pipistrelle		8	1	1	12	2	1	25	0.28
UNKNOWN			39					39	0.43	
Total Count	1611	3151	1224	678	1344	590	441			
6c	Barbastelle				1				1	0.03
	Common pipistrelle	88		89	455	220	44	118	1014	30.85
	Greater horseshoe				1				1	0.03
	Leisler's	2			3			2	7	0.21

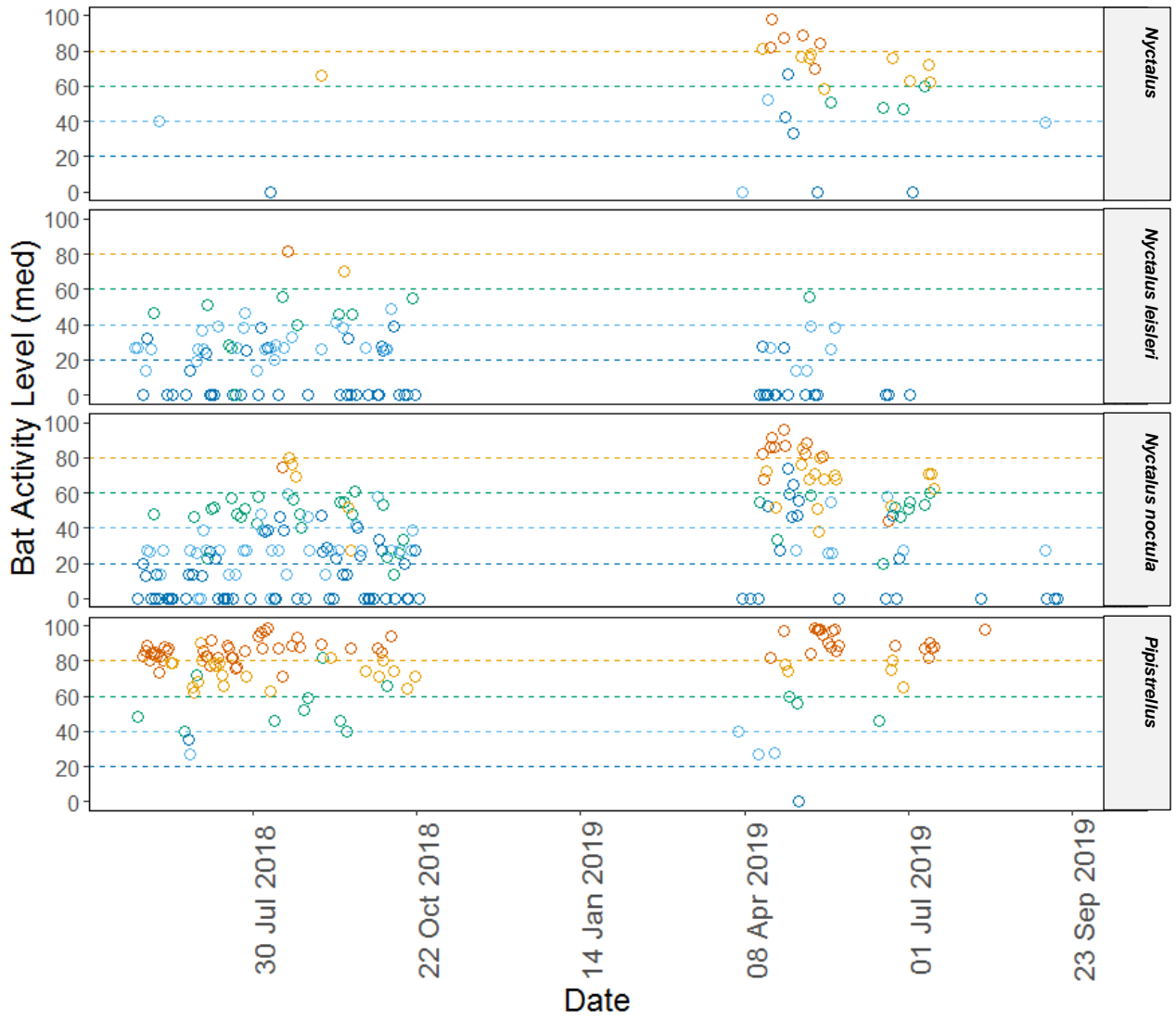
	Lesser horseshoe	7		1	5	75	6	36	130	3.95
	<i>Myotis.sp</i>	5		47	87	11	126	82	358	10.89
	Nathusius's pipistrelle				3				3	0.09
	Noctule	958		9	8	4	8	8	995	30.27
	Pipistrelle.sp			534	18	6	3		561	17.07
	<i>Plecotus.sp</i>			12	18	3	33	15	81	2.46
	Serotine				4	1	4		9	0.27
	Soprano pipistrelle				1	1	2	2	6	0.18
	UNKNOWN			121					121	3.68
	Total Count	1060		813	604	321	226	263		
7a	Common pipistrelle	4		435	112	36	11	1	599	52.45
	Greater horseshoe				7				7	0.61
	Leisler's				8	4	29	7	48	4.20
	Lesser horseshoe		1	9	123	65	17	1	216	18.91
	<i>Myotis.sp</i>	11	1	9	16	9	25		71	6.22
	Noctule	1	3	8	10	13	21	7	63	5.52
	<i>Nyctalus.sp</i>	1	2	3					6	0.53
	Pipistrelle.sp			1		2	1		4	0.35
	<i>Plecotus.sp</i>	16		1		10	15		42	3.68
	Serotine	6	3	26	11	9	12	3	70	6.13
	Soprano pipistrelle			3	5				8	0.70
	UNKNOWN			8					8	0.70
Total Count	39	10	503	292	148	131	19			
7b	Common pipistrelle	42	23	3	706	684	127	4	1589	50.02
	Leisler's	1	3			7			11	0.35
	Lesser horseshoe	131	105	20	35	2		13	306	9.63
	<i>Myotis.sp</i>	2	2	5	23 3	11	16	12	281	8.84
	Noctule	646	228	1	4	4	2	2	887	27.92
	Nyctaloid			1					1	0.03
	<i>Nyctalus.sp</i>	2		2					4	0.13
	Pipistrelle.sp	1		1	3				5	0.16
	<i>Plecotus.sp</i>	3	1	2	29	7	10		52	1.64
	Serotine	3	6	7	3	8			27	0.85
	Soprano pipistrelle			1	11		2		14	0.44
Total Count	831	368	43	1024	723	157	31			
7c	Common pipistrelle	3	25	469 9	321 7	231 8	97	581	10940	85.99
	Leisler's				7	1	2		10	0.08
	Lesser horseshoe			1	8	2	6	3	20	0.16
	<i>Myotis.sp</i>	34	5	477	633	139	6	11	1305	10.26
	Nathusius's pipistrelle							1	1	0.01

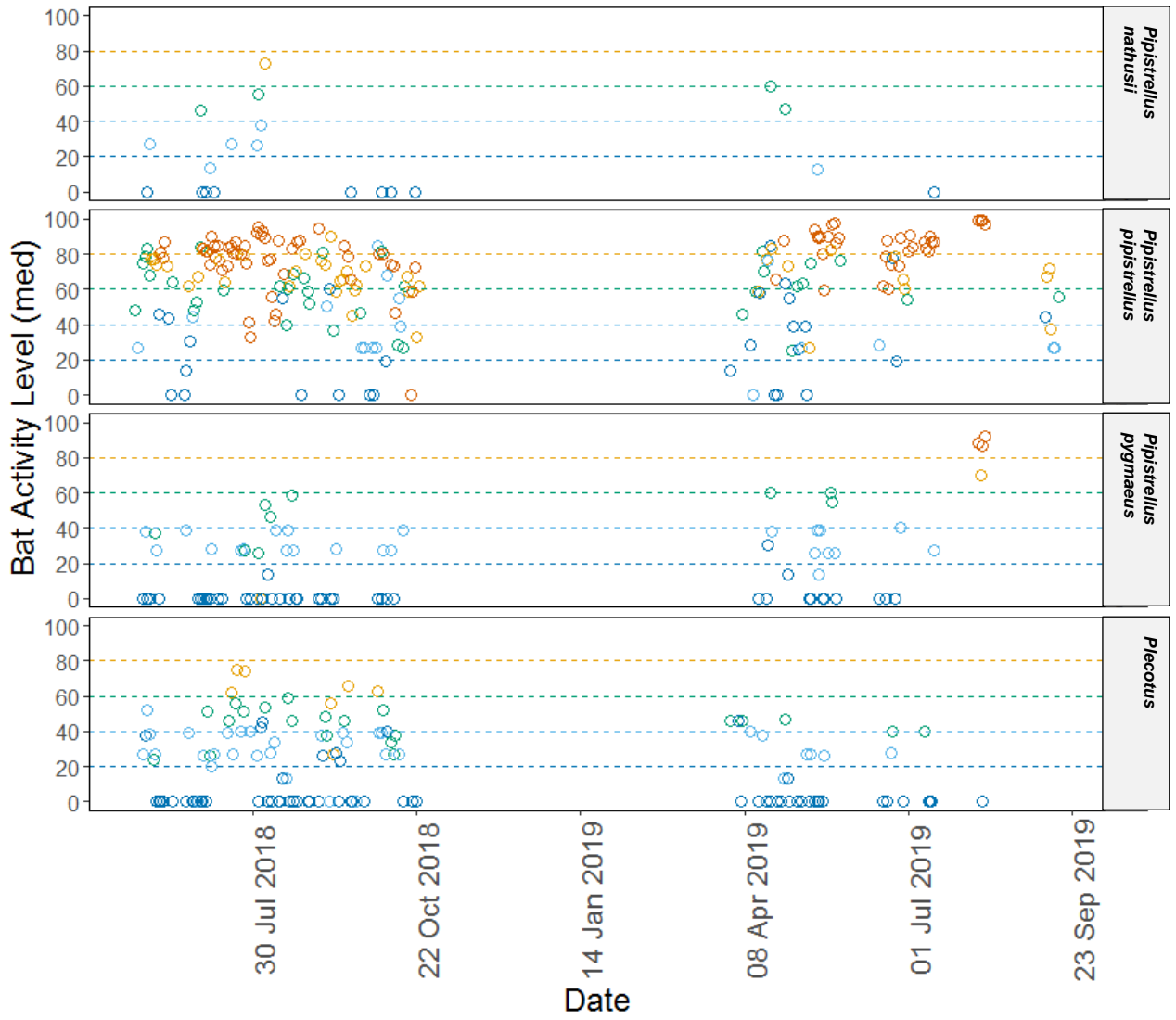
	Noctule			3	6	1		1	11	0.09
	Nyctaloid				32				32	0.25
	<i>Nyctalus.sp</i>					1			1	0.01
	Pipistrelle.sp	3			102	1			106	0.83
	<i>Plecotus.sp</i>	8		2	23	3	1	1	38	0.30
	Serotine			4	20	147			171	1.34
	Soprano pipistrelle				2	1			3	0.02
	UNKNOWN				84			1	85	0.67
	Total Count	48	30	5186	4134	2614	112	599		

Appendix H - Additional Ecobat Data

Figure 1. The activity level (percentile) of bats recorded across each night of the bat survey, split by species.



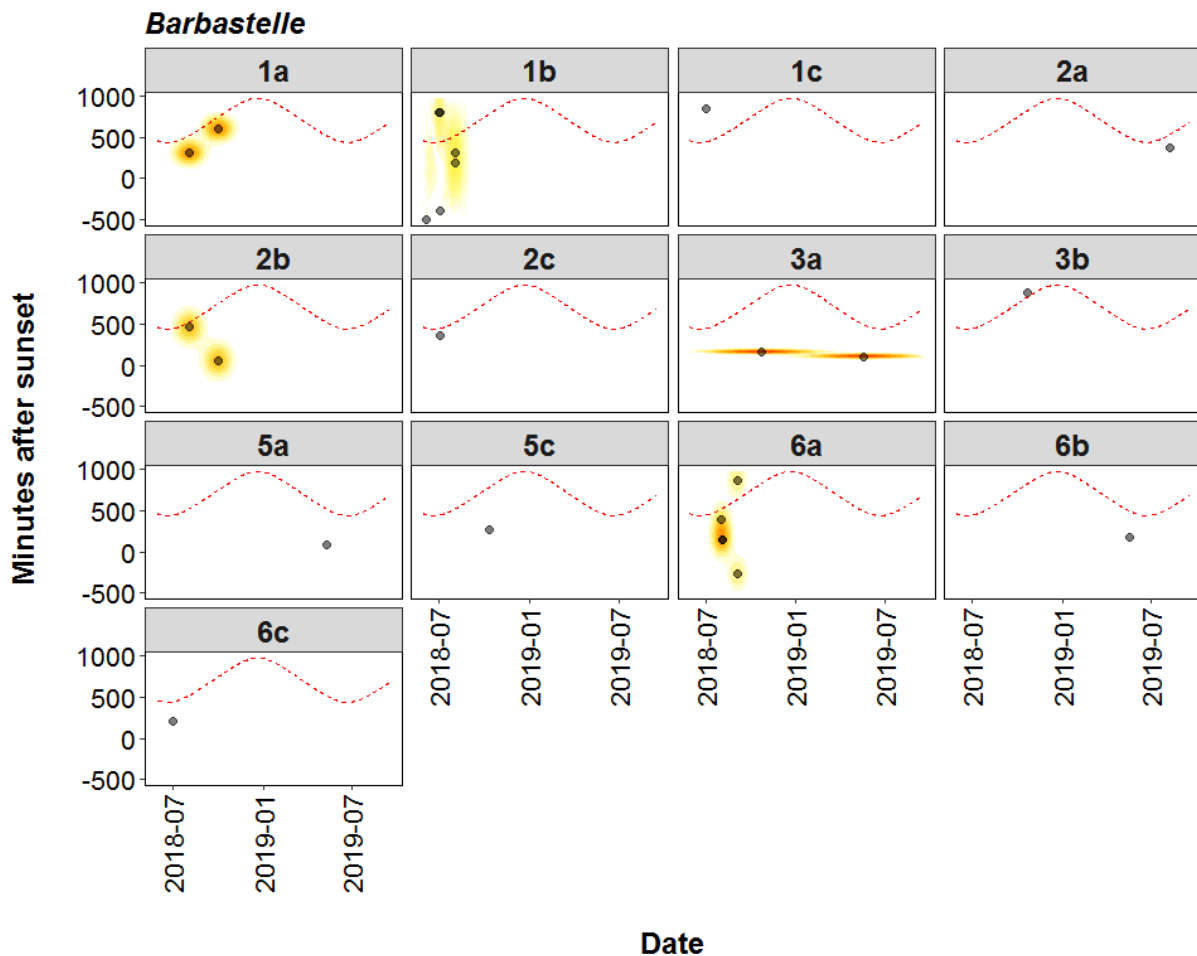


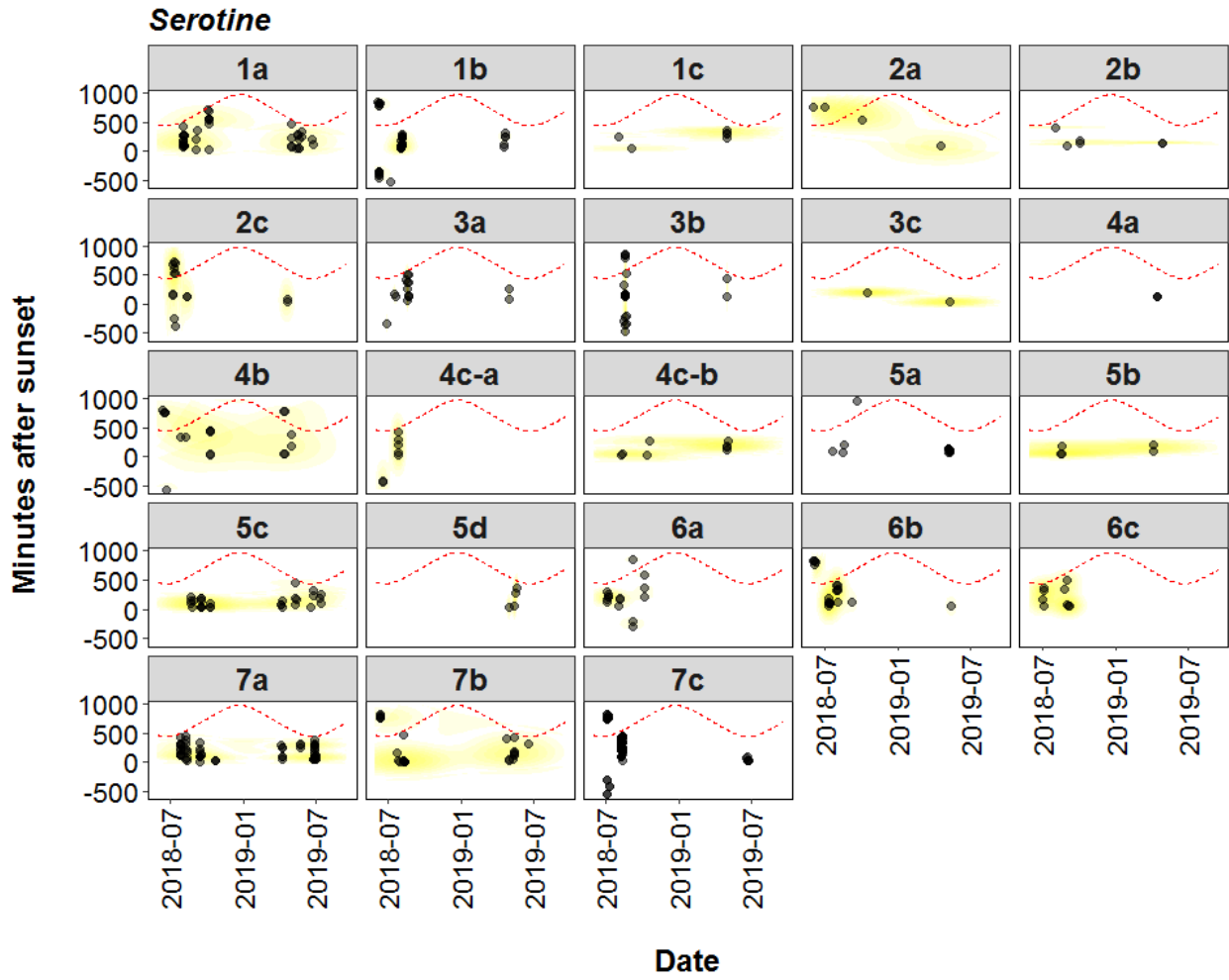


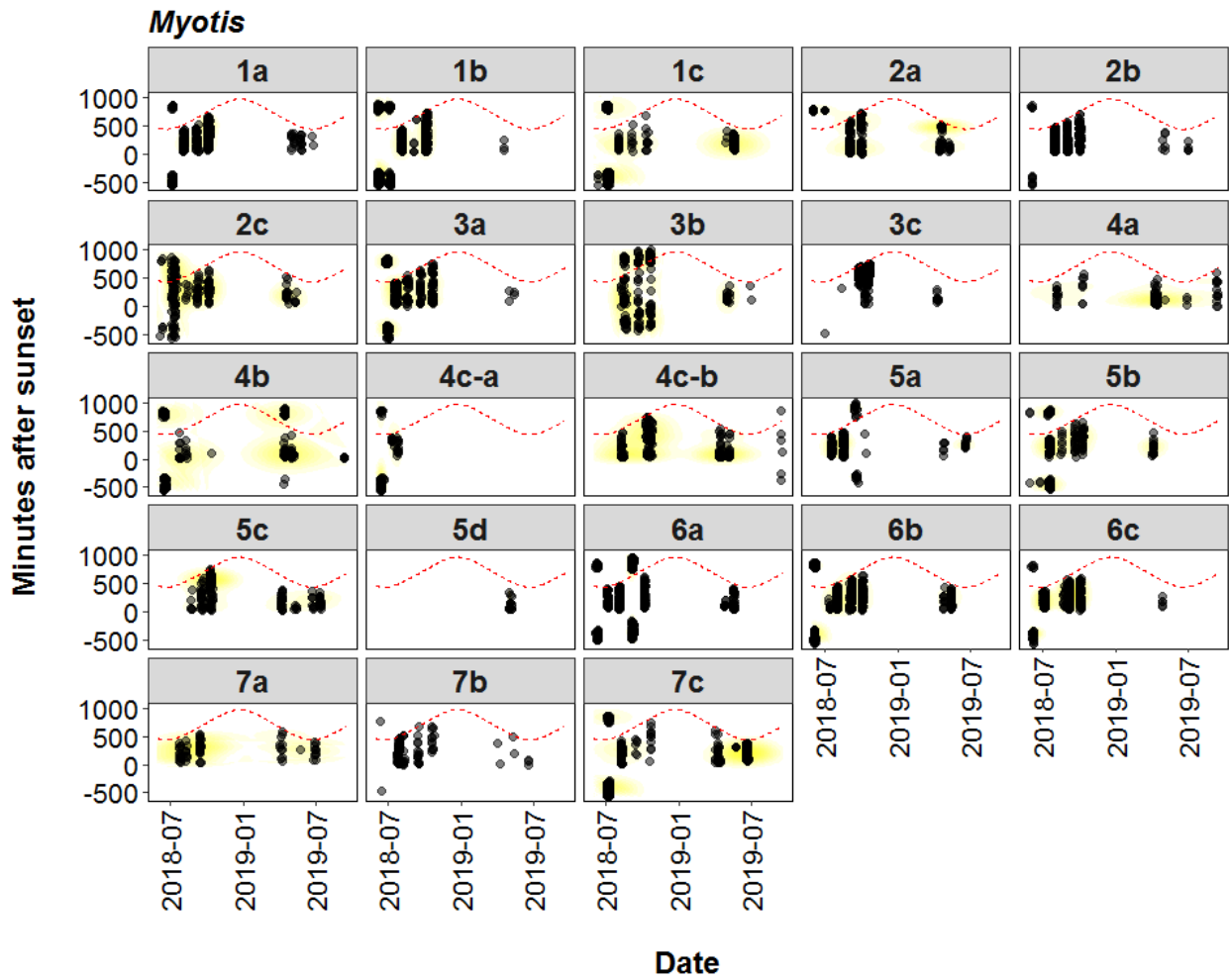
Per Detector

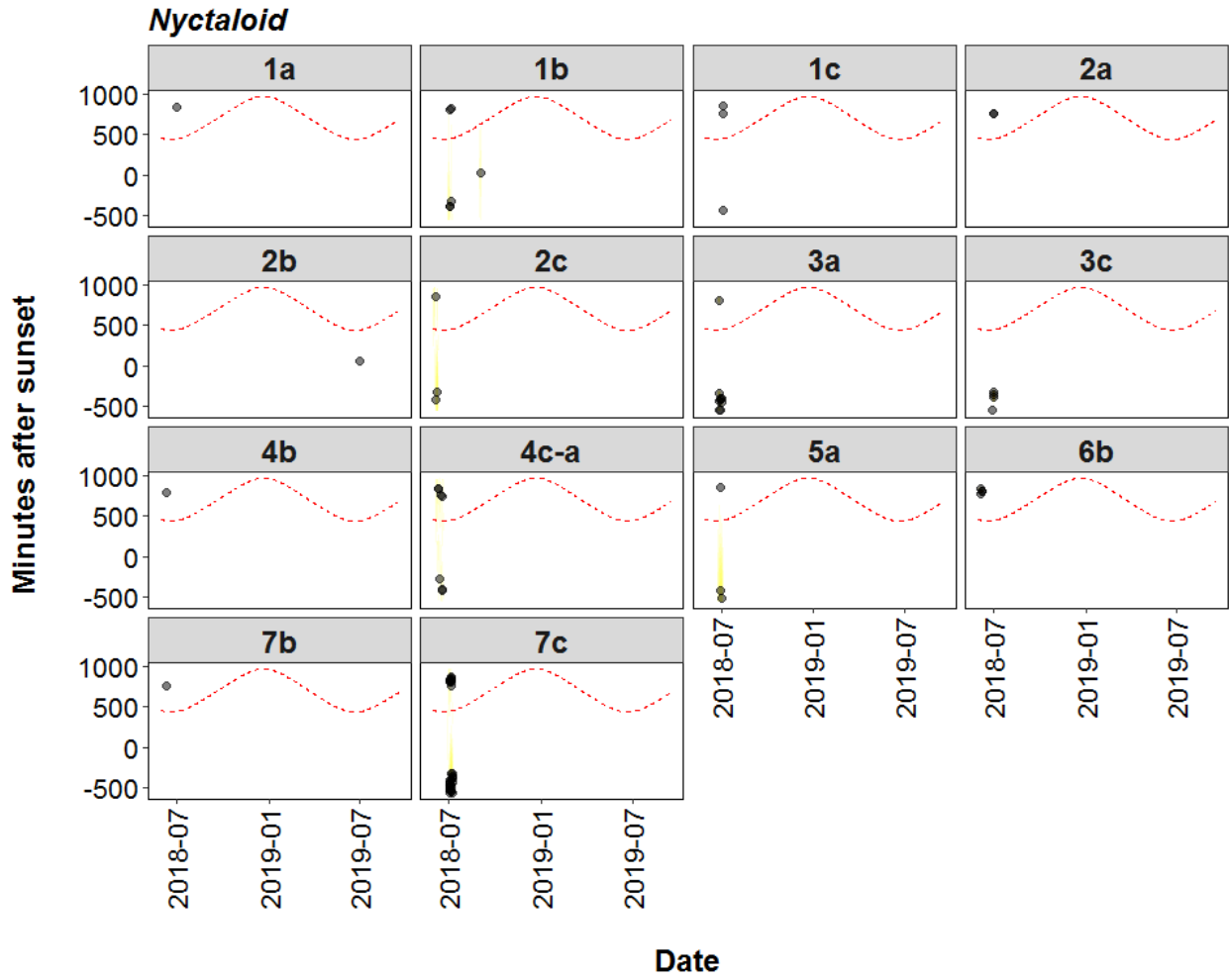
Timing of bat calls plotted as minutes before/after sunset, whereby 0 on the y axis represents sunset. Sunrise throughout the survey period is depicted as the red dashed line. Colours indicate kernel densities, with darkest colours showing peaks of activity. These colours are comparative only within each plot, and do not account for overall activity.

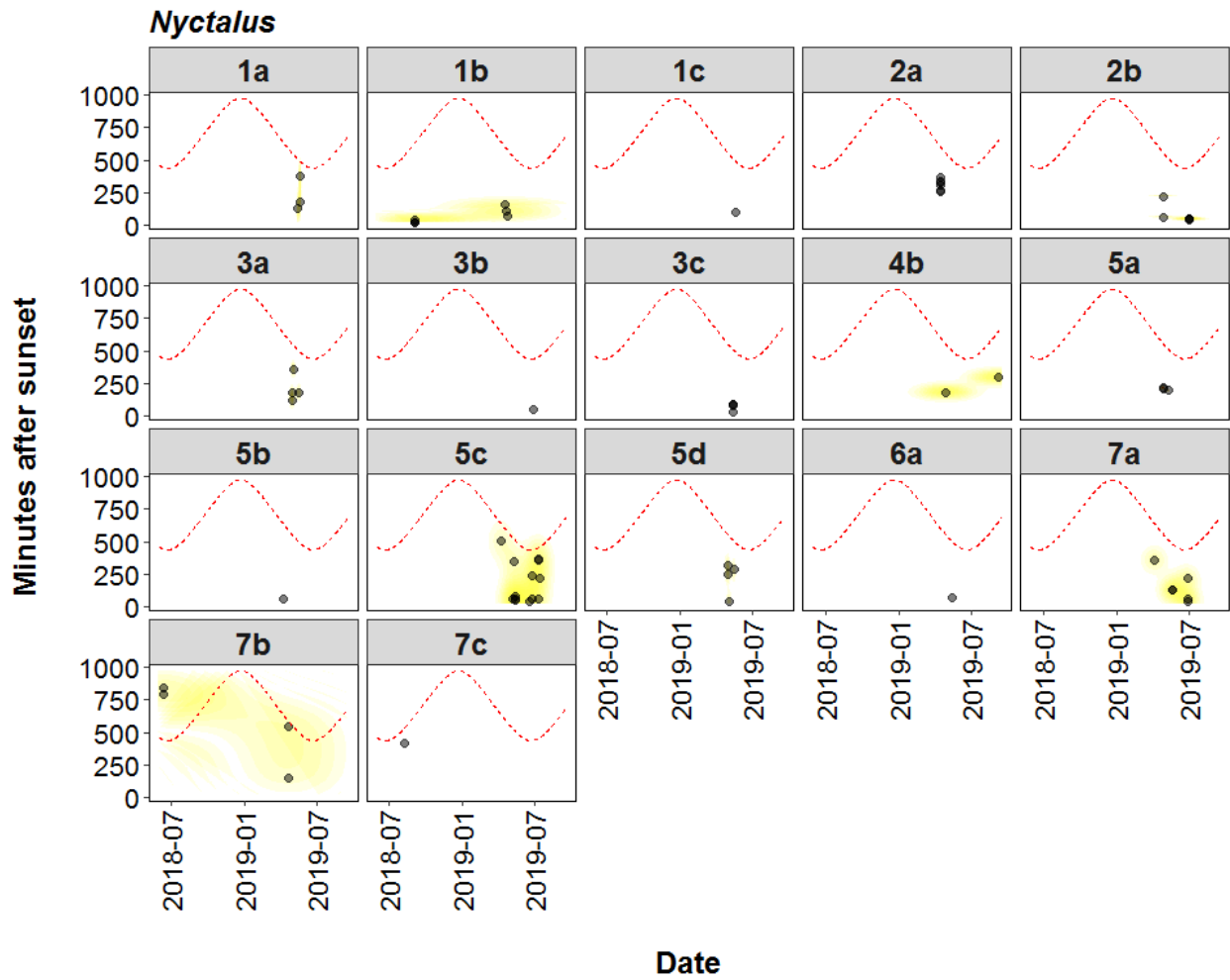
Figure 2 Distribution of Bat Activity Across the Night through Time

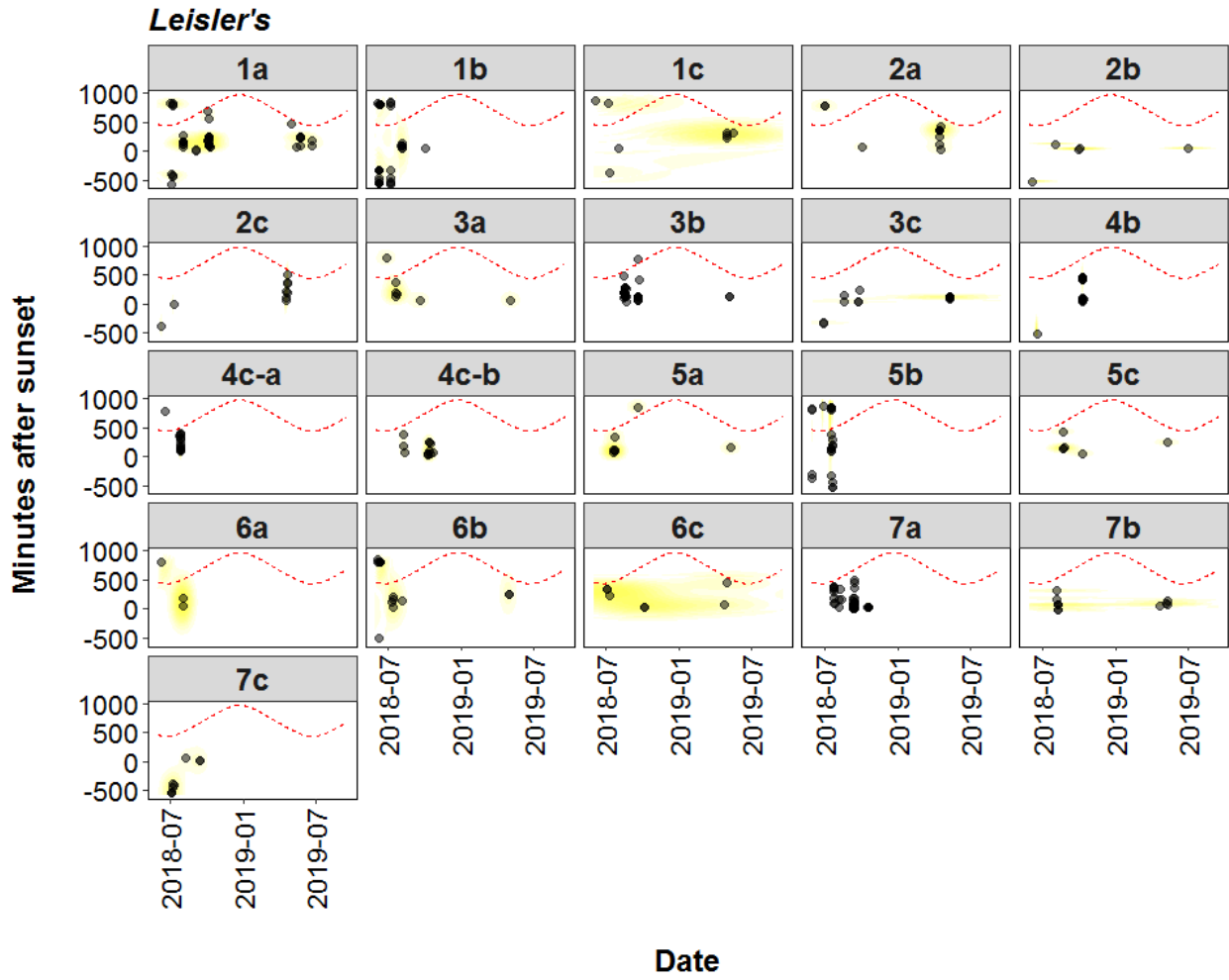


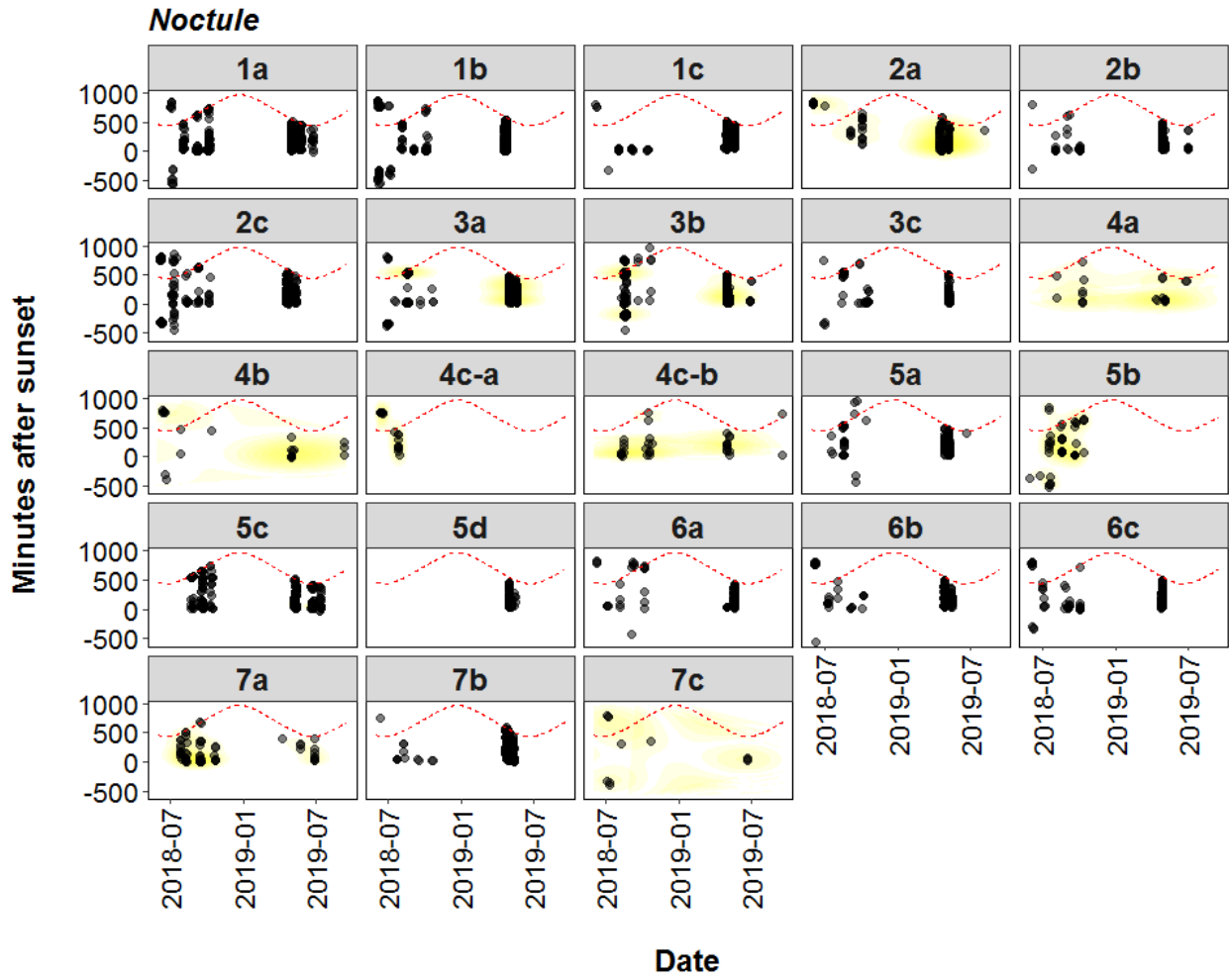


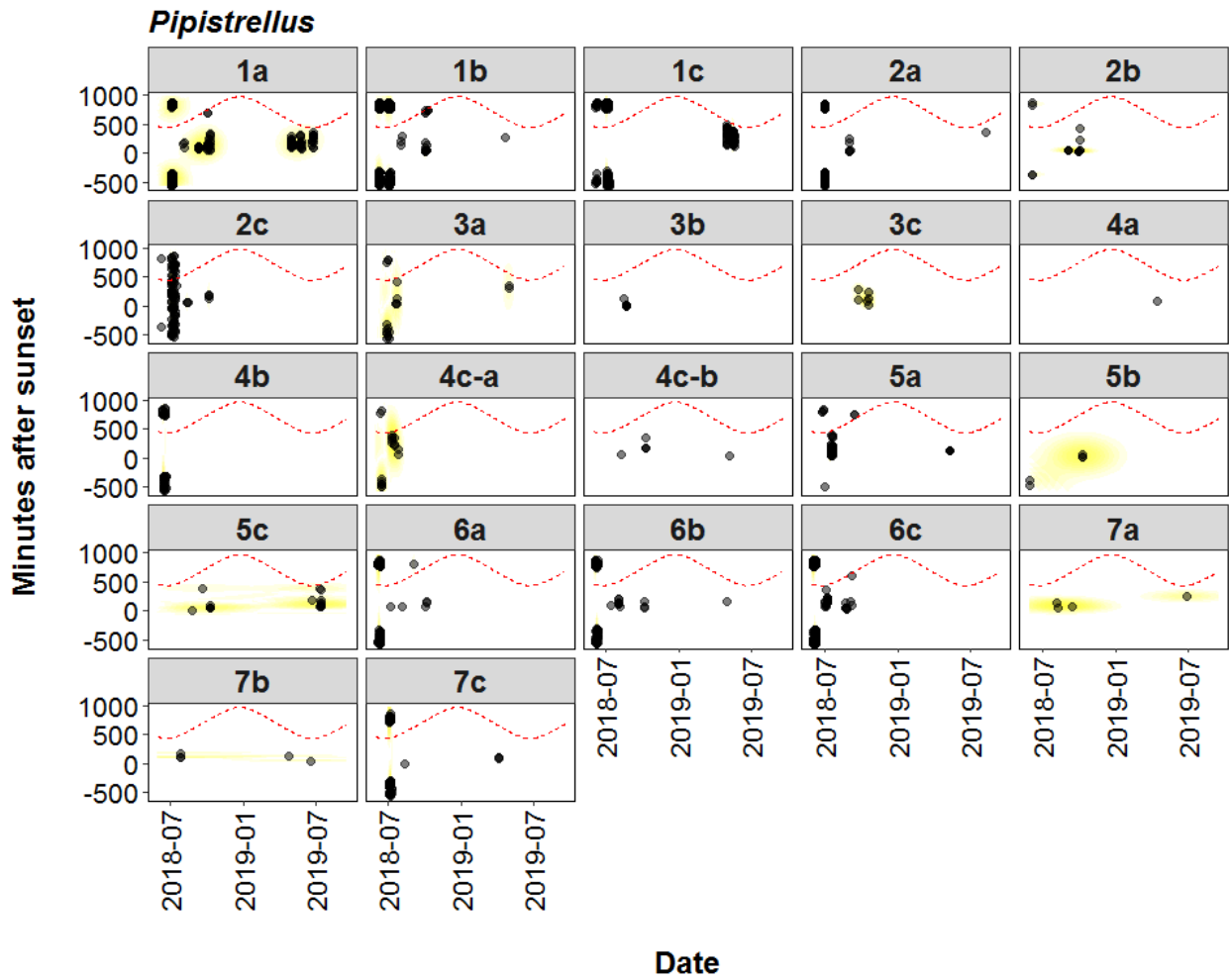


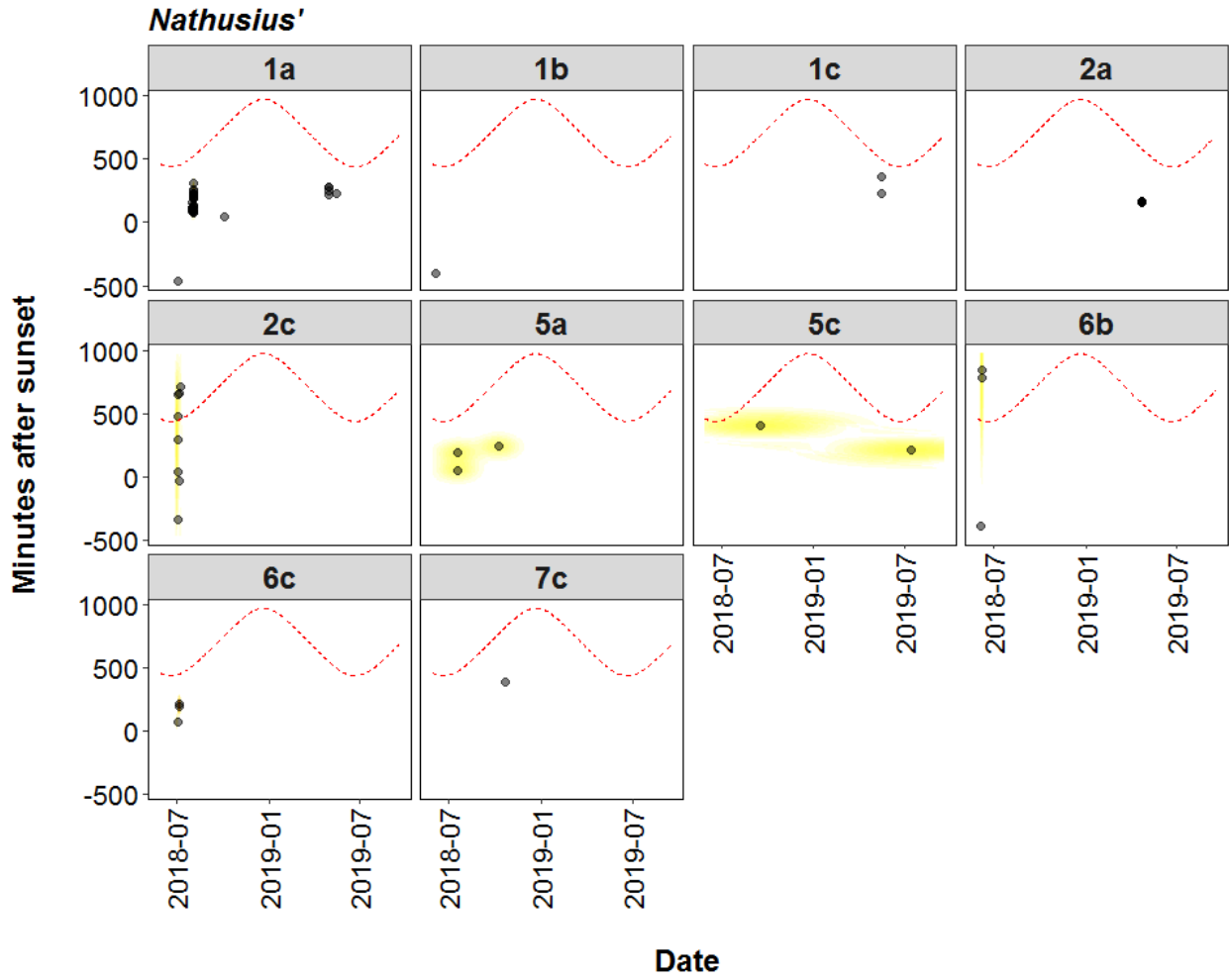


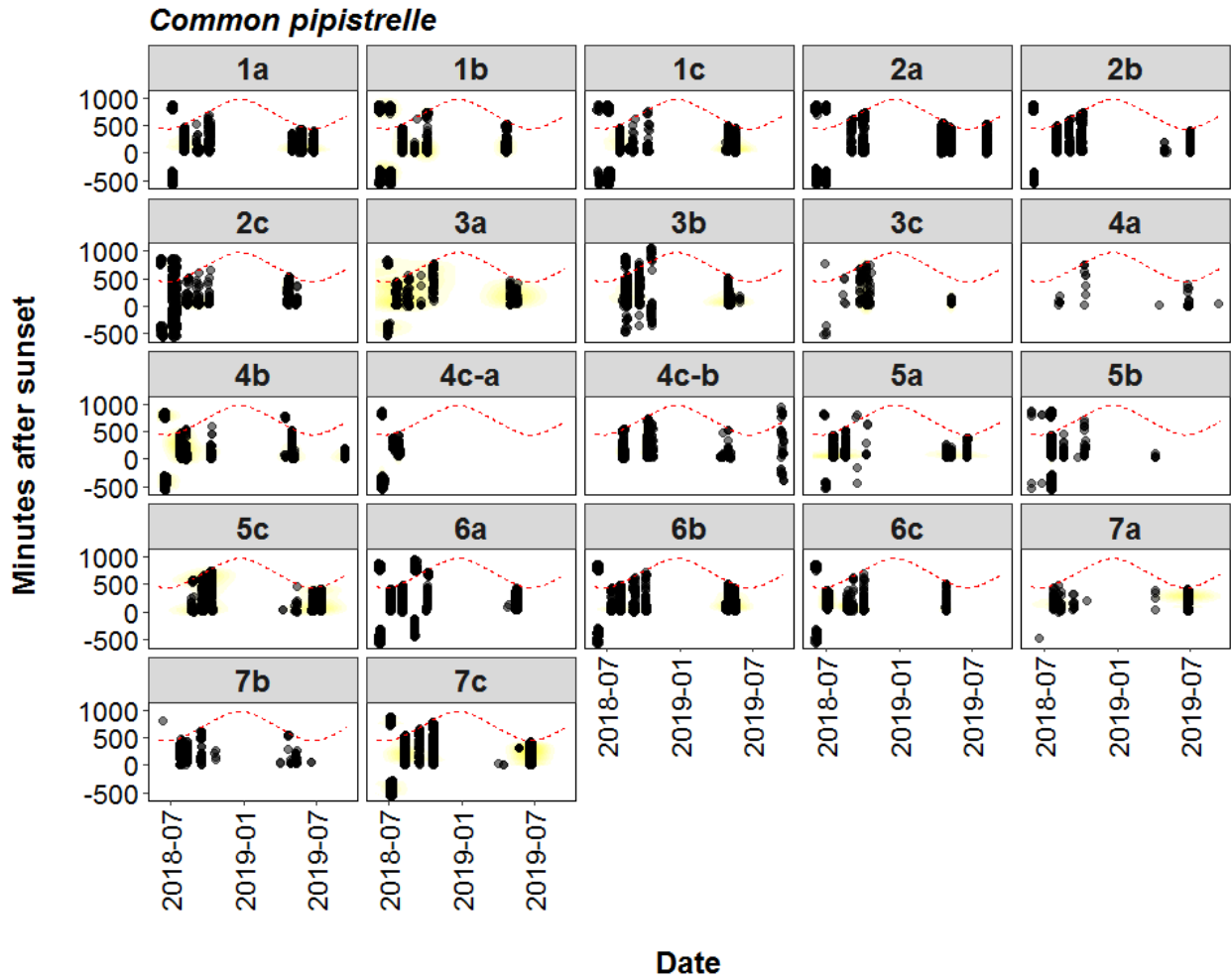


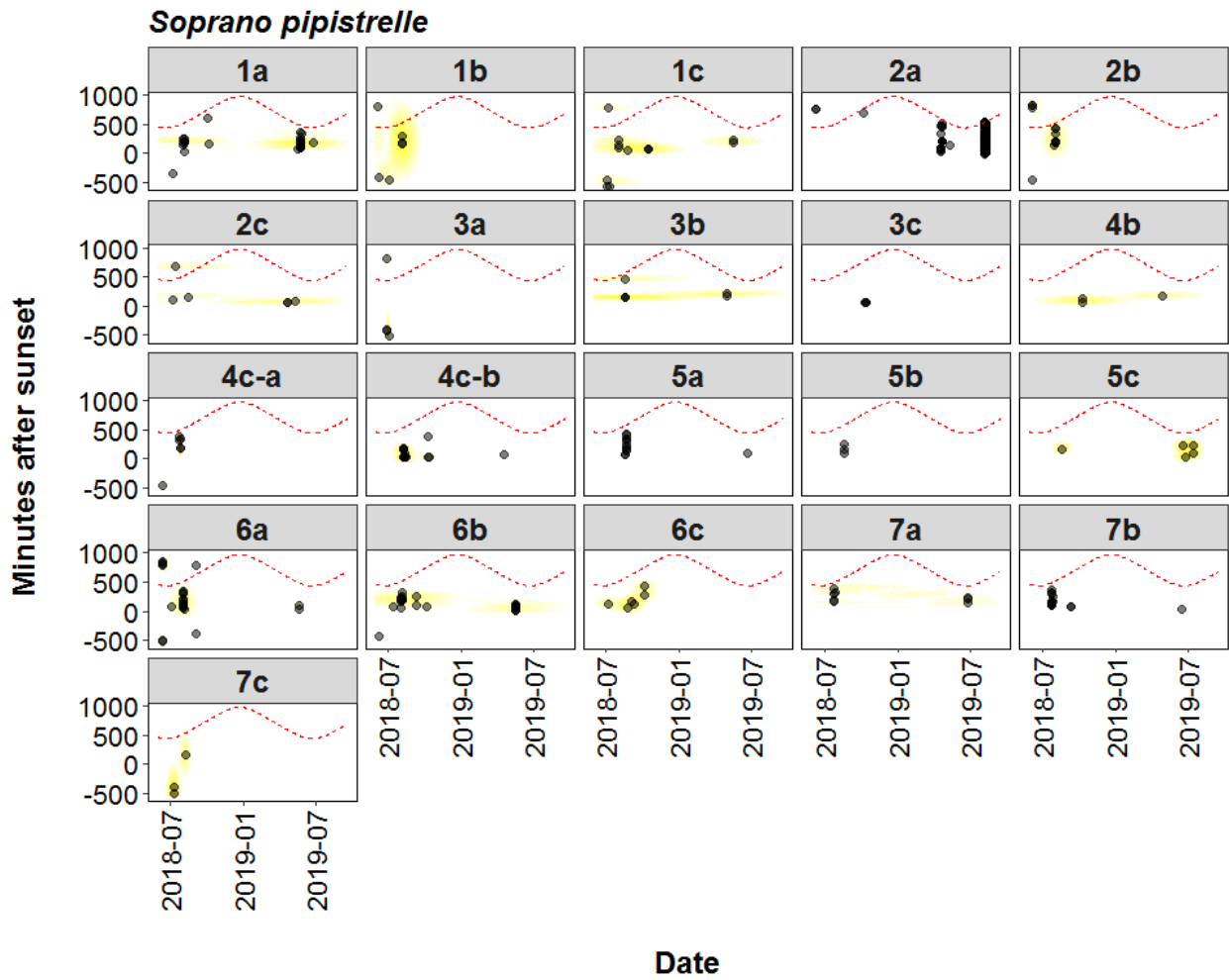


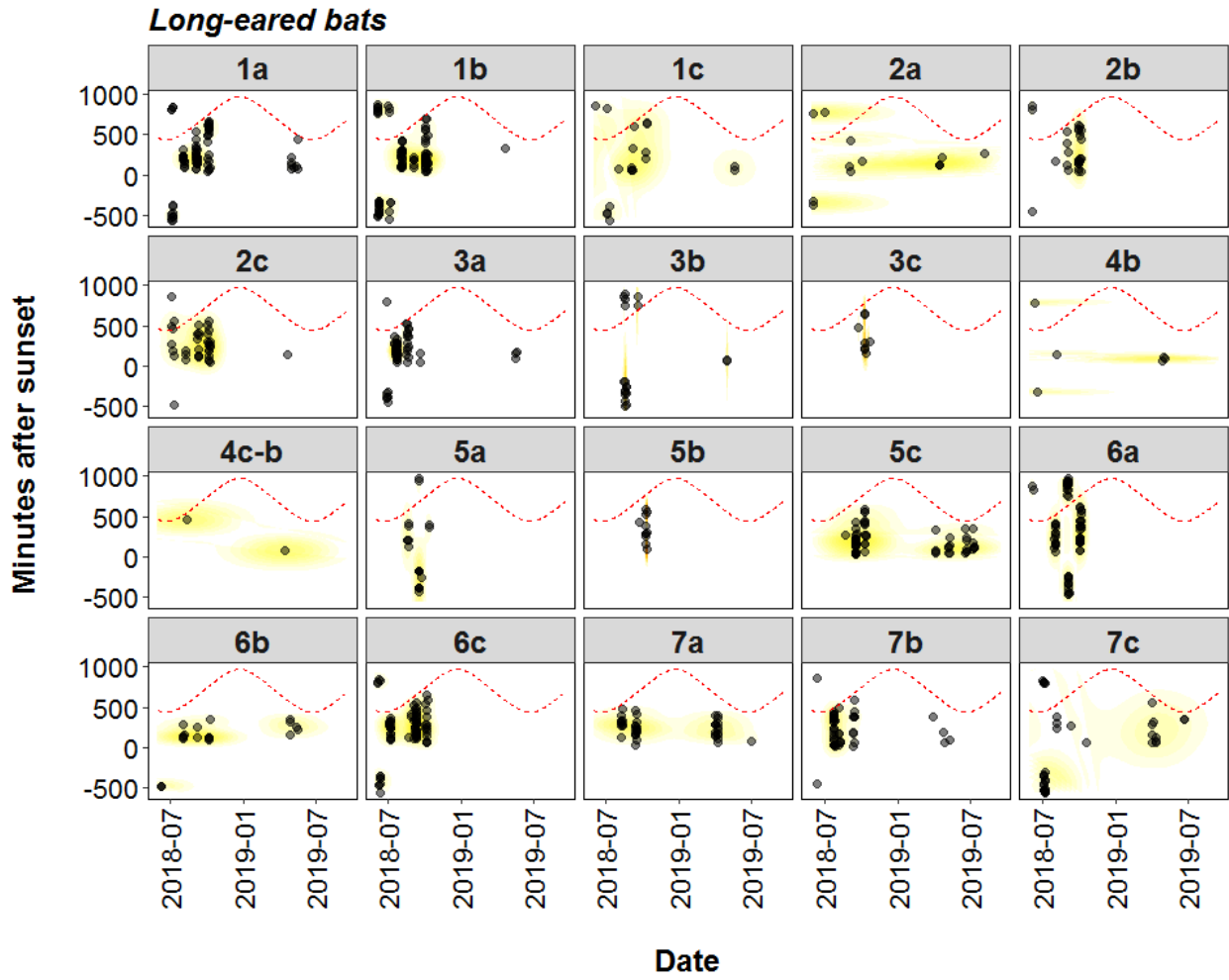


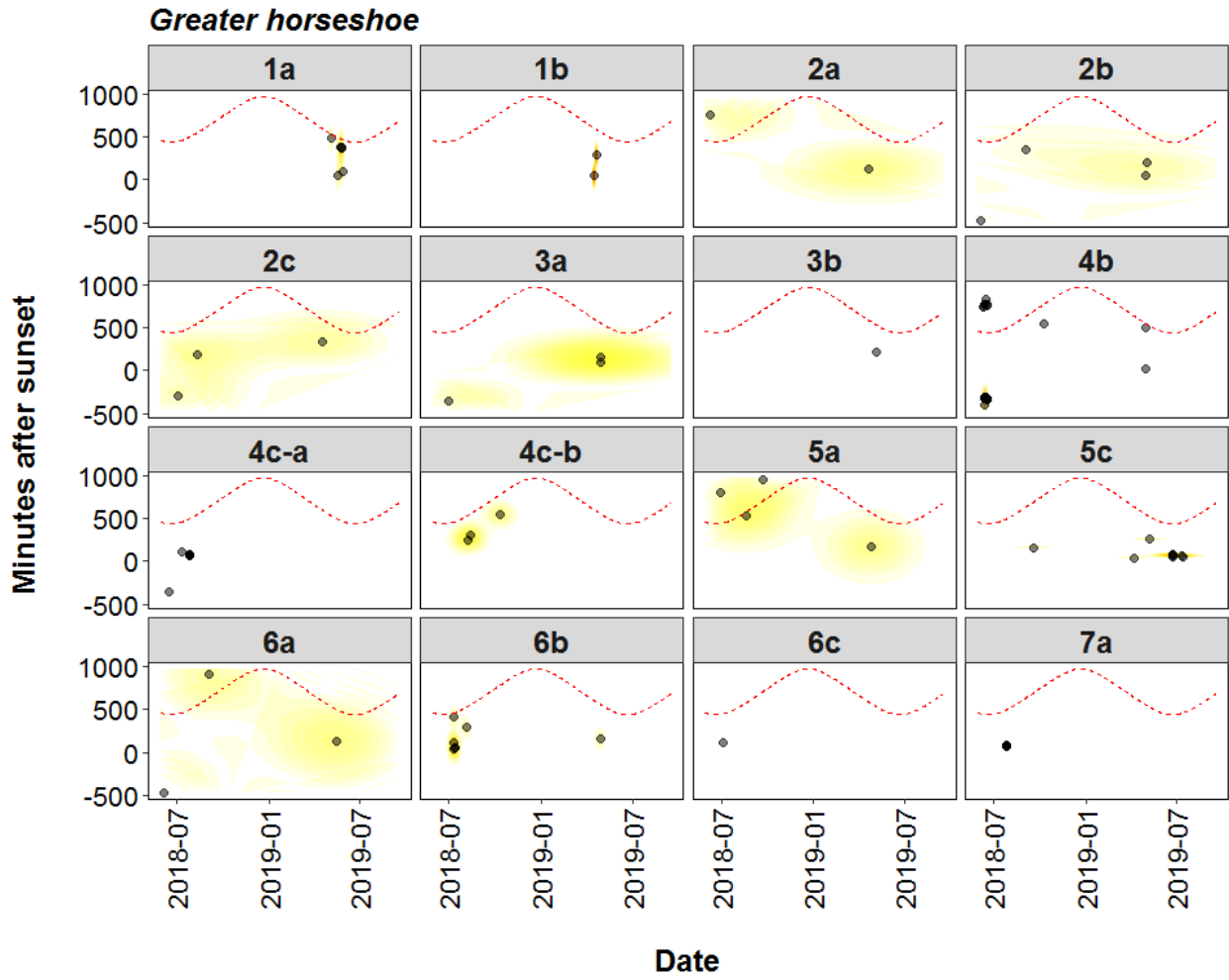


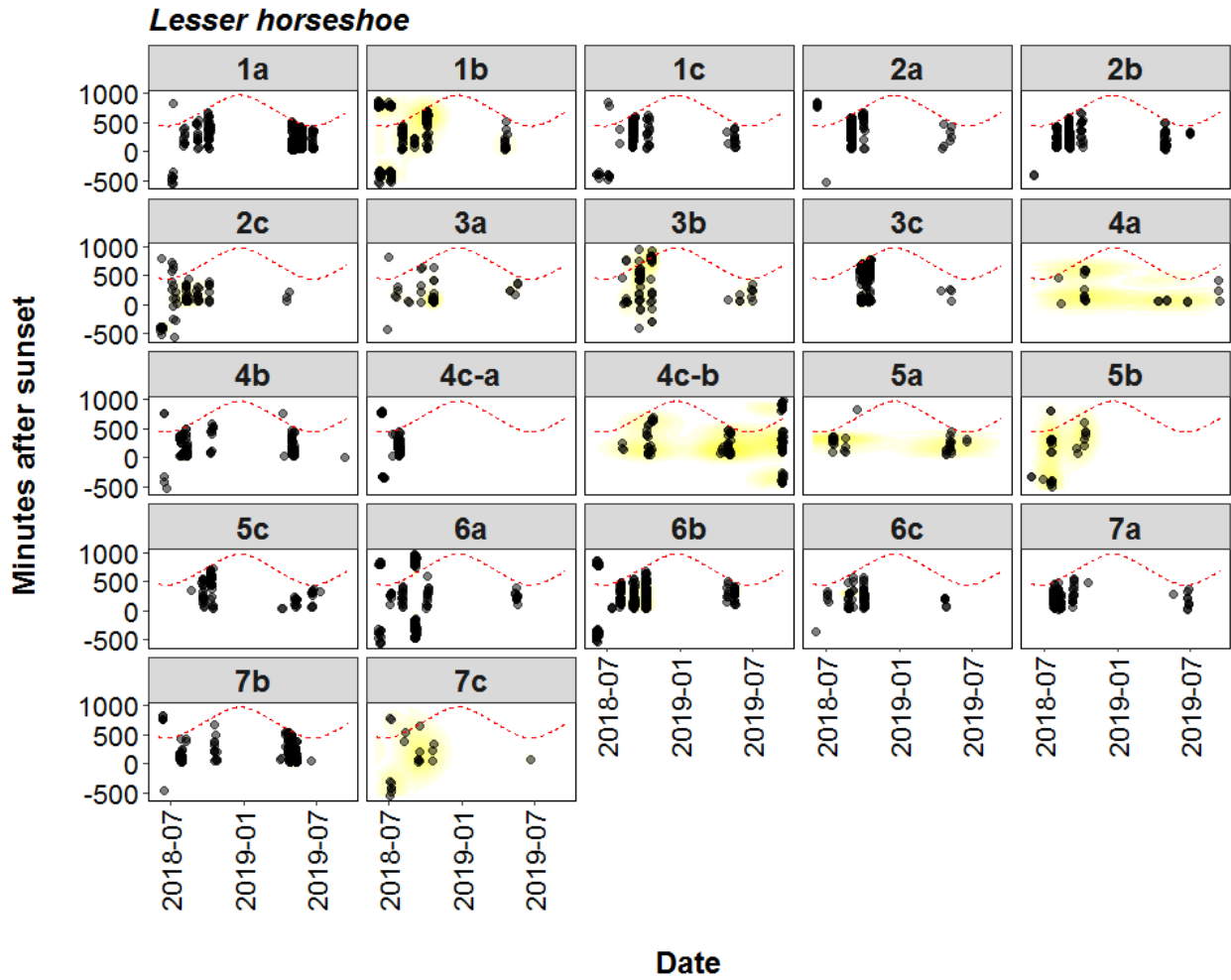








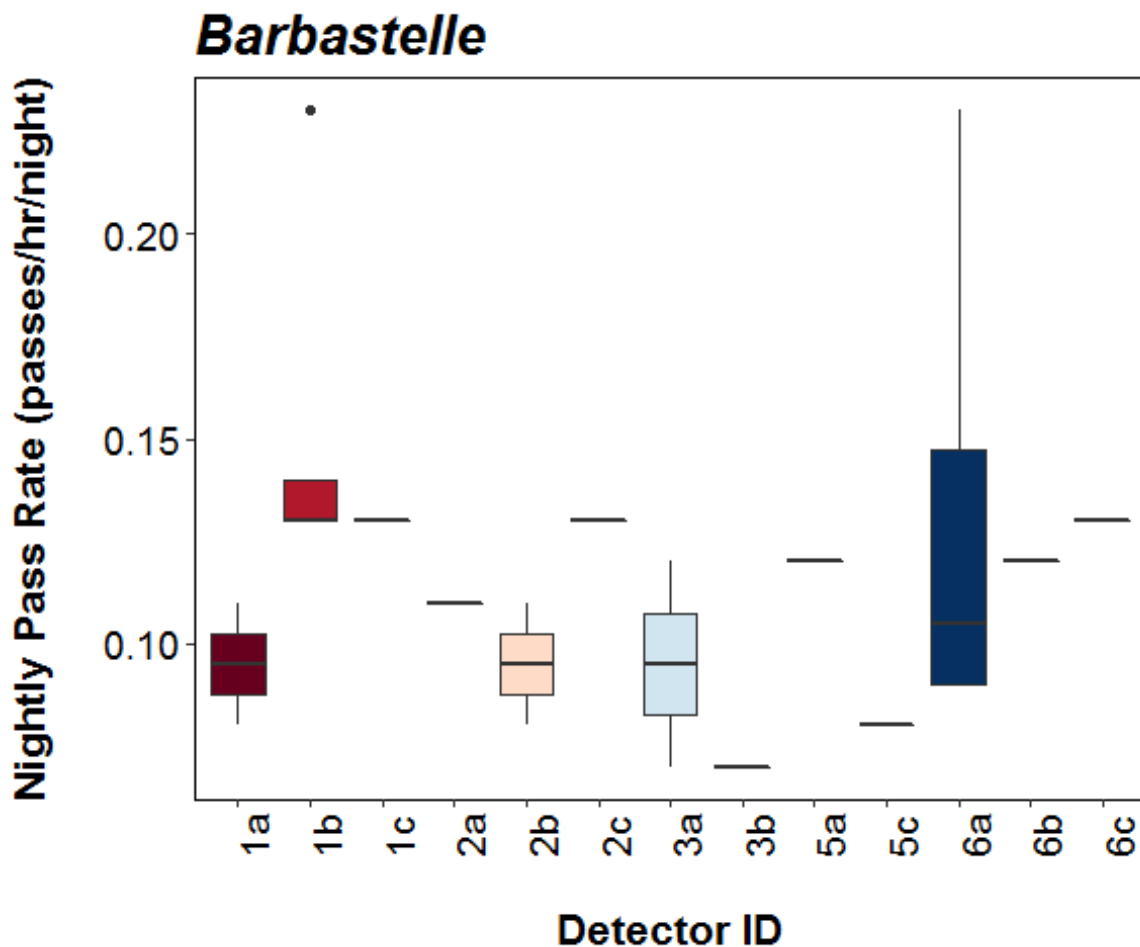




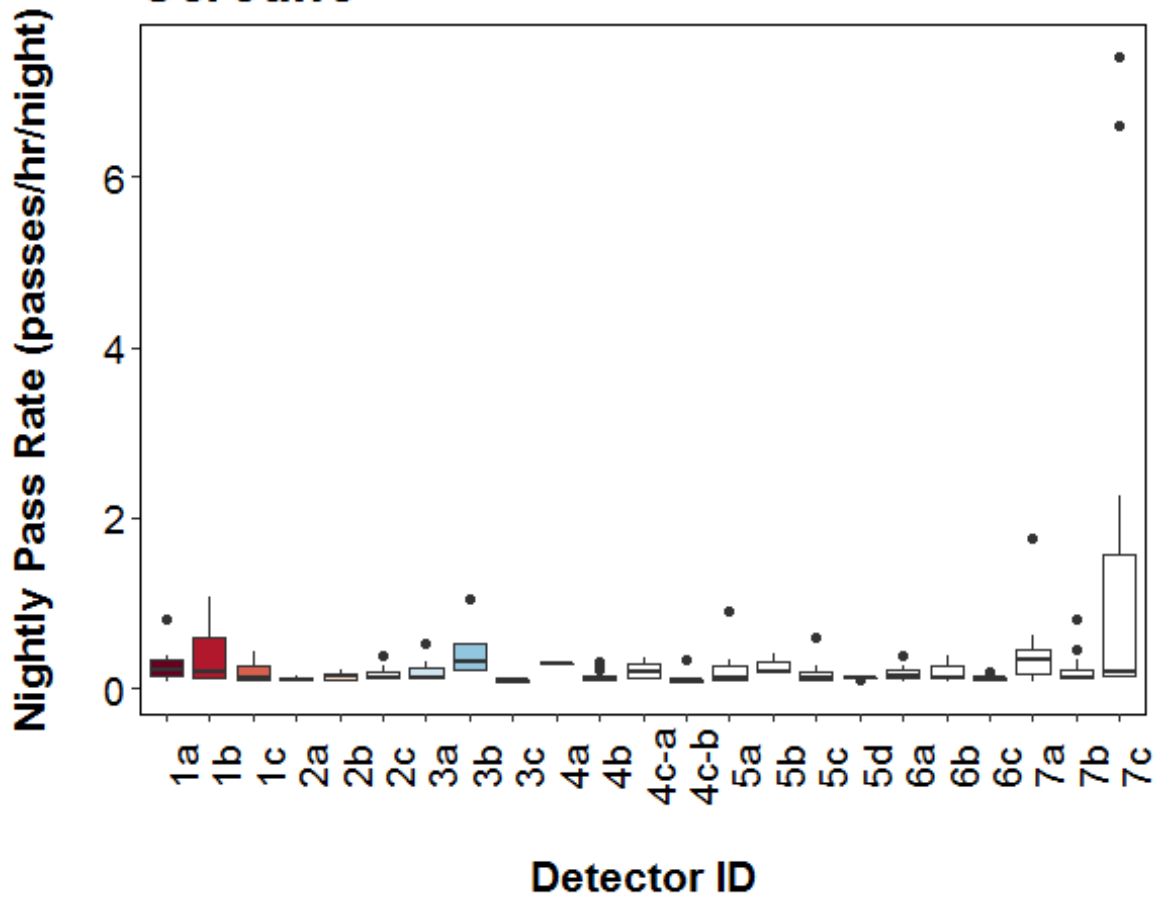
Per Detector - Figures

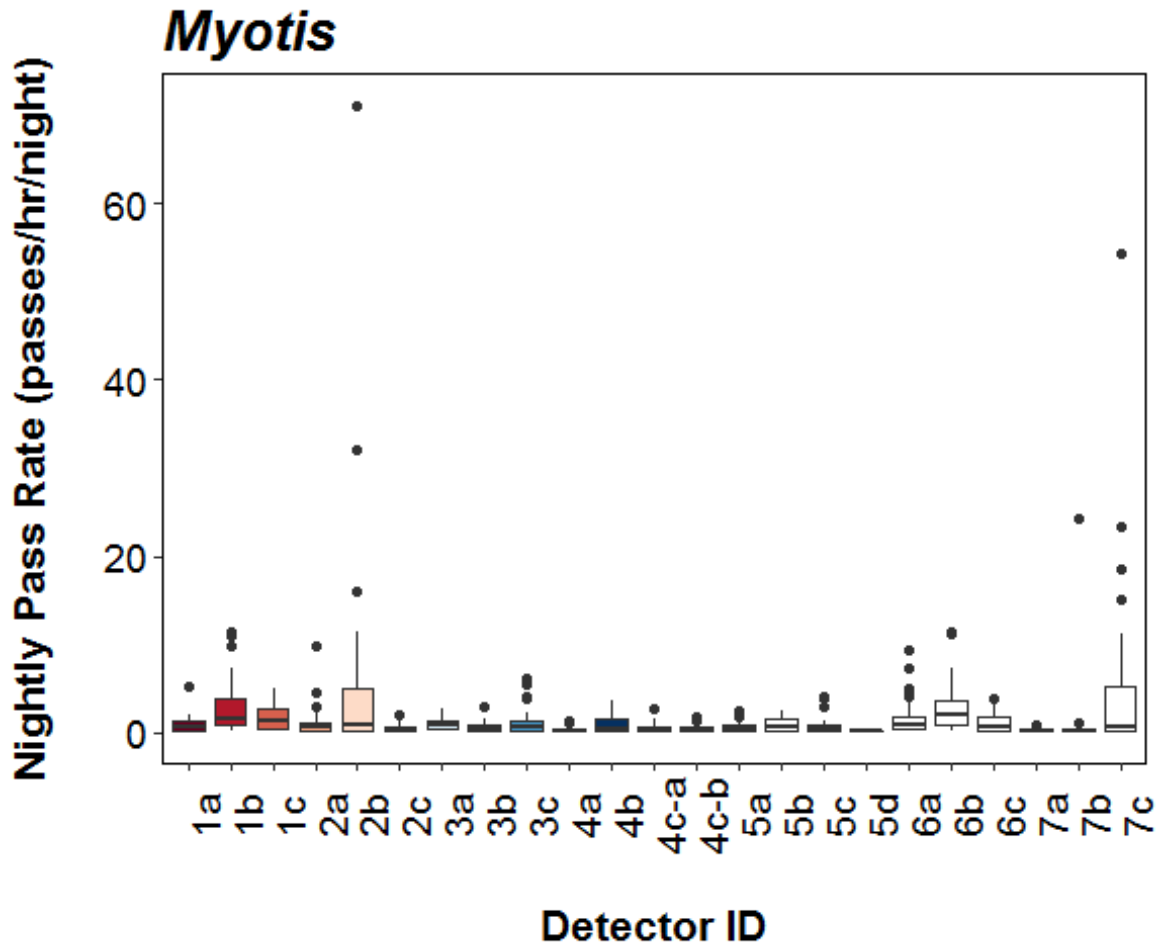
Figures show boxplots for the number of bat passes per hour each night, for each detector. The 'box' shows the interquartile range, which is where the middle 50% of the data lie. The line dividing the box is the median, the mid-point of the data. The 'whiskers' extend from the box and represent the ranges for the bottom 25% and the top 25% of the data values, excluding outliers. An outlier is any extreme value that lies further away from the box than 1.5 times the interquartile range. Outliers are shown as dots. Where very few passes are recorded it is not possible to produce the box, so the data are shown as a line.

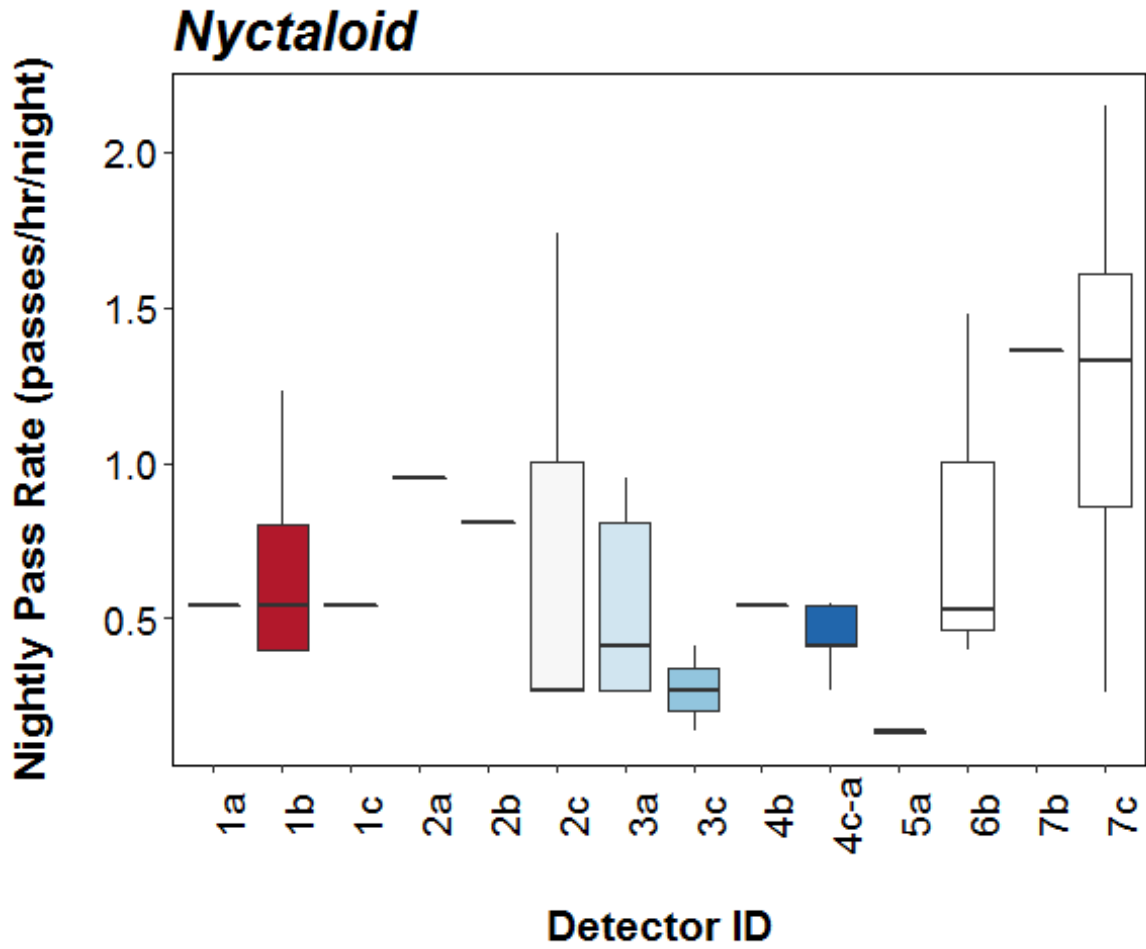
Figure 3 Nightly Bat Passes (Bat passes per hour)

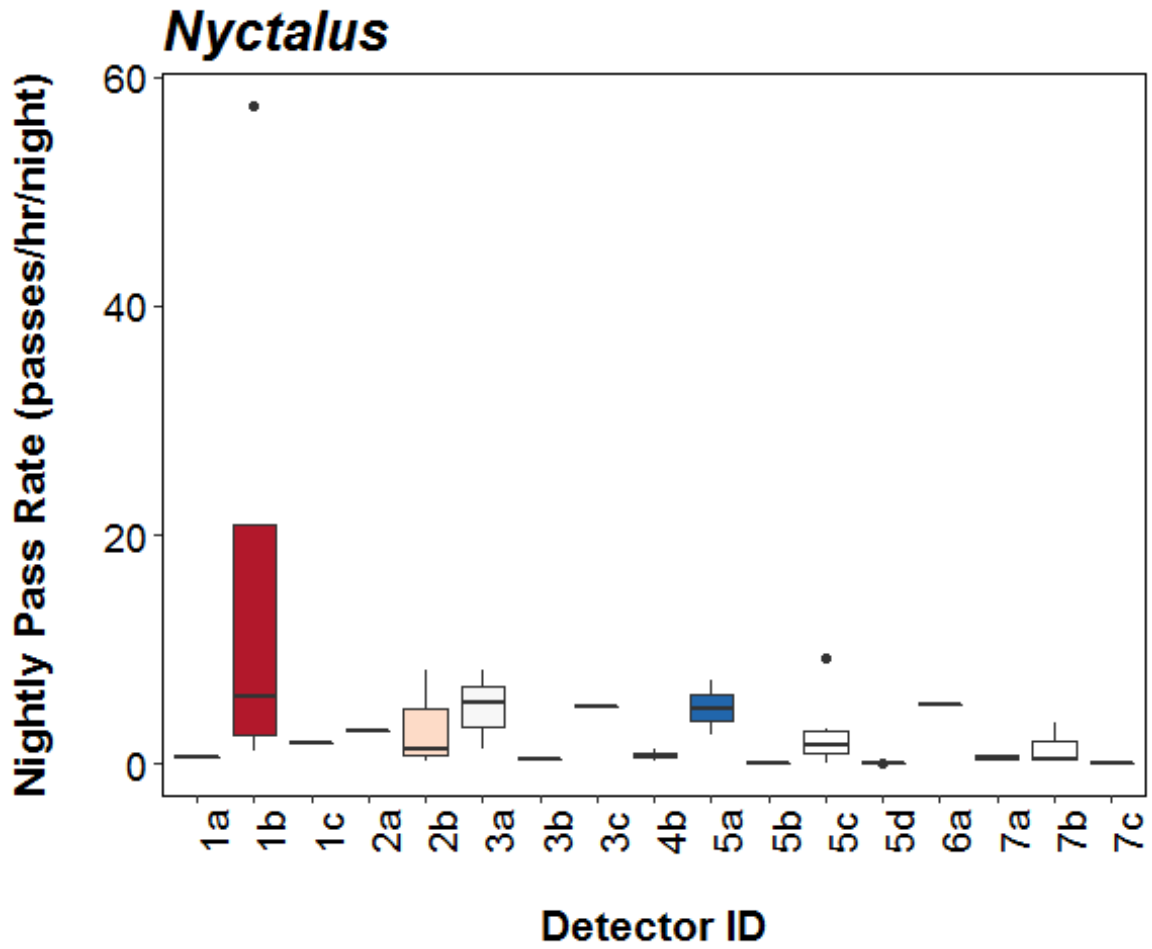


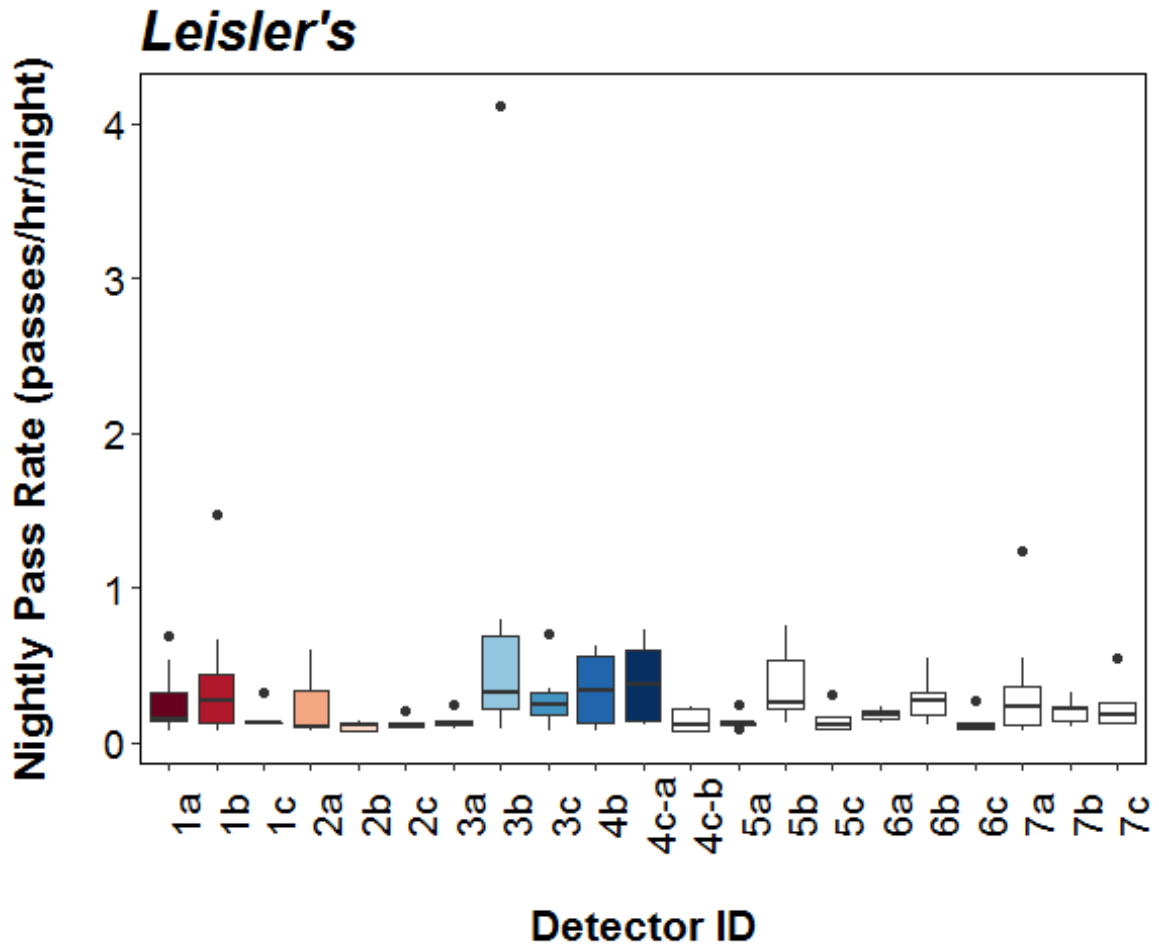
Serotine

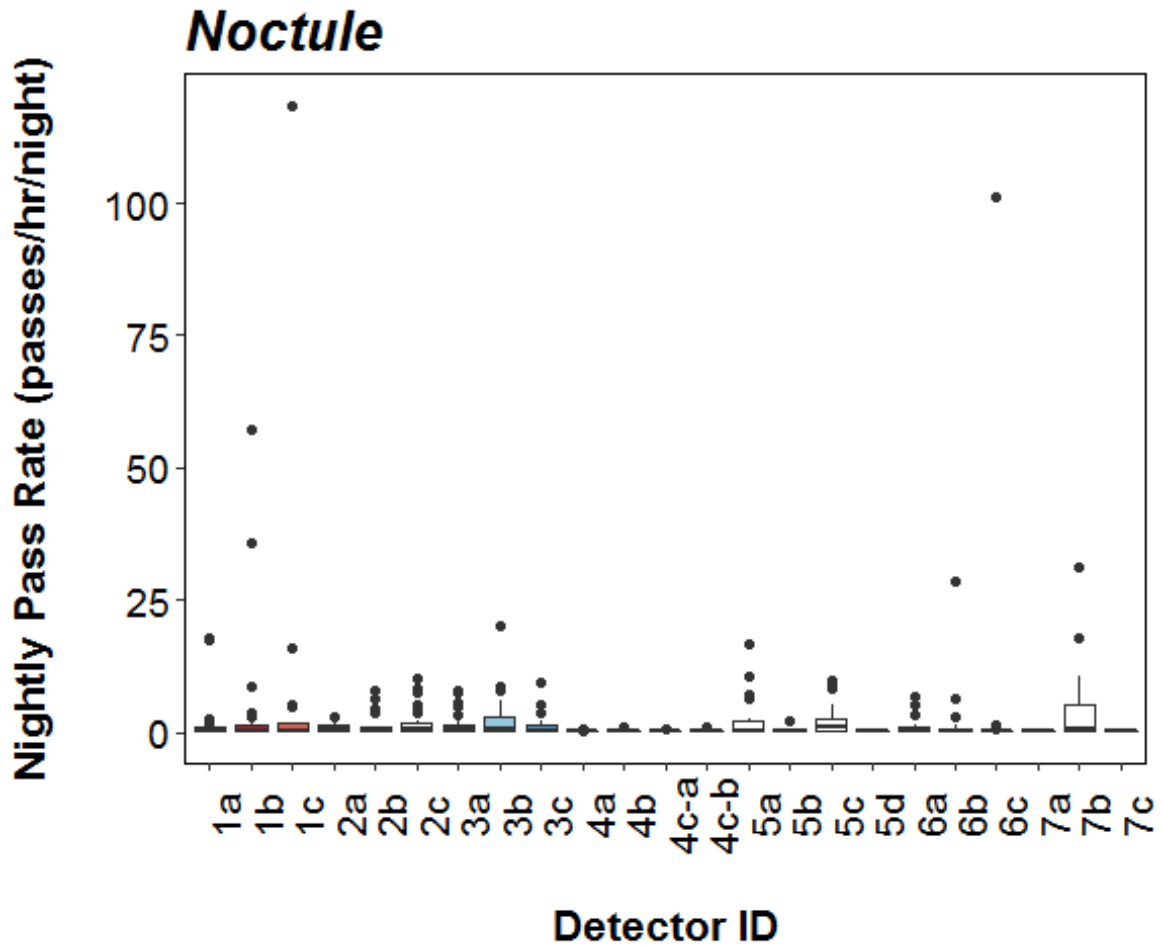


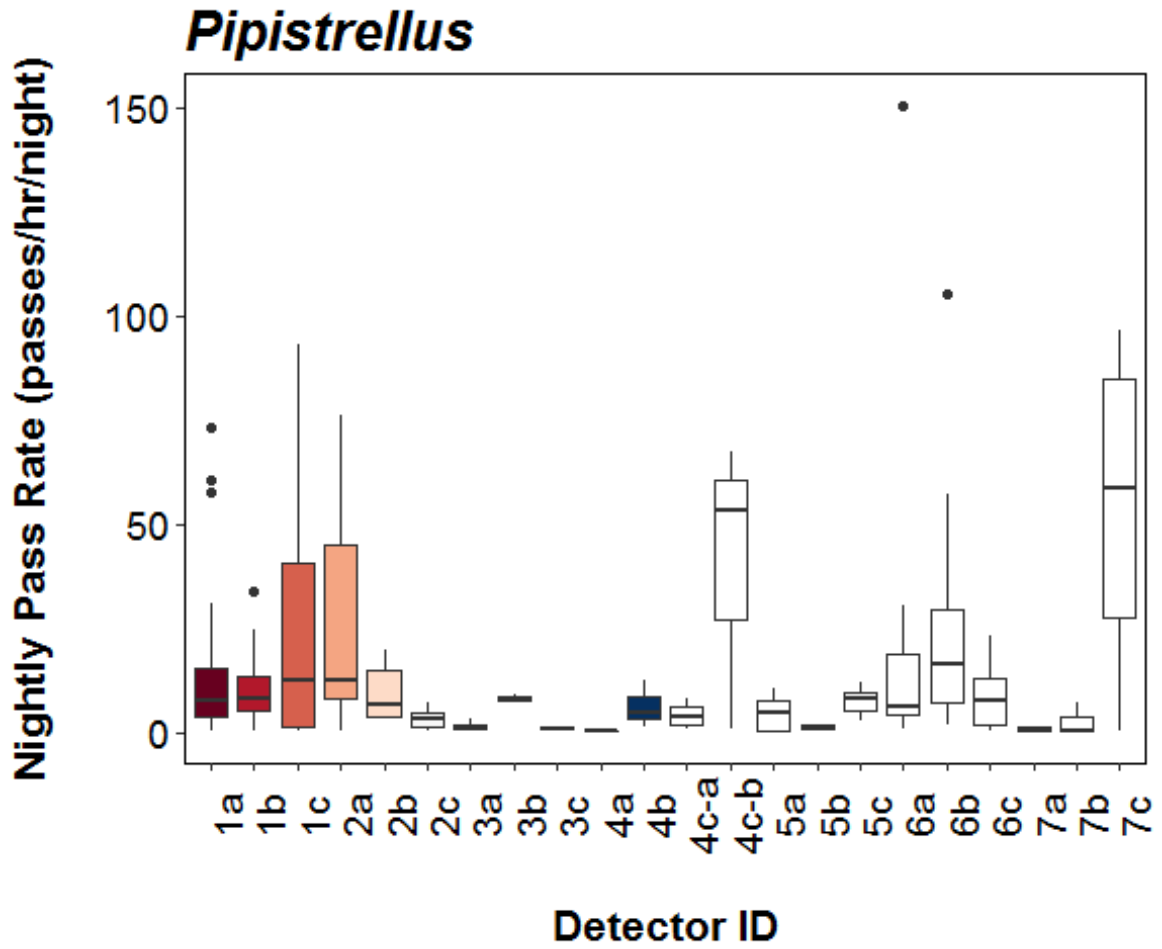


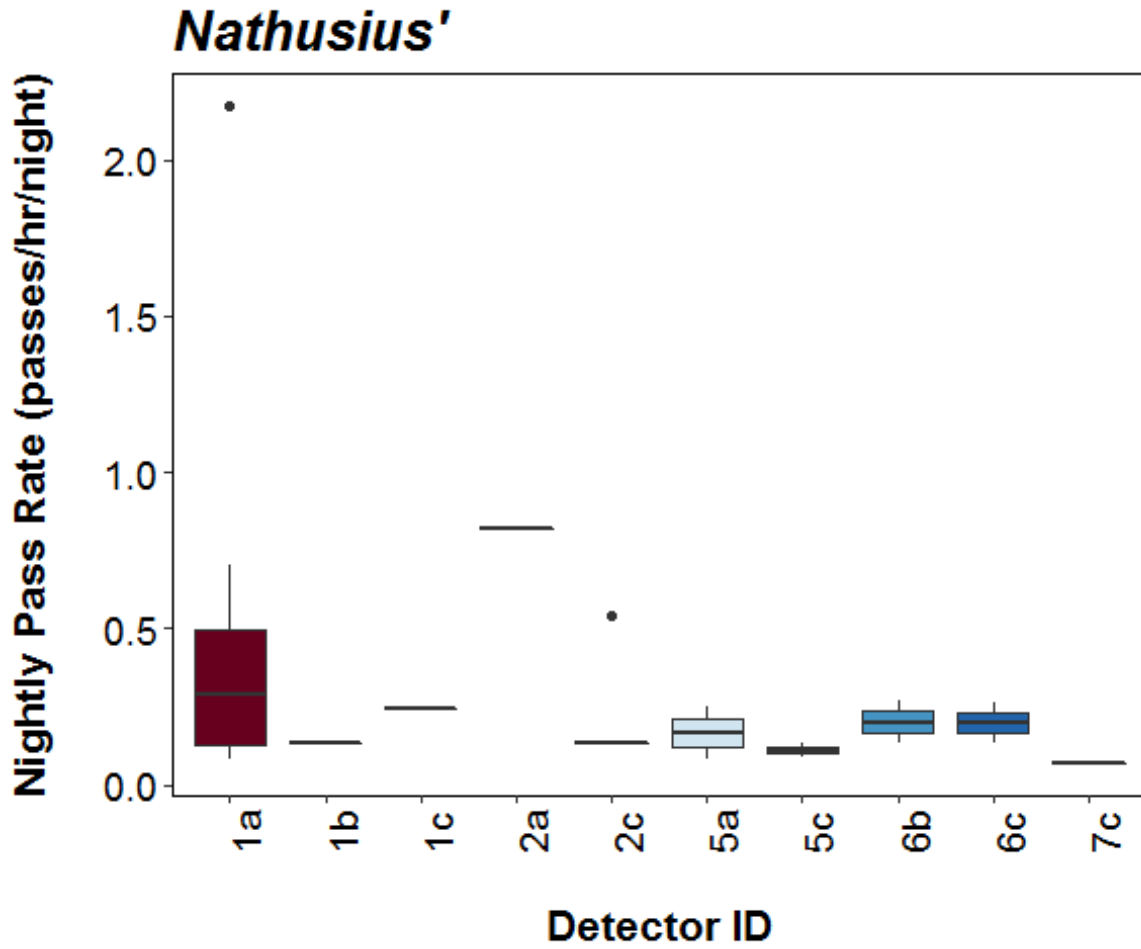




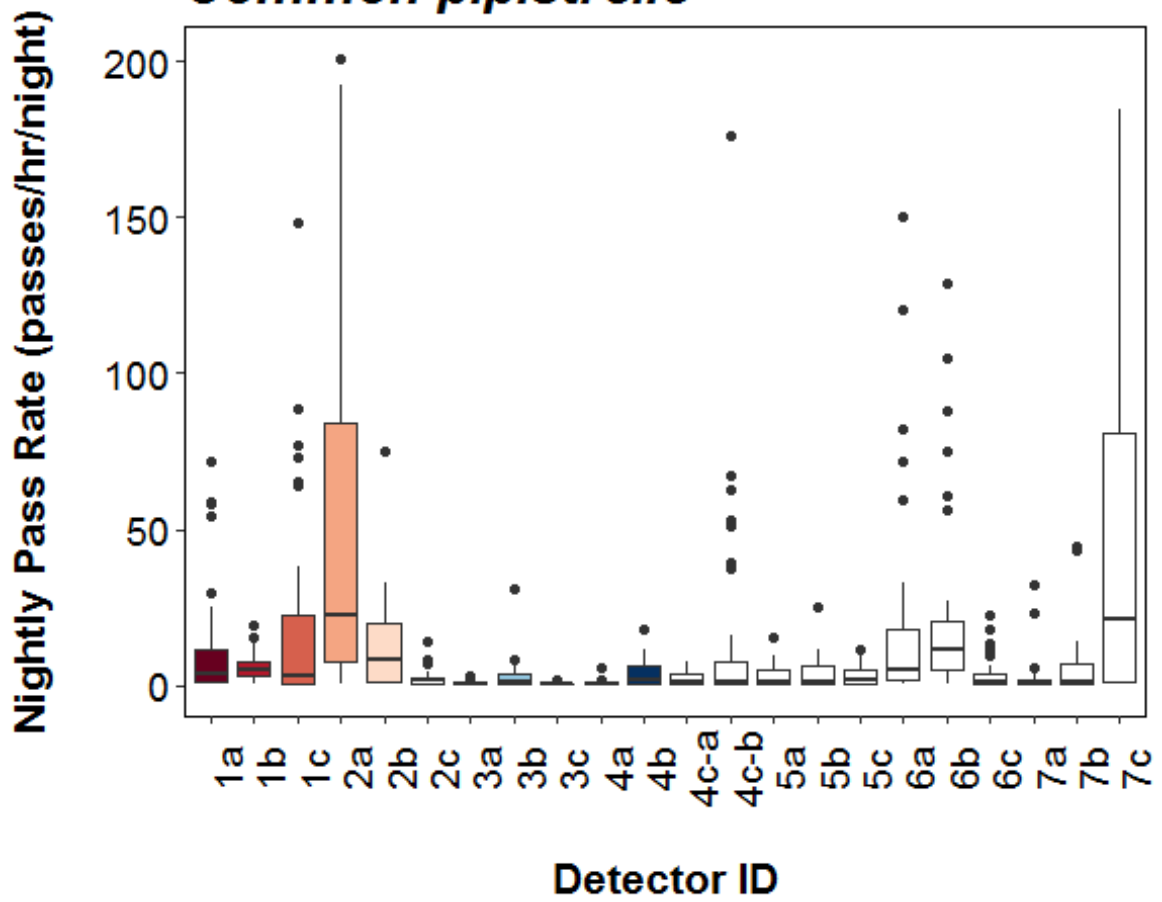




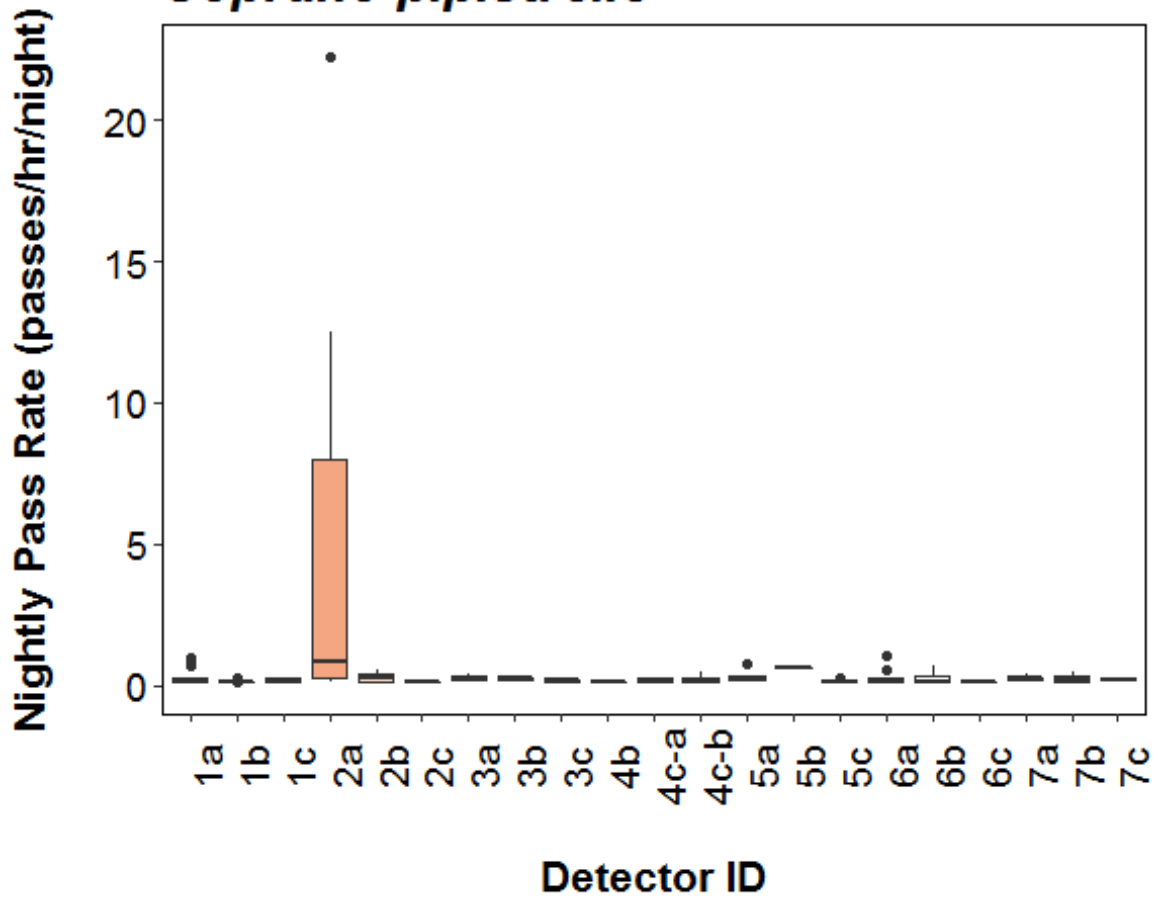


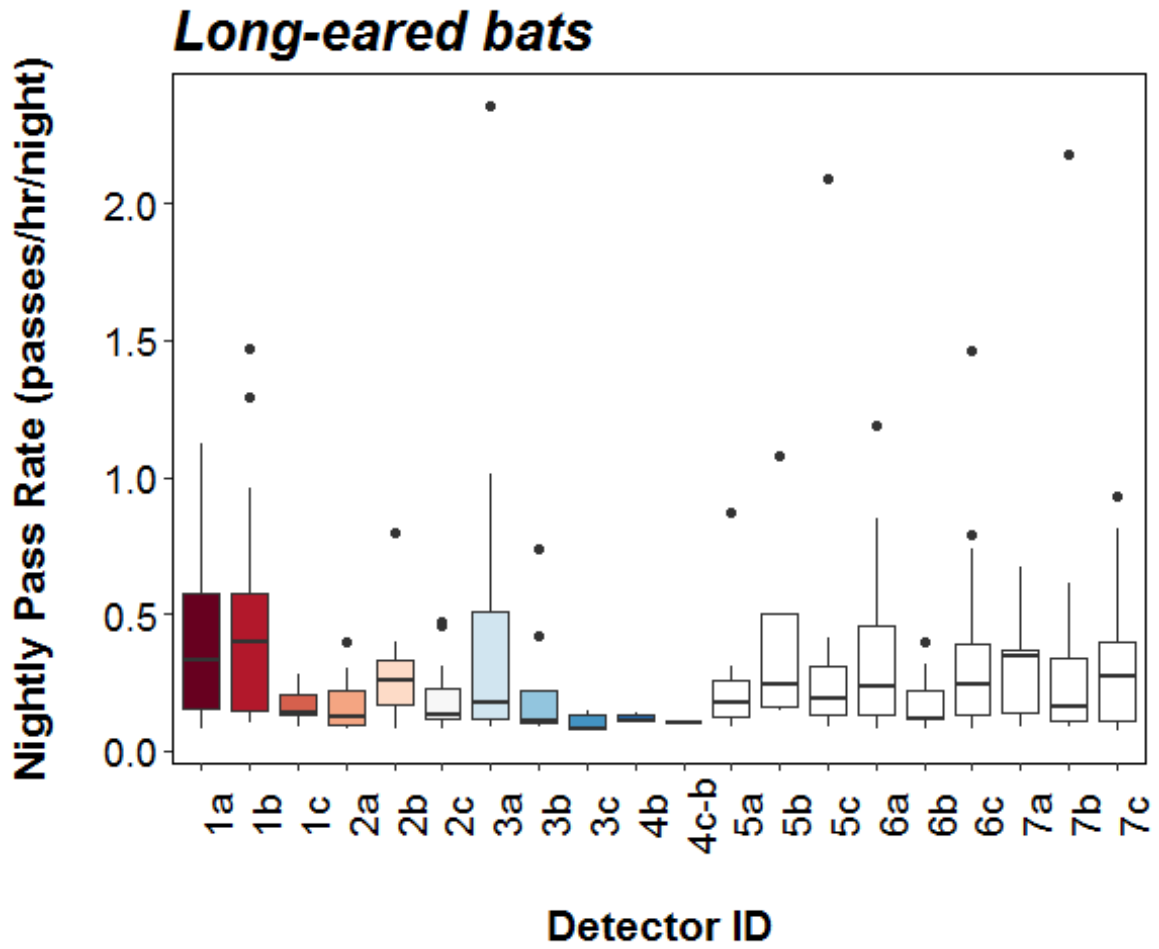


Common pipistrelle

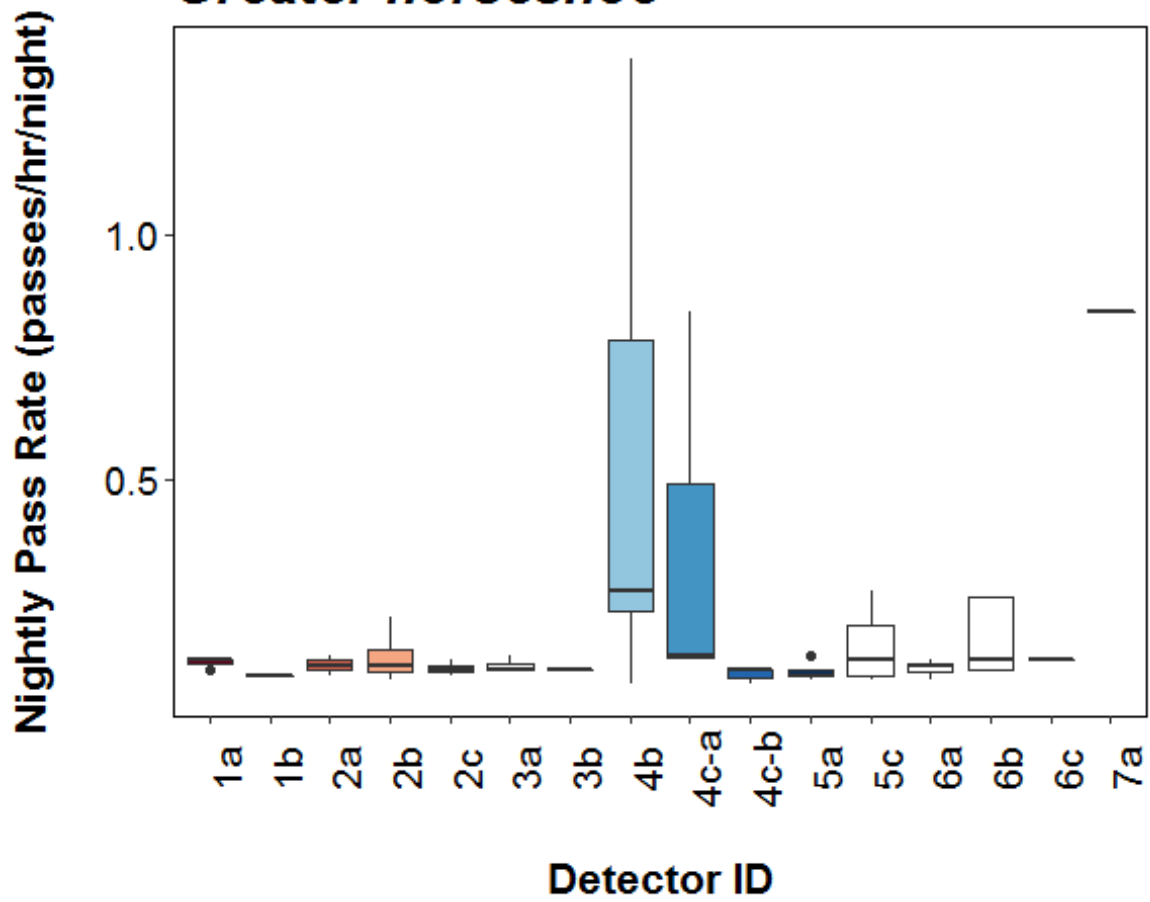


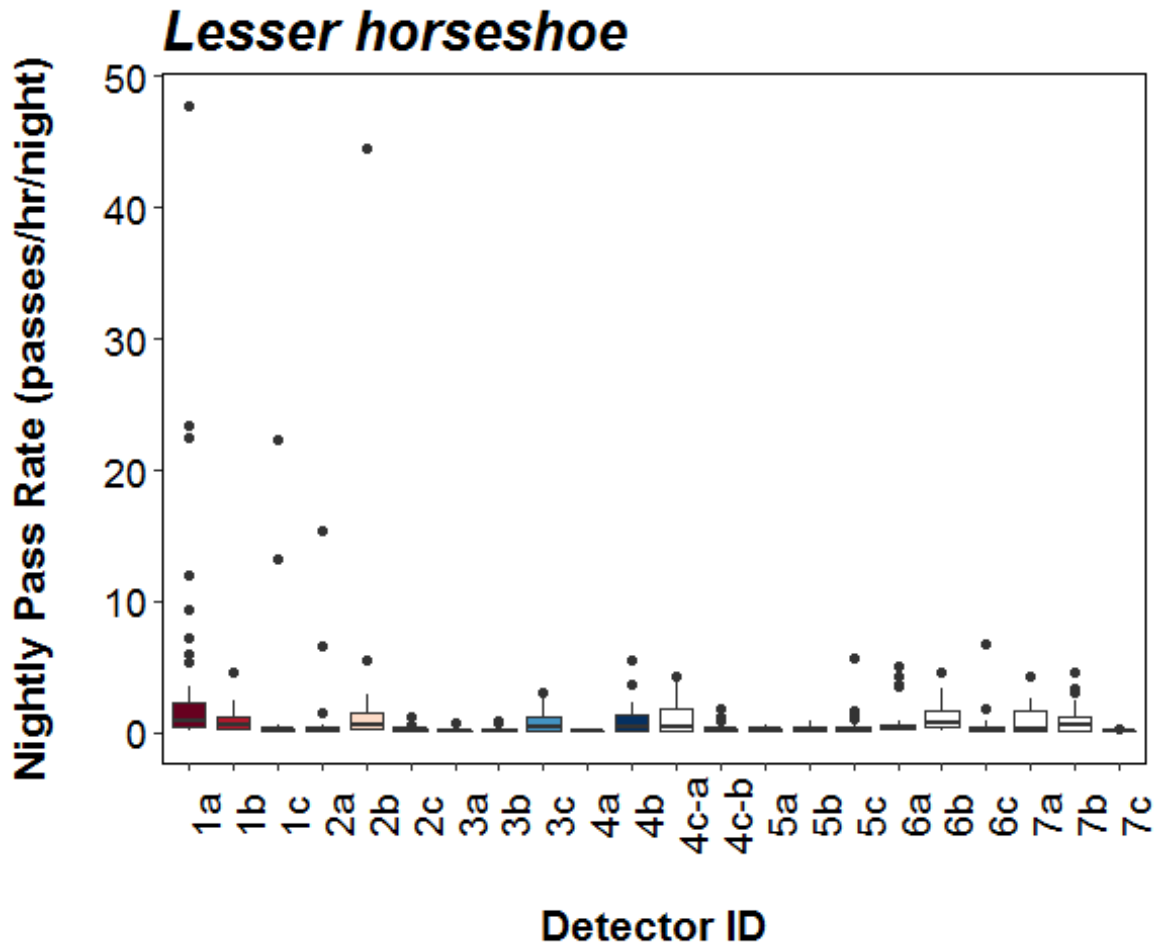
Soprano pipistrelle





Greater horseshoe





A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.7
Bat Crossing Point Survey Report

28 September 2020

Document Control

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Prepared by:

Arup

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Highways England Approval (Refer to Cover Sheet)

Revision	Title	Name	Date
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Foreword

This report sets out the results of bat crossing point surveys undertaken between June and September 2019. The objective of these 2019 surveys was to collect quantifiable data from existing bat commuting routes that would be directly severed by the scheme. This report should be read in conjunction with the other bat survey reports (namely the 2019 Bat Activity Survey Report, the 2019 Bat Roost Surveys Report, and the 2020 Bat Advanced Survey Techniques Report) to gain a full appreciation of the overall bat activity and species assemblages across the scheme.

Executive Summary

This report presents the methodology and baseline survey data recorded during the 2019 crossing point surveys across the scheme.

A framework of international (European), national and local legislation and planning policy guidance exists to protect and conserve bats.

The bat crossing point surveys were carried out in accordance with best practice survey guidelines published by DEFRA.

Seven bat commuting features which would be directly severed by the scheme were selected for crossing point surveys. This selection was based on the findings of a desk study, an appraisal of the suitability of the habitats on the ground, data from static bat detector recordings and bat activity transect surveys undertaken in 2018.

The number of commuting bats seen using the surveyed features and the overall levels of bat activity varied throughout the crossing point locations and survey months. Variability in bat activity also occurred due to the nature of the feature being surveyed and the quality of the commuting and foraging habitat for bats in the immediate and wider surroundings.

This survey fulfilled its objectives in producing quantifiable pre-construction data that can be used alongside the data from the same surveys repeated during construction and post-construction, to determine the effectiveness of any mitigation structures designed and built to help bats safely cross the scheme.

An assessment of potential impacts to bats will be undertaken within the Environmental Impact Assessment for the scheme, along with details of mitigation and compensation measures as appropriate.

1 Introduction

1.1 Purpose of this Document

- 1.1.1 The main objective of this report is to set out the results of bat crossing point surveys undertaken at seven linear habitat features which will be directly impacted by the scheme.
- 1.1.2 Surveys were completed during June, July, August and September 2019. The surveys aimed to provide baseline data on the level of bat activity and the species that are currently crossing the route of the scheme, prior to any construction activity. The surveys provide quantifiable data which can subsequently be compared to post-construction data, allowing for the effectiveness of any mitigation provided for bat passage to be assessed.
- 1.1.3 The surveys focussed on seven linear habitat features which would be severed or completely lost to facilitate construction of the scheme. Each location was selected for crossing point surveys because it had potential to provide an important flight line for bats, on the basis of bat activity surveys and acoustic static recording deployments completed in 2018.

1.2 Legislation

- 1.2.1 Bats are European Protected Species (EPS) and are protected under Regulation 41 of the Conservation of Habitats and Species Regulations 2017 (as amended)¹, known as the Habitats Regulations.
- 1.2.2 Under the Habitats Regulations, it is an offence to deliberately capture, injure or kill bats, deliberately disturb bats, or damage or destroy a breeding site or resting place of a bat species.
- 1.2.3 Bats receive further protection through inclusion on Schedule 5 of the Wildlife and Countryside Act (WCA) 1981 (as amended)². Under this Act it is an offence to intentionally kill, injure or take bats; intentionally or recklessly damage, destroy or obstruct access to any structure or place which a bat species uses for shelter or protection; and intentionally or recklessly disturb any bat species while it is occupying a structure or place which it uses for shelter or protection.
- 1.2.4 Actions which are prohibited by legislation can be made lawful on the approval and granting of a licence from Natural England (NE), subject to conditions.
- 1.2.5 The reader should refer to the original legislation for the definitive interpretation.

2 Methodology

2.1 Survey Methods

- 2.1.1 The crossing point surveys were carried out in accordance with DEFRA's "*Development of a cost-effective method for monitoring the effectiveness of mitigation for bats crossing linear transport infrastructure - WC1060*"³.
- 2.1.2 The locations of the crossing point surveys were selected to encompass potential bat commuting routes which would be severed or completely removed by the scheme. To identify potential commuting routes, the habitats within the boundary of the scheme were appraised using publicly available aerial imagery⁴ to look for features that could provide habitat connectivity for bats (such as hedgerows, treelines, woodland, rivers, streams and wetlands).
- 2.1.3 To further inform the identification of potential commuting routes, a review of desk study information was carried out including a review of the following:
- results of roost assessments carried out in 2018;
 - data from static bat detector surveys carried out in 2018; and
 - data from bat activity transect surveys undertaken in 2018.
- 2.1.4 Following the desk based scoping assessment, each potential commuting route was subject to a site walkover by suitably qualified bat ecologist -where access was available- to provide a ground truthing assessment of the feature as a likely commuting route.
- 2.1.5 A total of nine potential bat commuting routes which will be directly impacted by the scheme were selected following the desk study and site walkovers. These locations are referred to as 'crossing point' or 'CP' locations throughout the remainder of this report. Two crossing point locations (namely, CP8 and CP9) were selected for further survey following the desk study. However, access was denied by the land owner, thus no further surveys at these locations were completed.
- 2.1.6 The location of each surveyed crossing point is described in Table 1 and is shown in PEI Report Figures 8.22 to 8.28.
- 2.1.7 The crossing point surveys followed the methodology below:
- Six surveys were carried out between June and September 2019 (a single dusk survey in June, a dusk followed by a dawn survey in July and again in August, and a single dusk survey in September).
 - Dusk surveys commenced at sunset and continued for an hour and a half, while dawn surveys started an hour and a half prior to sunrise and continued until sunrise (the standard methodology recommends surveys continue for an hour from sunset, this was extended due to the presence of late emerging species in the locality).
 - Two surveyors were present at each survey location with one surveyor positioned at either side of where the scheme would breach the commuting route. The location of which the surveyors were situated at, along with their direction of sight is shown in within PEI Report Figures 8.22 to 8.28.
- 2.1.8 The same team of surveyors were used for each location as much as possible, to minimise any variation in recordings due to observer bias. Each surveyor was

equipped with an Elekon Batlogger M to help detect and identify any bats observed.

- 2.1.9 Prior to the start of the surveys, a daytime site visit was undertaken for each location by the lead surveyor to plan the works, assess any health and safety issues on site, and record the context of the survey location, including a note of adjacent vegetation to assist in judging the height of bat flight during the survey.
- 2.1.10 Each surveyor remained vigilant throughout the 90-minute survey to observe and count bats commuting along the linear feature and recorded the following information as set out in the standardised DEFRA methodology.
- time of the observation (HH:MM:SS);
 - species (if known);
 - the height of the bat above the commuting feature in metres (the lowest height was recorded if bats altered their flight height);
 - distance of the bat from the feature (on the horizontal plane) in metres;
 - the side of the feature that the bat commuted along (e.g. east or west); and
 - the direction the bat was flying in when it commuted along the feature (e.g. south to north).
- 2.1.11 Only those bats which were seen commuting along the length of the linear feature where it will be severed by the scheme, were counted as having crossed the route of the scheme. Those bats which did not fly far enough across the route before changing direction were not counted as having crossed.
- 2.1.12 If it was likely the same individual bat was commuting up and down the length of the linear feature crossing the scheme multiple times, each crossing was still counted. Other incidental records of bat activity (i.e. any bats observed which were not using the feature) were also recorded.
- 2.1.13 Surveys were conducted in suitable conditions for bat activity, i.e. temperature >7°C, relatively still (wind < 20 km/h) and dry conditions. Weather conditions were recorded at the start and end of each survey visit (see Appendix A).
- 2.1.14 All bat crossing point surveys were led by competent ecologists, familiar with bat ecology and surveying, and all are members of the Chartered Institute of Ecology and Environmental Management (CIEEM).
- 2.1.15 Following the surveys, all bat call recordings were analysed using BatExplorer, a bat analysis software package which is compatible with the bat detector used to undertake the surveys. Bat sound analysis was completed by experienced ecologists and the analysis was completed to species level where possible.
- 2.1.16 Following the sound analysis, the confirmed records of crossing bats *i.e.* those bats which were seen by surveyors to cross the scheme by using the feature that will be affected, were recorded within data spreadsheets in accordance with guidance³. Any duplicate crossing events, *i.e.* where bats were recorded crossing at the same time and at the same height and distance from the feature by both surveyors were counted as one pass.
- 2.1.17 The total counts of confirmed bats, species, and safe, unsafe or unknown flight height are included in the tables within this report. The “unknown height” category relates to recorded echolocation passes of rarer, more discrete species such as lesser horseshoe (*Rhinolophus hipposideros*) bats when no visual observation of the bat was made. Lesser horseshoe bats have a particularly rapid

and low flight height making visual observations often difficult to record⁵. This species also has a particularly directional call. Lesser horseshoe bat passes recorded were assumed to originate from bats which were likely to have crossed the feature and therefore have been included within the results.

- 2.1.18 A safe flight height for bats has been determined at 5m and above, this is based on the tallest trucks and heavy good vehicles in the UK height registering at 4.9m tall. It should be noted that 4.9m is not the legal limit but is the maximum height of vehicle which has been adopted through 'custom and practice'⁶.
- 2.1.19 Any other incidental records of bats on the recording forms which were not visually observed to cross the scheme were not transcribed into the data tables, except for any horseshoe bat (*Rhinolophus sp.*) passes. Horseshoe species of bat have a profoundly directional call⁷ and therefore any horseshoe bat recorded on a detector is considered to have been close enough to the surveyor stood on the crossing point to assume that the bat had likely crossed the feature.
- 2.1.20 The data tables provide the quantifiable data which can later be compared with the construction stage and post-construction stage surveys to be repeated at the same locations, and are shown in Appendix B.

2.2 Study Area

- 2.2.1 A description of each surveyed crossing point location, along with their location and the position of each surveyor can be found in Table 1 (drawings can be found in PEI Report Figures 8.22 to 8.28).

Table 1 Crossing point survey location and description

Crossing Point & Grid Reference	Feature & Connected habitats/features in the wider landscape	Surveys undertaken	Drawing Number
CP1 – SO 94718 13980	A narrow lane with an avenue of trees. The unlit lane is primarily used as a farm access track with limited vehicle passes. Tall linear vegetation borders each side. In the wider landscape CP1 is bordered on all sides by agricultural fields which are used for grazing livestock. Immediately to the north, parallel with the lane is a small pocket of plantation broadleaved woodland.	June – dusk only July – dusk and dawn August – dusk and dawn	PEI Report Figure 8.22 crossing point 1
CP2 – SO 94360 14526	Narrow lane bordered by a dry-stone wall and semi-mature trees. The unlit lane is planted with mature broadleaved trees on both sides. To the south is a large farm known as Stockwell Farm, with multiple associated agricultural buildings.	June – dusk only July – dusk and dawn August – dusk and dawn	PEI Report Figure 8.23 crossing point 2
CP3 – SO 94103 14830	Mature hedgerow between agricultural fields used for grazing. Located c.200m east of CP2. The mature hedgerow is surrounded on all aspects by agricultural fields used for pasture. To the north-east is a belt of woodland (CP4).	June – dusk only July – dusk and dawn August – dusk and dawn	PEI Report Figure 8.24 crossing point 3
CP4 – SO 93944 15236	Small section of woodland located c.200m north-east of CP3. CP4 is a semi-circular belt of mature broadleaved woodland between fields referred to as Shab Hill. To the east of	June – dusk only July – dusk and dawn August – dusk and dawn	PEI Report Figure 8.25 crossing point 4

Crossing Point & Grid Reference	Feature & Connected habitats/features in the wider landscape	Surveys undertaken	Drawing Number
	the site is an area of woodland known as Cally Hill Plantation.		
CP5 – SO 93985 15520	Mature conifer treeline c.12m tall, between fields. To the southeast of the site is Cally Hill plantation woodland and to the east is a small complex of buildings (Rushwood kennels). To the west is Birdlip radio station. Connected to the northern end of the feature is a triangular section of semi-mature broadleaved woodland (CP7).	June – dusk only July – dusk and dawn August – dusk and dawn September – dusk only	PEI Report Figure 8.26 crossing point 5
CP6 – SO 93929 15607	Section of hedgerow and scrub which is connected to a small area of woodland. The hedgerow separates two grass pasture fields. The hedgerow is surrounded on all aspects by agricultural fields. To the east c.100m is Ullen wood.	June – dusk only July – dusk and dawn August – dusk and dawn September – dusk only	PEI Report Figure 8.27 crossing point 6
CP7 – SO 94029 15626	Strip of semi-mature woodland triangular shaped and comprises of young broadleaved woodland bordered by an access track, connected to CP5 and CP6. The eastern terminal end of the woodland is connected to Ullen Wood.	June – dusk only July – dusk and dawn August – dusk and dawn September – dusk only	PEI Report Figure 8.28 crossing point 7
CP 8 - SO 93817 15921	Mature hedgerow L-shaped hedgerow located in between agricultural fields used for grazing. Located c.350m north west of CP6. To the north-east c.250m is Ullen Wood.	No survey access	N/A
CP 9 - SO 93522 16070	Northern section of woodland block known as Emma's Grove. Located 300m due west of CP8. Adjacent to the crossing point is the Air Balloon roundabout.	No survey access	N/A

2.3 Limitations and Assumptions

- 2.3.1 The Berthinussen & Altringham methodology advises conducting two preliminary dusk and dawn surveys (following the crossing point survey protocol) at any significant habitat feature or boundary that will be severed by the scheme to identify potential bat commuting routes. Any features where more than 10 bats are recorded using a flight path (1-5 for rare species), should then be selected for a full set of the crossing point surveys. However, since the project ecologists were already familiar with the area and were able to review the data from static and transect surveys carried out in 2018 it was decided that the two preliminary dusk and dawn surveys at each potential commuting feature were not required.
- 2.3.2 Crossing point surveys were undertaken between June to September. It should be noted that bat activity during September surveys is expected to be lower than in other bat active months (June-August which is the period recommended in the DEFRA methodology) and behaviour may not be typical of mid-summer activity. However, the spread of surveys undertaken was chosen to allow recording of seasonal bat activity rather than focussing on the core mid-summer.

- 2.3.3 The weather conditions on 20 August 2019 during the dusk survey at CP1, CP5, CP6 and CP7 was considered sub-optimal for a period of 27 minutes, as there was moderate rain during the survey. During this period of rainfall, the survey was halted due to a lack of bat activity and potential damage to detectors, between the period of 21:05 and 21:32. Once rainfall had subsided the survey continued for the final half an hour. Despite this period, the survey is still considered acceptable as the weather during most of the survey was suitable including for approximately 40 minutes after sunset. Bat activity was observed prior to, and after the period of moderate rainfall.
- 2.3.4 During the July dusk and dawn survey, only one surveyor was present at CP5, and therefore a lower overall total of bat passes at this feature may have been recorded. The surveyor stood at the Surveyor 1 position at CP5 (PEI Report Figure 8.26). The lack of a surveyor at the Surveyor 2 position is not considered to invalidate the survey findings because the majority of bat activity during the June, August and September surveys was recorded from the Surveyor 1 position. Thus, it is assumed that the majority of bats present in July would similarly have been recorded by this surveyor.
- 2.3.5 The study set out to survey all crossing points six times. However, crossing point surveys during September were conducted at CP5, CP6 and CP7 only. This is due to a local third-party culling operation which involved live firearms within the surrounding arable areas around CP1 - CP4. The culling operation created conditions where the risk of injury to a surveyor during the survey was considered unacceptably high. Subsequently the surveys at CP1, CP2, CP3 and CP4 during September were cancelled and not rescheduled. A total of 11 bats crossing were observed by surveyors across the three other locations surveyed in September, and it is assumed that a comparably low number of crossings would have been recorded at CP1-CP4 if the September surveys had been conducted there. Therefore, the lack of September data at CP1 – CP4 is not considered to invalidate the results and assessments made within this report.
- 2.3.6 The echolocation calls of *Myotis*⁸ species are difficult to accurately separate to species level^{9, 10} during sound analysis. Therefore all *Myotis sp.*, calls were identified to genus level only for this study.
- 2.3.7 Calls from long-eared bats are directional and usually very quiet, which makes them difficult to pick up on a detector. Therefore, there is the possibility that records of this genus in the wider landscape may have been underrepresented throughout the survey effort. To reduce the significance of this limitation, visual observations were used in combination with the recordings, which enabled for a better identification of this species during the surveys.
- 2.3.8 All long-eared bat calls were assumed to be limited to brown long-eared (*Plecotus auritus*) bat calls due to the known geographic range of the grey long-eared (*Plecotus austriacus*) bat, which is limited to more southern locations¹¹.
- 2.3.9 Ecological surveys are limited by factors which affect the presence of animals such as the time of year, migration patterns and behaviour. The absence of bat activity from any location during the surveys cannot be taken as conclusive proof that any of these species is not present or that it will not be present in the future.
- 2.3.10 The relatively low levels of crossing bats seen across some of the survey locations is likely to be a reflection of the short survey period i.e. only one hour after dusk and one hour before dawn. The majority of bats emerge from their

roosts 30 minutes after sunset and return to their roosts 30 minutes before sunrise therefore only a very short window of their activity period is sampled during these surveys. This survey duration, however, is as set out in the Berthinussen & Altringham methodology and some level of light is required to allow for confirmed bat pass.

3 Results & Analysis

3.1 Context

3.1.1 The results of the crossing point surveys at each of the seven survey locations are summarised below. Other incidental bat activity observed by the surveyors is described in the text below where relevant. Crossing point and surveyor locations are shown in PEI Report Figures 8.22 to 8.28.

3.2 Crossing Point 1

- 3.2.1 Throughout the course of the five survey visits between June and August a total of 119 bats were recorded using the feature, and one bat (lesser horseshoe bat) was assumed to have crossed the feature (Table 2). Relatively high levels of bat activity were observed by both surveyors at this location in comparison to the other crossing point locations.
- 3.2.2 At least six species were recorded crossing, namely; common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*), noctule (*Nyctalus noctula*), lesser horseshoe bat, *Myotis* species (*Myotis sp.*) and an unconfirmed *Nyctalus* species (*Nyctalus sp.*).
- 3.2.3 Common pipistrelle passes were recorded significantly more times than any other species. A total of 114 passes of common pipistrelle were registered equating to 95% of the activity at this location. Of those 114 passes, 104 passes were recorded at an unsafe flight height (i.e. 5m or less).
- 3.2.4 The flight direction of passes visually observed (119) varied considerably, with no obvious pattern being recorded. Of the 119 passes a total of five flight directions were recorded, with common pipistrelle activity being recorded in all five flight directions (Table 3). All passes from the other species recorded at CP1 were at an unsafe flight height, excluding a single noctule pass, which was recorded flying at 7m during the August dusk survey.
- 3.2.5 A total of one lesser horseshoe pass was recorded over the six survey visits. The pass was recorded by surveyor two, during the July dawn survey. The pass was recorded at 04:11am, 1 hour and 9 minutes before sunrise.
- 3.2.6 Both surveyors registered bat passes on every survey completed, with bat activity higher at the north-western end of the lane in June and higher at the south-eastern end of the lane in July and August (Figure 1).

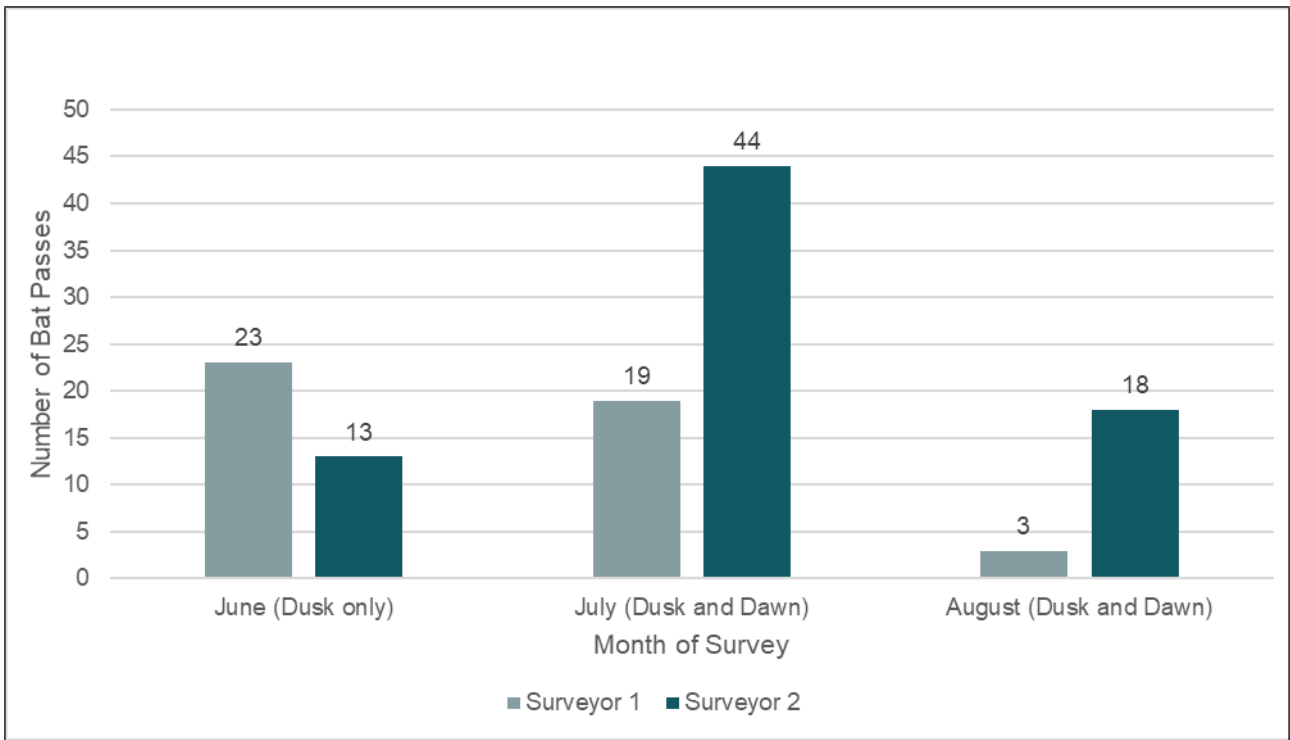


Figure 1 Number of bat passes in each month recorded by each surveyor

Table 2 Bat species and flight height recorded at Crossing Point 1

Species	Total crossings	Unsafe height (5m or less)	Safe height (over 5m)	Unknown height
All bat species	120	108	11	1
Common pipistrelle	114	104	10	0
Soprano pipistrelle	1	1	0	0
Noctule	2	1	1	0
<i>Myotis sp.</i>	1	1	0	0
Lesser horseshoe	1	0	0	1
<i>Nyctalus sp.</i>	1	1	0	0

Table 3 Bat flight direction and species recorded at Crossing Point 1

Flight direction	Total number of crossings	Species recorded (Number of times crossed)
North-East flying to South-West	12	Common pipistrelle (12)
East flying to West	33	Common pipistrelle (33)
South-East flying to North-West	38	Common pipistrelle (37) <i>Myotis</i> sp. (1)
West flying to East	12	Common pipistrelle (10) Soprano pipistrelle (1) Noctule (1)
North-West flying to South-East	24	Common pipistrelle (22) Noctule (1) <i>Nyctalus</i> sp. (1)
Unknown	1	Lesser horseshoe (1)

3.3 Crossing Point 2

- 3.3.1 Throughout the course of the five survey visits a total of 94 bat passes were observed at the crossing point location, and four passes (lesser horseshoe bats) were recorded where bats were assumed to have crossed the feature (Table 4). Relatively high levels of bat activity were observed by the surveyors at this location.
- 3.3.2 A total of 98 bats were recorded between the surveyors. At least four species were recorded, namely; common pipistrelle, noctule, lesser horseshoe bat, and *Myotis* species.
- 3.3.3 Common pipistrelle passes were recorded significantly more times than any other species. A total of 87 passes of common pipistrelle were registered, equating to 88% of the activity recorded at this crossing point. Of those 87 passes, 76 passes were at an unsafe flight height (i.e., 5m or less).
- 3.3.4 Of the other 11 passes recorded from three other species at this location, four passes were at an unsafe height and four were lesser horseshoe bats that were not observed (unknown height).
- 3.3.5 A total of four lesser horseshoe passes were recorded. Three passes were recorded during the July dusk survey, where both surveyors recorded this species. Additionally, a single pass was recorded by surveyor one during the August dusk survey.
- 3.3.6 Of the bats which were visually observed, (94 passes out of 98), the distance of which the bats were flying from the feature varied considerably. Generally common pipistrelle passes were recorded within a 5 m horizontal distance from the feature. Conversely, all noctule passes recorded were seen to be flying at over 5m laterally away from the crossing point feature.
- 3.3.7 The flight direction of bat passes which were visually observed varied with no obvious trend recorded. Of the 94 passes, four flight directions were recorded with common pipistrelle activity being recorded in all four flight directions (Table 5).

- 3.3.8 Both surveyors registered bat passes on every survey completed, with bat activity was highest at the south-western end of the lane in July and bat activity levels at the north-eastern survey point were comparable across the survey months (Figure 2).
- 3.3.9 Surveyor one also registered more bat passes (56) in total than surveyor two (42 passes) at this crossing point location although the difference is considered insignificant (Figure 2).

Table 4 Bat species and flight height recorded at Crossing Point 2

Species	Total crossings	Unsafe height (5m or less)	Safe height (over 5m)	Unknown height
All bat species	98	80	14	4
Common pipistrelle	87	76	11	0
Noctule	4	1	3	0
Lesser horseshoe	4	0	0	4
<i>Myotis</i> bat species	3	3	0	0

Table 5 Bat flight direction and species recorded at Crossing Point 2

Flight direction	Total number of crossings	Species recorded (Number of times crossed)
South flying to North	58	Common pipistrelle (54) <i>Myotis</i> sp. (3) Noctule (1)
North-West flying to South-East	24	Common pipistrelle (22) Noctule (1) <i>Nyctalus</i> sp. (1)
North flying to South	29	Common pipistrelle (26) Noctule (3)
East flying to West	1	Common pipistrelle (1)
West flying to East	6	Common pipistrelle (6)
Unknown	4	Lesser horseshoe (4)

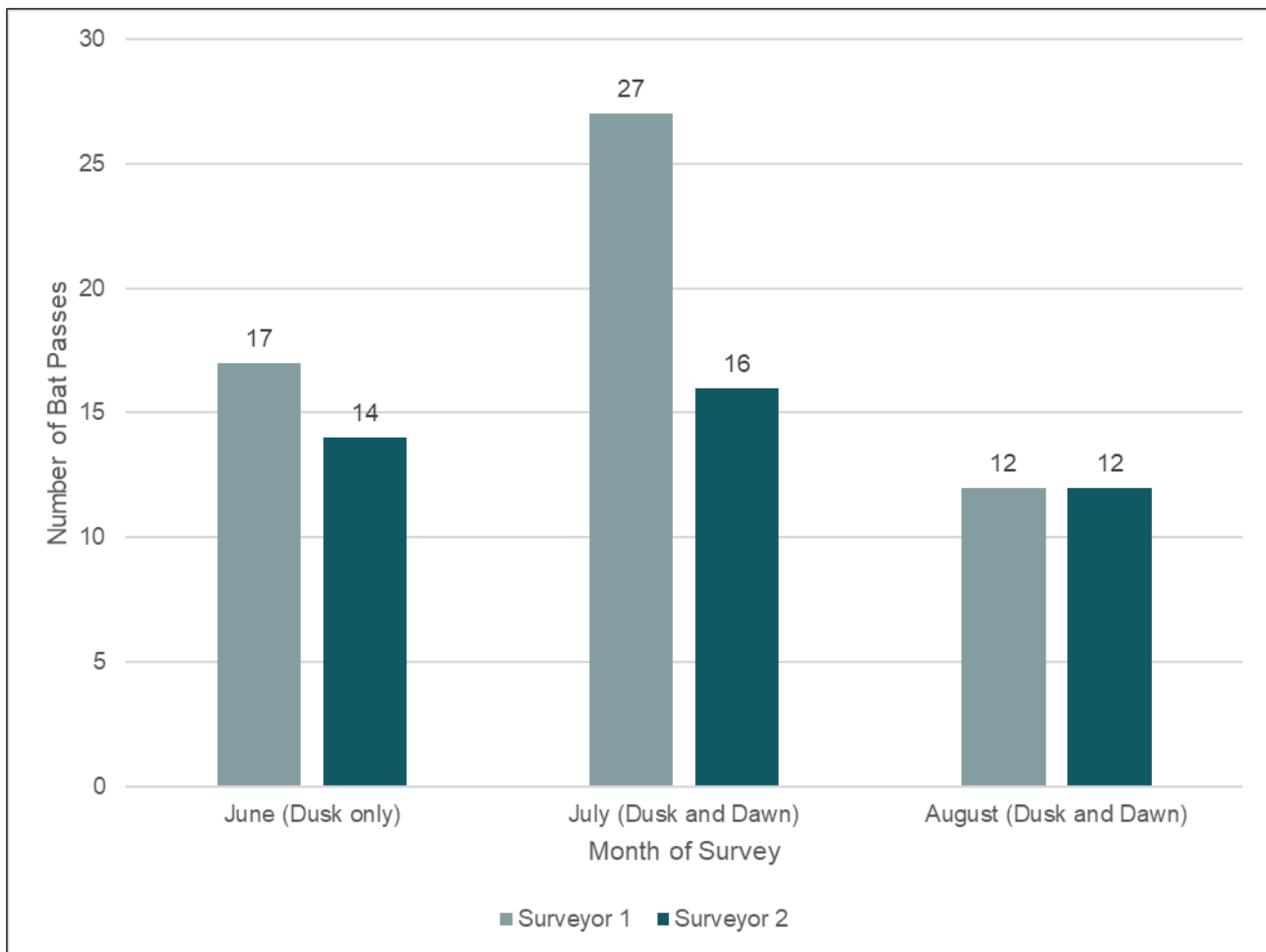


Figure 2 Number of bat passes in each month recorded by each surveyor

3.4 Crossing Point 3

- 3.4.1 Throughout the course of the five survey visits, a total of 29 bats were observed, and two bat passes (lesser horseshoe) were assumed to have crossed the feature (Table 6). Lower levels of bat activity were observed at this location in comparison with other crossing points.
- 3.4.2 A total of 31 bats were recorded between the surveyors. At least 6 species were recorded at the crossing location, namely; common pipistrelle, soprano pipistrelle, noctule, lesser horseshoe bat, *Myotis sp.* and serotine (*Eptesicus serotinus*).
- 3.4.3 Common pipistrelle bat passes were recorded significantly more times than any other species. A total of 22 common pipistrelle passes were registered equating to 70% of the activity. 14 passes of the common pipistrelle passes were recorded at an unsafe flight height.
- 3.4.4 Of the other nine passes recorded from five other species at this location, three passes were at an unsafe height, all of which were *Myotis sp.* passes.
- 3.4.5 Two lesser horseshoe bat passes were recorded as heard but not seen, meaning a flight height cannot be attributed to the pass. Four passes were recorded as noctule, serotine and soprano pipistrelle activity. All of which were recorded at a safe height (Table 6).

- 3.4.6 A total of two lesser horseshoe passes were recorded over the five visits between June to August. Both passes were recorded during dusk surveys, the first pass was recorded in July, while the second pass was recorded in August. Both passes were recorded audibly by surveyor two, but no visually observations were made.
- 3.4.7 Of the bats which were visually observed, the flight distance of the bats never exceeded 5m on a horizontal plane from the feature, suggesting bats were directly using the feature to aid safe flight.
- 3.4.8 Only two bat passes were registered in total during the June survey, both of which were recorded by surveyor two. This may suggest that the crossing point location is less favourable to the local bat assemblage during June. Additionally, during the July surveys, surveyor one registered 18 passes, whereas surveyor two only registered a single serotine pass (Figure 3).
- 3.4.9 The flight direction of the bat passes visually observed varied with no obvious trend recorded. A total of four flight directions were recorded although only one bat was observed flying from the east to the west, which was a serotine pass during the June dusk survey. This pass was recorded as a commuting pass, with the bat being observed at a safe flight height above 5m.
- 3.4.10 Surveyor two registered bat passes on every survey completed although registered considerably less activity overall than surveyor one meaning bat activity was higher at the northern end of the hedgerow. (Figure 3).

Table 6 Bat species and flight height recorded at Crossing Point 3

Species	Total crossings	Unsafe height (5m or less)	Safe height (over 5m)	Unknown height
All bat species	31	19	10	2
Common pipistrelle	22	14	8	0
Soprano pipistrelle	1	0	1	0
Lesser horseshoe	2	0	0	2
<i>Myotis</i> bat species	3	3	0	0
Noctule	2	0	2	0
Serotine	1	0	1	0

Table 7 Bat species and flight height recorded at Crossing Point 3

Flight direction	Total number of crossings	Species recorded (Number of times crossed)
South flying to North	19	Common Pipistrelle (15) <i>Myotis</i> sp. (3) Soprano Pipistrelle (1)
West flying to East	4	Common Pipistrelle (3) Noctule (1)
North flying to South	4	Common Pipistrelle (3) Noctule (1)
East flying to West	1	Serotine (1)
Unknown	2	Lesser horseshoe (2)

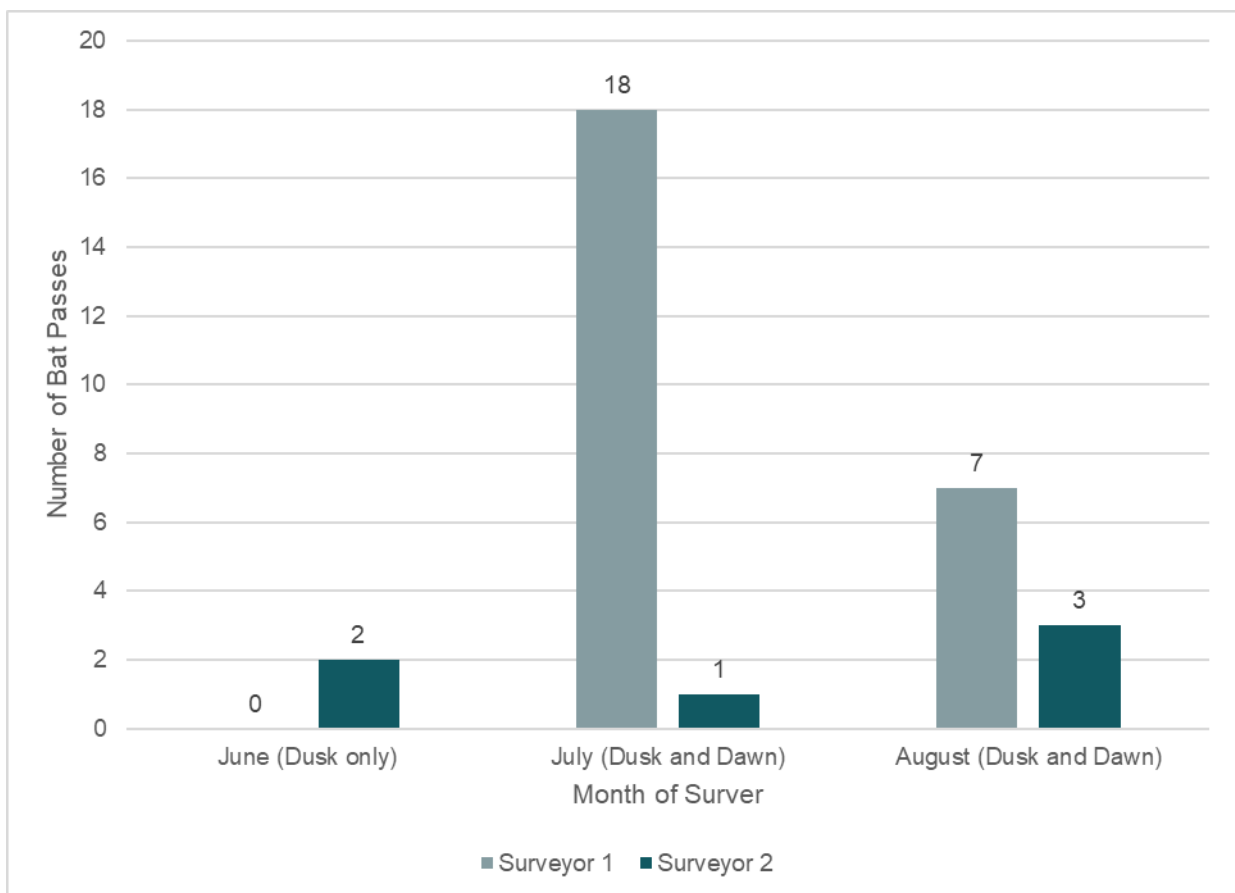


Figure 3 Number of bat passes in each month recorded by each surveyor

3.5 Crossing Point 4

3.5.1 Throughout the course of the five survey visits a total of 60 bats were seen using the crossing point (Table 8). Moderate levels of bat activity were observed at this location when compared with other crossing point locations across the scheme.

- 3.5.2 A total of 60 bat passes were recorded, comprising of four species, namely; common pipistrelle, noctule, soprano pipistrelle and serotine.
- 3.5.3 Common pipistrelle passes were recorded significantly more times than any other species at this location. 50 passes were associated to common pipistrelle activity, out of a total of 60 passes, which equates to 83% of the activity recorded at this crossing point. However, of those passes the distribution of a safe or unsafe flight height was almost evenly split (24 unsafe passes, 26 safe passes).
- 3.5.4 Of the other 10 passes recorded from the three-other species, nine passes were at an unsafe height (three noctule passes, five soprano pipistrelle passes and one serotine pass), although one soprano pipistrelle pass was recorded at a safe height.
- 3.5.5 The distance of which the bats were recorded flying from the feature (on a horizontal plane) varied significantly, although generally common pipistrelle passes were recorded within a 5m distance of the feature. Conversely, all the noctule passes recorded were seen flying at least <5 m away from the crossing point feature, and in some cases as far as 15 m from the feature.
- 3.5.6 Considerably more passes (57) were registered to the north of the woodland with the highest level of activity being recorded in August. A total of three bat passes over five survey visits between June and August were observed by surveyor 2 (Figure 4). Surveyor 1 was situated to the south of a belt of woodland and therefore benefitted from a more sheltered environment which could account for the greater number of bats recorded.
- 3.5.7 Two flights directions were observed at this crossing point, with bats flying west to east and east to west. Although most passes observed were bats flying in an east to west direction (Table 9).

Table 8 Bat species and flight height recorded at Crossing Point 4

Species	Total crossings	Unsafe height (5m or less)	Safe height (over 5m)	Unknown height
All bat species	60	30	30	0
Common pipistrelle	50	24	26	0
Soprano pipistrelle	6	5	1	0
Noctule	3	0	3	0
Serotine	1	1	0	0

Table 9 Bat species and flight height recorded at Crossing Point 4

Flight direction	Total number of crossings	Species recorded (Number of times crossed)
West flying to East	9	Common pipistrelle (7) Noctule (2)
East flying to West	51	Common pipistrelle (43) Soprano pipistrelle (6) Noctule (1) Serotine (1)

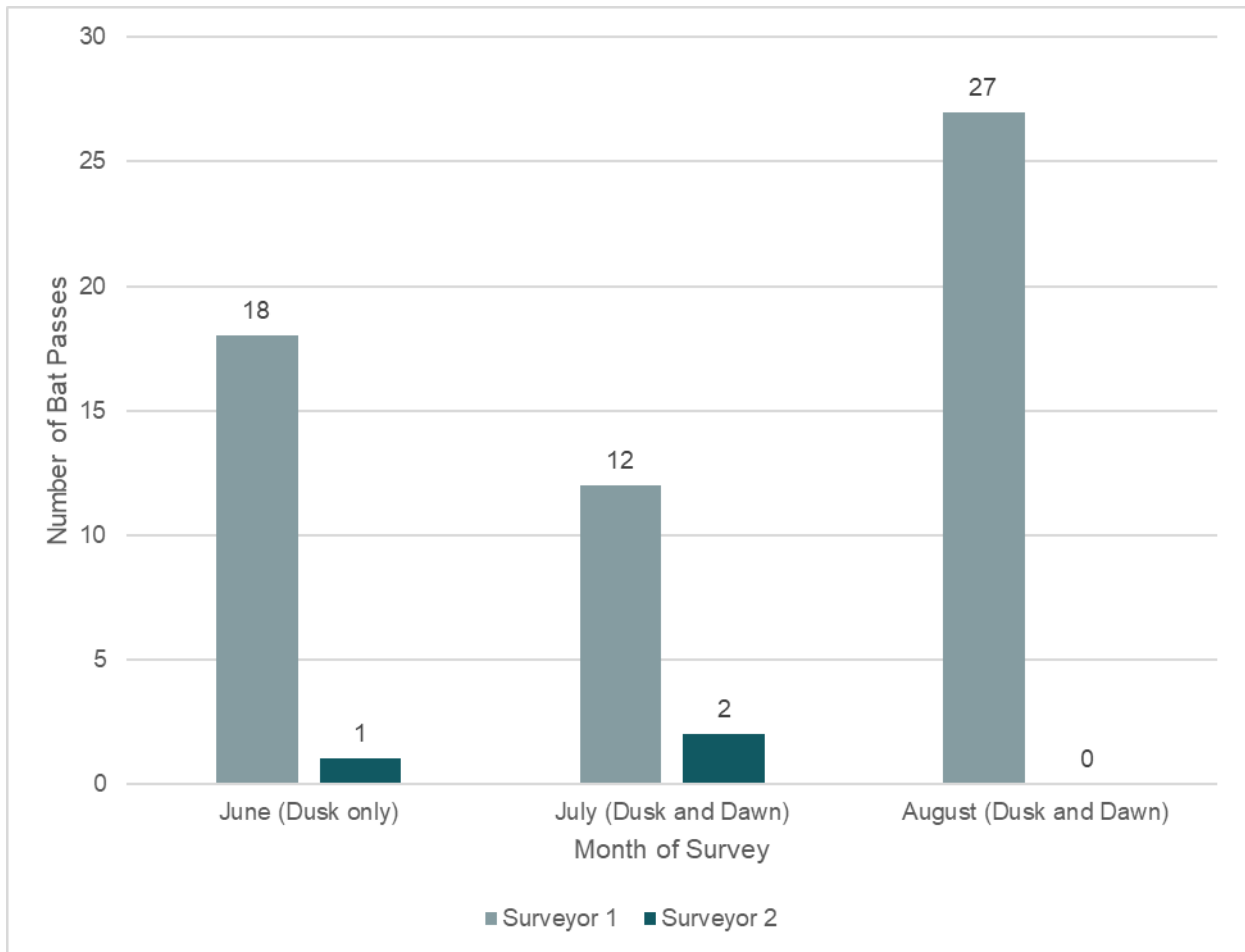


Figure 4 Number of bat passes in each month recorded by each surveyor

3.6 Crossing Point 5

- 3.6.1 Throughout the six survey visits between June and September, a total of 110 bats were observed at the crossing point (Table 10) and a further two bat passes (Lesser horseshoe bats) were assumed to have crossed the feature. High levels of bat activity were observed at this location when compared to other crossing points across the scheme.
- 3.6.2 Of the 112 bats recorded between the surveyors, at least six species were recorded namely; common pipistrelle, noctule, lesser horseshoe bat, Myotis species, serotine and Leisler's bat.
- 3.6.3 Common pipistrelle bat passes contributed to 68 of the 112 passes recorded, equating to 60% of the activity at this site. 67 of the common pipistrelle passes were recorded at a safe flight height. Noctule passes were the second most recorded species at this location. A total of 35 noctule passes were recorded, all of which were recorded at a safe flight height (Table 10).
- 3.6.4 All other bat species recorded were all flying at a safe height, apart from the two lesser horseshoe bat passes, which were not visually observed. The lesser horseshoe bat passes were both recorded on the September dusk survey at 19:53pm and 20:29pm respectively. Sunset during the September survey commenced at 19:01pm, suggesting that this bat emerged from a location relatively close to CP5.
- 3.6.5 Most of the activity recorded was bats directly using the feature. Of the bats which were visually observed, the flight distance from the feature varied the distance never exceeded 15m on a horizontal plane.
- 3.6.6 The highest level of noctule activity was recorded at CP5 when compared to the other crossing point locations, however many of the passes recorded were attributed to a single bat continually foraging along the feature (as noted by the surveyor).
- 3.6.7 All bat passes were recorded by only one surveyor at any time during the surveys. During the June and July surveys, surveyor 1 recorded all the activity at this location, however during the August and September surveys, surveyor two recorded all the bat activity. September activity was considerably lower when compared to the other surveyed months (Figure 5).
- 3.6.8 Two flight directions were visually observed a south to north and a north to south flight path. Common pipistrelle and noctule passes were recorded in similar quantities flying in either direction (Table 11). No east to west lateral bat passes were observed which suggests that bats do not cross over the existing conifer tree line at CP5.

Table 10 Bat species and flight height recorded at Crossing Point 5

Species	Total crossings	Unsafe height (5m or less)	Safe height (over 5m)	Unknown height
All bat species	112	1	109	2
Common pipistrelle	68	1	67	0
Leisler's bat	1	0	1	0
Noctule	35	0	35	0
Lesser horseshoe	2	0	0	2
<i>Myotis</i> bat species	5	0	5	0
Serotine	1	0	1	0

Table 11 Bat species and flight height recorded at Crossing Point 5

Flight direction	Total number of crossings	Species recorded (Number of times crossed)
North flying to South	56	Common pipistrelle (36) <i>Myotis</i> sp. (2) Noctule (16) Leisler's bat (1) Serotine (1)
South flying to North	54	Common pipistrelle (32) <i>Myotis</i> (3) Noctule (19)
Unknown	2	Lesser horseshoe (2)

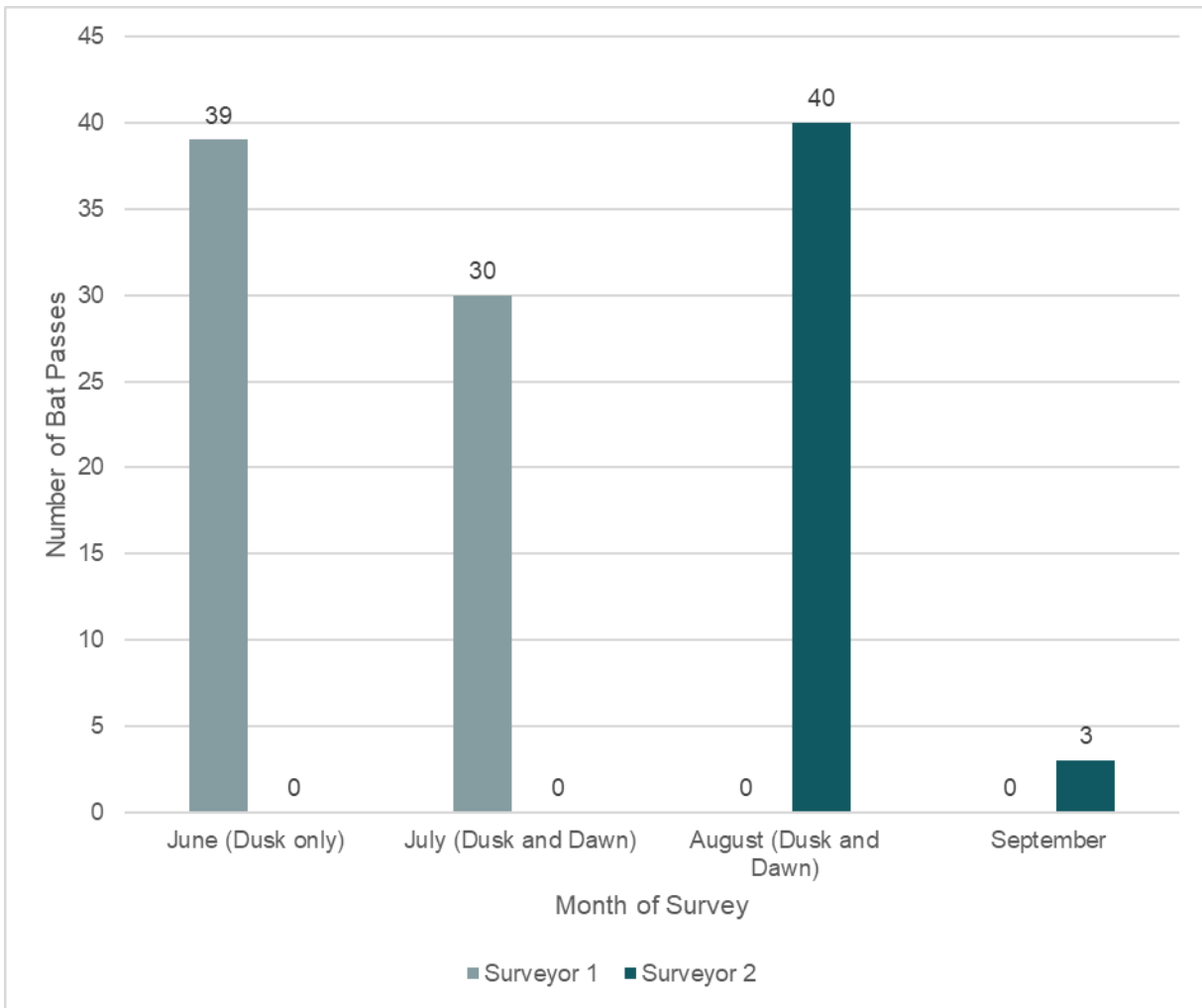


Figure 5 Number of bat passes in each month recorded by each surveyor

3.7 Crossing Point 6

- 3.7.1 Throughout the six survey visits a total of 41 bats were observed at the crossing point (Table 12) and 11 lesser horseshoe bats were assumed to have crossed the feature. Moderate levels comprising of a good species diversity of bat activity were observed at this location.
- 3.7.2 Of the 52 passes noted, at least six species were recorded, namely; common pipistrelle, noctule, lesser horseshoe bat, *Myotis* species, unconfirmed pipistrelle species, and brown long-eared.
- 3.7.3 Common pipistrelle bat passes contributed to half of the activity recorded at this site. 26 of the common pipistrelle passes were recorded at an unsafe flight height (Table 12).
- 3.7.4 Lesser horseshoe passes were the second most commonly recorded species on site. A total of 13 passes were recorded although only two passes were visually observed, both of which were at an unsafe flight height (i.e., 5m or less).
- 3.7.5 All *Myotis sp.* passes were recorded at a safe flight height, whereas a single noctule pass and brown long eared bat pass were both recorded at an unsafe flight height.
- 3.7.6 Most of the activity recorded on site was created from bats directly using the feature. Of the bats which were visually observed, the distance of which the bats were recorded was regularly below 5 m laterally on a horizontal plane.
- 3.7.7 Comparable levels of bat activity were observed by both surveyors across the survey months, although a spike in activity was recorded at the southern end of the hedgeline during the July survey (Figure 6).
- 3.7.8 The flight direction of the bat passes visually observed (41 out of 52) varied, with no obvious trend recorded. Of the passes recorded eight different flight directions were recorded with common pipistrelle bats being recorded along seven different flight orientations (Table 13).
- 3.7.9 The two lesser horseshoe bats that were visually observed were recorded flying from the east to the west during the June dusk survey by surveyor 2. Additionally, surveyor 2 noted both passes as being very close to the hedge-line. This may suggest that the hedgerow at CP6 is an important feature for lesser horseshoe bats.

Table 12 Bat species and flight height recorded at Crossing Point 6

Species	Total crossings	Unsafe height (5m or less)	Safe height (over 5m)	Unknown height
All bat species	52	40	1	11
Common pipistrelle	27	26	1	0
Unidentified pipistrelle	1	1	0	0
Noctule	1	1	0	0
Lesser horseshoe	13	2	0	11
<i>Myotis</i> bat species	9	0	9	0
Brown long-eared bat	1	1	0	0

Table 13 Bat species and flight height recorded at Crossing Point 6

Flight direction	Total number of crossings	Species recorded (Number of times crossed)
North-West flying to South-East	3	<i>Myotis sp.</i> (3)
North-West flying to West	3	Common Pipistrelle (3)
East flying to West	9	Common Pipistrelle (7) Lesser horseshoe bat (2)
South-East flying to East	3	Common pipistrelle (2) Brown long-eared (1)
South-East flying to North-West	2	Common pipistrelle (1) Noctule (1)
South Flying to North	3	Common pipistrelle (1) <i>Myotis sp.</i> (2)
South-West Flying East	2	Common pipistrelle (1) <i>Myotis sp.</i> (1)
West flying to East	16	Common pipistrelle (12) <i>Myotis sp.</i> (3) Pipistrelle <i>sp.</i> (1)
Unknown	11	Lesser horseshoe (11)

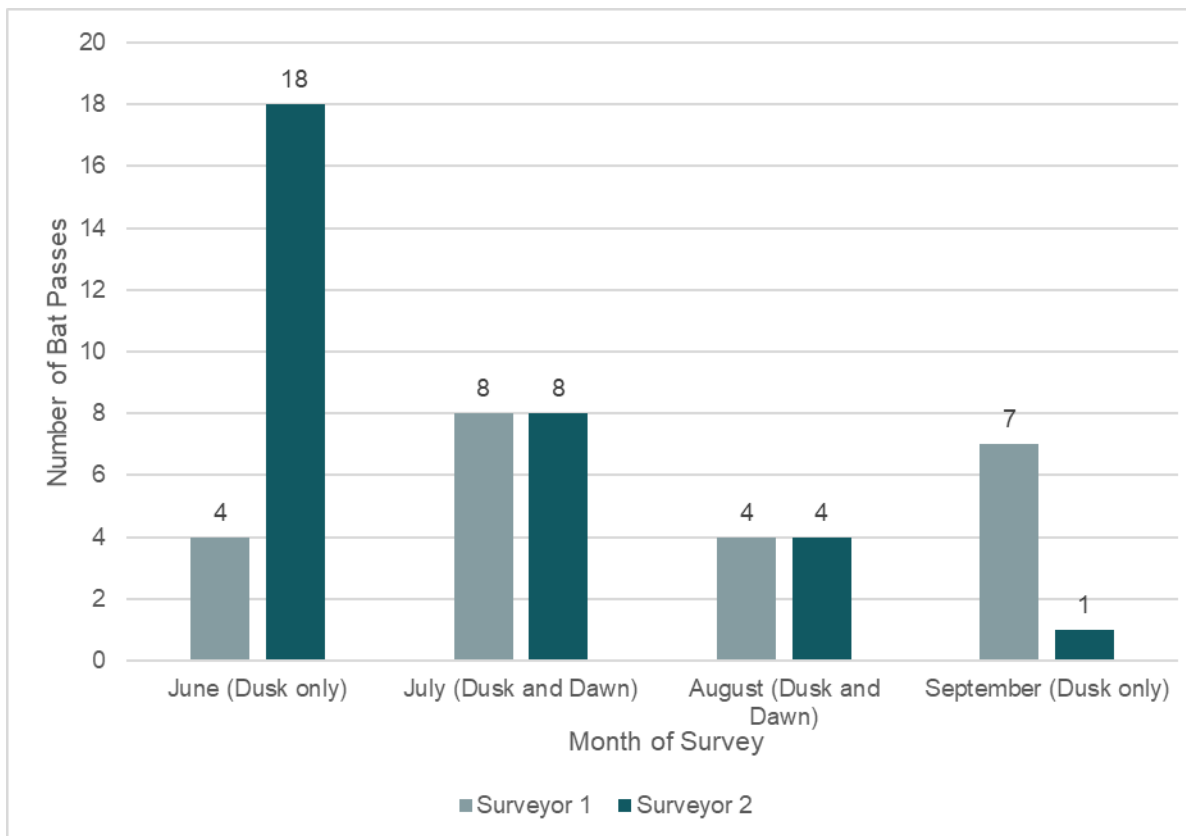


Figure 6 Number of bat passes in each month recorded by each surveyor

3.8 Crossing Point 7

- 3.8.1 Throughout the course of the six survey visits between a total of 127 bats were observed at the crossing point, with a further four lesser horseshoe assumed to have crossed the feature (Table 14). Bat activity was high at this location when compared to other crossing points, although the majority of activity was recorded to the north of the woodland.
- 3.8.2 At least five species were recorded at the crossing location, namely; common pipistrelle, noctule, lesser horseshoe bat, *Myotis* species and serotine.
- 3.8.3 Common pipistrelle bat passes contributed to 112 of the 131 passes recorded, equating to 86% of the activity at the crossing point. 85 of the common pipistrelle passes were recorded at an unsafe flight height.
- 3.8.4 A total of nine passes of *Myotis sp.* were recorded at this location, eight of which were recorded at an unsafe flight height. A total of four lesser horseshoe bat passes were recorded across the July and August surveys. Horseshoe passes were recorded during both dusk and dawn surveys.
- 3.8.5 Bat activity was considerably higher at the northern face of the woodland. A sudden drop in activity was observed during the September survey visit (Figure 7). Most of the activity recorded on site were bats directly using the feature. at the south-western end of the lane in July and bat activity levels at the north-eastern survey point were comparable across the survey months (Figure 2).
- 3.8.6 The direction of flight of the bat passes visually observed (127) varied significantly with no obvious trend recorded. Of the passes seven flight directions were recorded with common pipistrelle activity being recorded in all orientations (Table 15).

Table 14 Bat species and flight height recorded at Crossing Point 7

Species	Total crossings	Unsafe height (5m or less)	Safe height (over 5m)	Unknown height
All bat species	131	97	30	4
Common pipistrelle	112	85	27	0
Serotine	3	3	0	0
Noctule	3	1	2	0
Lesser horseshoe	4	0	0	4
<i>Myotis</i> bat species	9	8	1	0

Table 15 Bat species and flight height recorded at Crossing Point 7

Flight direction	Total number of crossings	Species recorded (Number of times crossed)
West flying to East	21	Common pipistrelle (19) <i>Myotis sp.</i> (2)
South-West flying to North-East	3	Common pipistrelle (3)
South flying North	24	Common pipistrelle (19) <i>Myotis sp.</i> (3) Serotine (2)
North flying to West	2	Common pipistrelle (2)
North flying to South	24	Common pipistrelle (17) Noctule (3) <i>Myotis sp.</i> (4)
North-East flying to South-West	21	Common pipistrelle (21)
East flying to West	32	Common pipistrelle (31) Serotine (1)
Unknown	4	Lesser horseshoe (4)

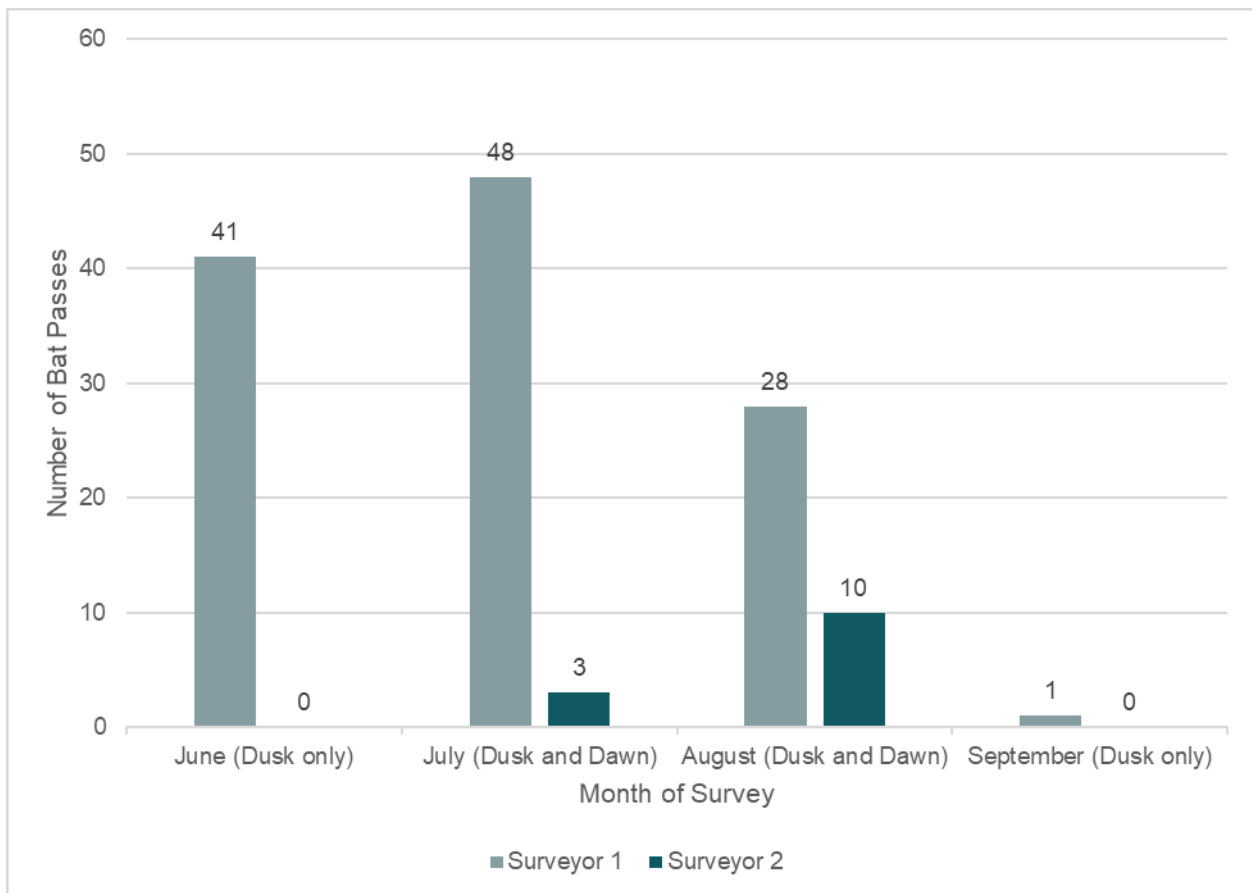


Figure 7 Number of bat passes in each month recorded by each surveyor

4 Conclusions and recommendations

- 4.1.1 This survey fulfilled its objectives in producing quantifiable data that can be used and compared alongside data procured from replicate surveys which should be repeated during pre-construction.
- 4.1.2 The number of commuting bats seen by surveyors at each survey location and the overall levels of bat activity varied considerably according to the nature of the feature being surveyed and the quality of the commuting and foraging habitat for bats in the immediate surroundings.
- 4.1.3 CP5, CP6, and CP7 are all ecologically connected features that produced high levels of bat activity from a diverse species composition. The scheme will fragment much of the habitat in this area and therefore it is recommended that mitigation efforts are focussed at these locations.
- 4.1.4 Lesser horseshoe bats, which are listed as an Annex II species on the European Communities Council Directive¹² were recorded more times at CP6 than at any other location. Additionally, this species was recorded on every survey visit, suggesting that this feature is flight route for this species used year-round.
- 4.1.5 Common pipistrelle bats were observed at every crossing point location and were the most recorded species at all survey locations. Generally, the flight height for this species fluctuated, however a correlation between flight height and the height of the vegetation along the feature was observed at some crossing point locations.
- 4.1.6 For instance, CP5 and CP7 recorded the highest number of safe bat passes (Table 10 and Table 14) and both CP5 and CP7 comprise mature trees which were above 5m in height. Whereas at CP1 almost all bat passes were recorded at an unsafe flight height, and at this location the avenue of trees along the feature were immature and less than 5m tall.
- 4.1.7 It is recommended that the data in this report is used to inform high level decisions relating to the proposed impacts and appropriate mitigation on the Annex II bat populations occurring in the area of the existing A417. Although this report does not provide an impact assessment, the significant presence of Annex II species is likely to result in impacts from the proposed road widening, to foraging and commuting bats, and the potential roost loss and habitat severance/fragmentation for Annex II and other species of bat.

End notes and References

- ¹ *The Conservation of Habitats and Species and Planning (Various Amendments) (England and Wales) Regulations 2018*. Available at: <http://www.legislation.gov.uk/ukxi/2018/1307/made> (Accessed: 20/10/2019).
- ² *Wildlife and Countryside Act 1981*. (Accessed: 20/10/2019).
- ³ Development of a cost-effective method for monitoring the effectiveness of mitigation for bats crossing linear transport infrastructure - WC1060.
- ⁴ <https://maps.google.co.uk>
- ⁵ Billington, G. and Rawlinson, M.D., 2006. *A review of horseshoe bats flight lines and feeding areas*. Countryside Council for Wales.
- ⁶ McKinnon, A. (2010). Britain without Double-deck Lorries . *An Assessment of the Effects on Traffic Levels, Road Haulage Costs, Fuel Consumption and CO2 Emissions*. 1 (1), 1.
- ⁷ Schnitzler, H.U. and Grinnell, A.D., 1977. Directional sensitivity of echolocation in the horseshoe bat, *Rhinolophus ferrumequinum*. *Journal of comparative physiology*, 116(1), pp.51-61.
- ⁸ The *Myotis* bats: Daubenton's, Bechs Billington, G. and Rawlinson, M.D., 2006. *A review of horseshoe bats flight lines and feeding areas*. Countryside Council for Wales. tein's, whiskered, Brandt's and alcatheo bats (and often Natterer's bat) are difficult to differentiate from call analysis alone. Considering the rarity of greater mouse-eared bat in the UK, this species is highly unlikely to be present.
- ⁹ Parsons, S. and Jones, G. (2000) *Acoustic identification of 12 species of echolocating bat by discriminant function analysis and artificial neural networks*. *Journal of Experimental Biology* 203: 2641–2656.
- ¹⁰ Walters, C.L., Freeman, R., Collen, A., Dietz, C., Fenton, M.B., Jones, G., Obrist, M.K., Puechmaille, S.J., Sattler, T., Siemers, B.M., Parsons, S. and Jones, K.E. (2012) *A continental-scale tool for acoustic identification of European bats*. *Journal of Applied Ecology* 49: 1064–1074.
- ¹¹ Bat Conservation Trust. (2008). Grey Long Eared. *Species Fact Sheet*. (Available at: https://cdn.bats.org.uk/pdf/About%20Bats/greylongeared_11.02.13.pdf?mtime=20181101151300)
- ¹² Council Directive 92/43/EEC Availabe: <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0043:EN:HTML> (Accessed 30/10/2019)

Appendices

Appendix A Weather conditions during surveys

A.1 June Dusk Survey

Date of Survey	Sunset	Survey times		Temperature (°C)		Humidity (%)		Wind Speed (Beaufort) / Direction		Cloud cover		Weather the night before	General Conditions
		Start	End	Start	End	Start	End	Start	End	Start	End		
27/06/19	21:32	21:30	23:02	17	15	60	65	3	4	0	0	Warm, still and dry	Dry, slight breeze picking up during survey

A.2 July Dusk Survey

Date of Survey	Sunset	Survey times		Temperature (°C)		Humidity (%)		Wind Speed (Beaufort) / Direction		Cloud cover		Weather the night before	General Conditions
		Start	End	Start	End	Start	End	Start	End	Start	End		
24/07/19	21.11	21:11	22:41	20	18	86	86	2	1	4	3	Warm and dry	Dry although quite misty at the end of the survey

A.3 July Dawn Survey

Date of Survey	Sunrise	Survey times		Temperature (°C)		Humidity (%)		Wind Speed (Beaufort) / Direction		Cloud cover		Weather the night before	General Conditions
		Start	End	Start	End	Start	End	Start	End	Start	End		
25/07/19	05.20	03:50	05:20	19	18	84	76	1	2	2	1	Warm and dry	Still night, wind slightly increasing toward end of survey

A.4 August Dusk Survey

Date of Survey	Sunset	Survey times		Temperature (°C)		Humidity (%)		Wind Speed (Beaufort) / Direction		Cloud cover		Weather the night before	General Conditions
		Start	End	Start	End	Start	End	Start	End	Start	End		
20/08/19	20.23	20:23	21:53	16	14	66	77	2	2	7	5	Warm and dry	Light rain started at 20:32 survey suspended at 21:07-21:30 due to rain. Survey recommenced after rain stopped

A.5 August Dawn Survey

Date of Survey	Sunrise	Survey times		Temperature (°C)		Humidity (%)		Wind Speed (Beaufort) / Direction		Cloud cover		Weather the night before	General Conditions
		Start	End	Start	End	Start	End	Start	End	Start	End		
21/08/19	06.02	04:32	06:02	13	12	83	83	1	1	3	4	Warm and light rain in parts	Misty throughout survey

A.6 September Dusk Survey

Date of Survey	Sunrise	Survey times		Temperature (°C)		Humidity (%)		Wind Speed (Beaufort) / Direction		Cloud cover		Weather the night before	General Conditions
		Start	End	Start	End	Start	End	Start	End	Start	End		
25/09/19	19.01	19:01	20:31	16	15	84	84	1	1	3	3	Heavy rain	Still, calm night

Appendix B Raw survey data – Bats seen crossing at each CP Location

B.1 CP1

Table 16 Survey Results at CP1

Survey Date	Survey Number	Location	Height from Ground (m)	Distance	Side	Direction From	Species	Surveyor Location	Notes
27.06.2019	Dusk 1	CP1	3	0	South	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	4	0	Central	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	4	10	South	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	4	0	Central	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	

27.06.2019	Dusk 1	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	5	0	Central	NE-SW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
27.06.2019	Dusk 1	CP1	2.5	0	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	5.5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	3.5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	3.5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	3	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
27.06.2019	Dusk 1	CP1	2.5	0	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	2.5	0	South	E-W	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	3	0	South	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	2.5	0	South	E-W	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	2.5	0	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	2.5	0	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	2.5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
27.06.2019	Dusk 1	CP1	2.5	0	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
24.07.2019	Dusk 2	CP1	3	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.1	
24.07.2019	Dusk 2	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	Foraging
24.07.2019	Dusk 2	CP1	4	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.1	Foraging
24.07.2019	Dusk 2	CP1	4	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	Foraging
24.07.2019	Dusk 2	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
24.07.2019	Dusk 2	CP1	3	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.1	
24.07.2019	Dusk 2	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
24.07.2019	Dusk 2	CP1	3	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.1	Foraging
24.07.2019	Dusk 2	CP1	3	0	Central	SE-NW	<i>Myotis sp.</i>	CP1.1	

24.07.2019	Dusk 2	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
24.07.2019	Dusk 2	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
24.07.2019	Dusk 2	CP1	3	1	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
24.07.2019	Dusk 2	CP1	5	1.5	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	4	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	6	0	Central	W- E	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	W- E	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
24.07.2019	Dusk 2	CP1	5	0	Central	W- E	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	W- E	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	6	0	Central	W- E	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	6	0	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
24.07.2019	Dusk 2	CP1	5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging

24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
24.07.2019	Dusk 2	CP1	5	0	Central	E - W	<i>Pipistrellus pipistrellus</i>	CP1.2	Commuting
24.07.2019	Dusk 2	CP1	5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
24.07.2019	Dusk 2	CP1	4	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	6	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	4	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	6	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	
24.07.2019	Dusk 2	CP1	7	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	
25.07.2019	Dawn 3	CP1	3	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.1	Foraging
25.07.2019	Dawn 3	CP1	4	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.1	Foraging
25.07.2019	Dawn 3	CP1	2	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	Foraging
25.07.2019	Dawn 3	CP1	3	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.1	
25.07.2019	Dawn 3	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
25.07.2019	Dawn 3	CP1	4	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.1	
25.07.2019	Dawn 3	CP1	3	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.1	
25.07.2019	Dawn 3	CP1	3	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.1	
25.07.2019	Dawn 3	CP1	5	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
25.07.2019	Dawn 3	CP1	6	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
25.07.2019	Dawn 3	CP1	5	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
25.07.2019	Dawn 3	CP1	4	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging

25.07.2019	Dawn 3	CP1	5	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
25.07.2019	Dawn 3	CP1	6	0	Central	SE-NW	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging
25.07.2019	Dawn 3	CP1	6	0	Central	NW-SE	<i>Pipistrellus pipistrellus</i>	CP1.2	Foraging

B.2 CP2

Table 17 Survey Results at CP2

Survey Date	Survey Number	Location	Height from Ground (m)	Distance	Side	Direction From	Species	Surveyor Location	Notes
20.06.2019	Dusk 1	CP2	10	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Crossed the lane
20.06.2019	Dusk 1	CP2	10	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Middle of lane
20.06.2019	Dusk 1	CP2	10	2	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	Middle of lane
20.06.2019	Dusk 1	CP2	10	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Middle of lane
20.06.2019	Dusk 1	CP2	10	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Middle of lane
20.06.2019	Dusk 1	CP2	10	2	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	Middle of lane
20.06.2019	Dusk 1	CP2	10	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	foraging
20.06.2019	Dusk 1	CP2	10	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	foraging
20.06.2019	Dusk 1	CP2	10	2	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	2X bats foraging
20.06.2019	Dusk 1	CP2	5	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	x3 bats Foraging
20.06.2019	Dusk 1	CP2	2	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	x3 bats Foraging and crossing lane
20.06.2019	Dusk 1	CP2	2	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	x5 bats Foraging
20.06.2019	Dusk 1	CP2	2	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	3 x foraging
20.06.2019	Dusk 1	CP2	2	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	3 x foraging
20.06.2019	Dusk 1	CP2	N/A	N/A	N/A	N/A	<i>Rhinopholus hipposideros</i>	CP2.1	HNS
20.06.2019	Dusk 1	CP2	8	0	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	2X bats foraging middle of lane
20.06.2019	Dusk 1	CP2	N/A	N/A	N/A	N/A	<i>Rhinopholus hipposideros</i>	CP2.1	HNS
20.06.2019	Dusk 1	CP2	4	7	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	4	6	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	5	7	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	4	6	East	S-N	<i>Myotis sp.</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	3	5	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane

20.06.2019	Dusk 1	CP2	6	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	5	7	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	5	5	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	5	6	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	5	7	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	5	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Middle of lane
20.06.2019	Dusk 1	CP2	N/A	N/A	N/A	N/A	<i>Rhinopholus hipposideros</i>	CP2.2	HNS
24.07.2019	Dusk 2	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Crossed the lane
24.07.2019	Dusk 2	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Middle of lane
24.07.2019	Dusk 2	CP2	4	0	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	2	0	East	E-W	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	3	0	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	3	0	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	2	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	3	0	East	W-E	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	3	0	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	4	0	East	W-E	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2019	Dusk 2	CP2	3	0	W	W-E	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2020	Dusk 2	CP2	3	0	W	W-E	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2021	Dusk 2	CP2	3	0	W	W-E	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
24.07.2021	Dusk 2	CP2	4	3	West	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting

24.07.2019	Dusk 2	CP2	5	2	West	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
24.07.2019	Dusk 2	CP2	4	0	West	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
24.07.2019	Dusk 2	CP2	4	1	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
24.07.2019	Dusk 2	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
24.07.2019	Dusk 2	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
24.07.2019	Dusk 2	CP2	3	0	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
24.07.2019	Dusk 2	CP2	5	5	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
24.07.2019	Dusk 2	CP2	5	5	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
24.07.2019	Dusk 2	CP2	4	2	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
24.07.2019	Dusk 2	CP2	5	1	W	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
25.07.2019	Dawn 3	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
25.07.2019	Dawn 3	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
25.07.2019	Dawn 3	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
25.07.2019	Dawn 3	CP2	2	4	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
25.07.2019	Dawn 3	CP2	3	3	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
25.07.2019	Dawn 3	CP2	4	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
25.07.2019	Dawn 3	CP2	4	2	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
25.07.2019	Dawn 3	CP2	3	5	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
25.07.2019	Dawn 3	CP2	3	4	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
25.07.2019	Dawn 3	CP2	5	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
25.07.2019	Dawn 3	CP2	3	5	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
25.07.2019	Dawn 3	CP2	3	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
25.07.2019	Dawn 3	CP2	3	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
25.07.2019	Dawn 3	CP2	3	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
25.07.2019	Dawn 3	CP2	3	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
25.07.2019	Dawn 3	CP2	3	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
20.08.2019	Dusk 4	CP2	4	0	East	W-E	<i>Pipistrellus pipistrellus</i>	CP2.1	Commuting

20.08.2019	Dusk 4	CP2	14	6	East	N-S	<i>Nyctalus noctula</i>	CP2.1	Foraging
20.08.2019	Dusk 4	CP2	14	6	East	S-N	<i>Nyctalus noctula</i>	CP2.1	Foraging
20.08.2019	Dusk 4	CP2	3	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
20.08.2019	Dusk 4	CP2	4	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
20.08.2019	Dusk 4	CP2	3	0	East	S-N	<i>Myotis sp.</i>	CP2.1	Foraging
20.08.2019	Dusk 4	CP2	3	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
20.08.2019	Dusk 4	CP2	4	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
20.08.2019	Dusk 4	CP2	4	0	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
20.08.2019	Dusk 4	CP2	4	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
20.08.2019	Dusk 4	CP2	4	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.1	Foraging
20.08.2019	Dusk 4	-	-	-	-	-	<i>Rhinolophus hipposideros</i>	CP2.1	HNS
20.08.2019	Dusk 4	CP2	4	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
20.08.2019	Dusk 4	CP2	10	5	East	N-S	<i>Nyctalus noctula</i>	CP2.2	Foraging
20.08.2019	Dusk 4	CP2	3	1	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
20.08.2019	Dusk 4	CP2	3	1	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
20.08.2019	Dusk 4	CP2	4	1	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
20.08.2019	Dusk 4	CP2	4	1	East	S-N	<i>Myotis sp.</i>	CP2.2	Foraging
20.08.2019	Dusk 4	CP2	4	1	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
20.08.2019	Dusk 4	CP2	4	1	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
20.08.2019	Dusk 4	CP2	4	1	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
20.08.2019	Dusk 4	CP2	5	1	East	S-N	<i>Pipistrellus pipistrellus</i>	CP2.2	Foraging
20.08.2019	Dawn 5	CP2	4	0	East	N-S	<i>Pipistrellus pipistrellus</i>	CP2.2	Commuting
20.08.2019	Dawn 5	CP2	4	7	East	N-S	<i>Nyctalus noctula</i>	CP2.2	Commuting

B.3 CP3

Table 18 Survey Results at CP3

Survey Date	Survey Number	Location	Height from Ground (m)	Distance	Side	Direction From	Species	Surveyor Location	Notes
27.06.2019	Dusk 1	CP3	3.5	3	Central	S-N	<i>Pipistrellus pipistrellus</i>	CP3.2	
27.06.2019	Dusk 1	CP3	-	-	-	-	<i>Rhinolophus hipposideros</i>	CP3.2	
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	3	West	N-S	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Myotis sp.</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Myotis sp.</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Myotis sp.</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	5.5	0	West	E-W	<i>Serotine</i>	CP3.2	Commuting
25.07.2019	Dawn 3	CP3	5	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	5	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	4	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
20.08.2019	Dusk 4	CP3	2	0	East	N-S	<i>Pipipstellus pipistrellus</i>	CP3.1	
20.08.2019	Dusk 4	CP3	6	2	East	S-N	<i>Pipipstellus pygmaeus</i>	CP3.1	

20.08.2019	Dusk 4	CP3	6	0	East	W-E	<i>Pipipstellus pipistrellus</i>	CP3.1	
20.08.2019	Dusk 4	CP3	8	0	East	W-E	<i>Noctule</i>	CP3.1	
20.08.2019	Dusk 4	CP3	3	1	East	W-E	<i>Pipipstellus pipistrellus</i>	CP3.1	
20.08.2019	Dusk 4	CP3	5	1	West	W-E	<i>Pipipstellus pipistrellus</i>	CP3.1	
20.08.2019	Dusk 4	CP3	8	2	East	N-S	<i>Noctule</i>	CP3.2	
20.08.2019	Dusk 4	CP3	2.5	2	West	W-E	<i>Pipipstellus pipistrellus</i>	CP3.2	
20.08.2019	Dusk 4	CP3	-	-	-	W-E	<i>Rhinolophus Hipposideros</i>	CP3.2	
21.08.2019	Dawn 5	CP3	4	0	East	N-S	<i>Pipipstellus pipistrellus</i>	CP3.1	Commuting
27.06.2019	Dusk 1	CP3	3.5	3	Central	S-N	<i>Pipistrellus pipistrellus</i>	CP3.2	
27.06.2019	Dusk 1	CP3	-	-	-	-	<i>Rhinolophus hipposideros</i>	CP3.2	
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	3	West	N-S	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Myotis sp.</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Myotis sp.</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Myotis sp.</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	2	0	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
24.07.2019	Dusk 2	CP3	5.5	0	West	E-W	<i>Eptesicus serotinus</i>	CP3.2	Commuting
25.07.2019	Dawn 3	CP3	5	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	5	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	4	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging

25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
25.07.2019	Dawn 3	CP3	7	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP3.1	Foraging
20.08.2019	Dusk 4	CP3	2	0	East	N-S	<i>Pipipstellus pipistrellus</i>	CP3.1	
20.08.2019	Dusk 4	CP3	6	2	East	S-N	<i>Pipipstellus pygmaeus</i>	CP3.1	
20.08.2019	Dusk 4	CP3	6	0	East	W-E	<i>Pipipstellus pipistrellus</i>	CP3.1	
20.08.2019	Dusk 4	CP3	8	0	East	W-E	<i>Nyctalus noctula</i>	CP3.1	
20.08.2019	Dusk 4	CP3	3	1	East	W-E	<i>Pipipstellus pipistrellus</i>	CP3.1	
20.08.2019	Dusk 4	CP3	5	1	West	W-E	<i>Pipipstellus pipistrellus</i>	CP3.1	
20.08.2019	Dusk 4	CP3	8	2	East	N-S	<i>Nyctalus noctula</i>	CP3.2	
20.08.2019	Dusk 4	CP3	2.5	2	West	W-E	<i>Pipipstellus pipistrellus</i>	CP3.2	
20.08.2019	Dusk 4	CP3	N/A	N/A	N/A	N/A	<i>Rhinolophus Hipposideros</i>	CP3.2	
21.08.2019	Dawn 5	CP3	4	0	East	N-S	<i>Pipipstellus pipistrellus</i>	CP3.1	Commuting

B.4 CP4**Table 19 Survey Results at CP4**

Survey Date	Survey Number	Location	Height from Ground (m)	Distance	Side	Direction From	Species	Surveyor Location	Notes
27.06.2019	Dusk 1	CP4	10	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	10	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	8	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	8	2	South	W-E	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	6	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	10	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	3	0	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	8	3	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	8	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	8	4	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	10	3	South	W-E	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	3	4	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	6	3	South	W-E	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	7	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	8	3	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	6	5	South	W-E	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	10	0	South	W-E	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	15	1	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
27.06.2019	Dusk 1	CP4	3	5	North	E-W	<i>Eptesicus serotinus</i>	CP4.2	Foraging
24.07.2019	Dusk 2	CP4	18	15	South		<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
24.07.2019	Dusk 2	CP4	16	6	South	E-W	<i>Nyctalus noctula</i>	CP4.1	Foraging
24.07.2019	Dusk 2	CP4	15	15	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging

24.07.2019	Dusk 2	CP4	10	15	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
24.07.2019	Dusk 2	CP4	18	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
24.07.2019	Dusk 2	CP4	15	15	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
24.07.2019	Dusk 2	CP4	15	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
24.07.2019	Dusk 2	CP4	18	3	South	E-W	<i>Pipistrellus pygmaeus</i>	CP4.1	Foraging
24.07.2019	Dusk 2	CP4	18	5	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
24.07.2019	Dusk 2	CP4	18	6	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
24.07.2019	Dusk 2	CP4	15	10	North	W-E	<i>Nyctalus noctula</i>	CP4.2	Foraging
24.07.2019	Dusk 2	CP4	10	10	North	W-E	<i>Nyctalus noctula</i>	CP4.2	Foraging
25.07.2019	Dawn 3	CP4	8	15	South	-	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
25.07.2019	Dawn 3	CP4	8	15	South	-	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dusk 4	CP4	2	3	South	E-W	<i>Pipistrellus pygmaeus</i>	CP4.1	Foraging
20.08.2019	Dusk 4	CP4	2	3	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dusk 4	CP4	1	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dusk 4	CP4	1	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dusk 4	CP4	2	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dusk 4	CP4	3	1	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dusk 4	CP4	2	1	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	3	5	South	E-W	<i>Pipistrellus pygmaeus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	3	5	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	2	5	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	2	4	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	3	6	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	3	7	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	3	3	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging

20.08.2019	Dawn 5	CP4	3	3	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	3	6	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	3	3	South	E-W	<i>Pipistrellus pygmaeus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	3	5	South	E-W	<i>Pipistrellus pygmaeus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	3	5	South	E-W	<i>Pipistrellus pygmaeus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	2	5	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	2	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	2	1	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2019	Dawn 5	CP4	2	1	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2020	Dawn 5	CP4	2	1	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2021	Dawn 5	CP4	2	1	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2022	Dawn 5	CP4	3	2	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging
20.08.2023	Dawn 5	CP4	3	1	South	E-W	<i>Pipistrellus pipistrellus</i>	CP4.1	Foraging

B.5 CP5**Table 20 Survey Results at CP5**

Survey Date	Survey Number	Location	Height from Ground (m)	Distance	Side	Direction From	Species	Surveyor Location	Notes
27.06.2019	Dusk 1	CP5	8	5	W	N-S	<i>Eptesicus serotinus</i>	CP5.1	
27.06.2019	Dusk 1	CP5	8	5	W	N-S	<i>Myotis sp</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	5	W	N-S	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	5	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	0	Central	N-S	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	0	Central	N-S	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	0	Central	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	0	Central	N-S	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	N-S	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	N-S	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	10	5	W	N-S	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	5	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	3	W	N-S	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	5	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	5	W	N-S	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	10	5	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	12	15	W	N-S	<i>Nyctalus noctula</i>	CP5.1	

27.06.2019	Dusk 1	CP5	15	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	Foraging
27.06.2019	Dusk 1	CP5	10	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	Foraging
27.06.2019	Dusk 1	CP5	10	10	W	N-S	<i>Nyctalus noctula</i>	CP5.1	Foraging
27.06.2019	Dusk 1	CP5	10	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	Foraging
27.06.2019	Dusk 1	CP5	10	10	W	S-N	<i>Nyctalus noctula</i>	CP5.1	Foraging
27.06.2019	Dusk 1	CP5	10	7	W	S-N	<i>Nyctalus noctula</i>	CP5.1	Foraging
27.06.2019	Dusk 1	CP5	6	2	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
27.06.2019	Dusk 1	CP5	15	0	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
27.06.2019	Dusk 1	CP5	8	2	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
27.06.2019	Dusk 1	CP5	8	2	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
27.06.2019	Dusk 1	CP5	8	2	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
27.06.2019	Dusk 1	CP5	8	2	W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
27.06.2019	Dusk 1	CP5	8	5	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	10	5	W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	10	5	W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	8	2	W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	Foraging
24.07.2019	Dusk 2	CP5	8	5	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	10	5	W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	8	12	W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	8	2	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	8	5	W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	

24.07.2019	Dusk 2	CP5	8	5	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	12	0	Central	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	Foraging
24.07.2019	Dusk 2	CP5	8	5	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	8	2	W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	12	0	Central	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	15	0	Central	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	8	5	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	8	2	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	Multiple bats
24.07.2019	Dusk 2	CP5	8	10	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	8	5	W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
24.07.2019	Dusk 2	CP5	10	3	W	N-S	<i>Myotis sp</i>	CP5.1	
24.07.2019	Dusk 2	CP5	10	5	W	S-N	<i>Myotis sp</i>	CP5.1	
24.07.2019	Dusk 2	CP5	10	2	W	S-N	<i>Myotis sp</i>	CP5.1	
25.07.2019	Dawn 3	CP5	10		W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
25.07.2019	Dawn 3	CP5	15	0	Central	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
25.07.2019	Dawn 3	CP5	8	10	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
25.07.2019	Dawn 3	CP5	10		W	S-N	<i>Pipistrellus pipistrellus</i>	CP5.1	
25.07.2019	Dawn 3	CP5	10	5	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
25.07.2019	Dawn 3	CP5	12	2	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
25.07.2019	Dawn 3	CP5	10	5	W	N-S	<i>Pipistrellus pipistrellus</i>	CP5.1	
25.07.2019	Dawn 3	CP5	15	2	W	N-S	<i>Nyctalus leisleri</i>	CP5.1	
25.07.2019	Dawn 3	CP5	10	5	W	S-N	<i>Myotis sp</i>	CP5.1	
20.08.2019	Dusk 4	CP5	8	3	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	8	3	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	8	3	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	8	3	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	8	3	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging

20.08.2019	Dusk 4	CP5	8	3	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	8	3	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	8	3	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	8	3	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging

20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
20.08.2019	Dusk 4	CP5	9	3.5	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Foraging
21.08.2019	Dawn 5	CP5	10	2	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	
21.08.2019	Dawn 5	CP5	10	5	E	N-S	<i>Pipistrellus pipistrellus</i>	CP5.2	
21.08.2019	Dawn 5	CP5	15	10	E	N-S	<i>Nyctalus noctula</i>	CP5.2	
21.08.2019	Dawn 5	CP5	15	10	E	N-S	<i>Nyctalus noctula</i>	CP5.2	
21.08.2019	Dawn 5	CP5	15	5	E	N-S	<i>Nyctalus noctula</i>	CP5.2	
21.08.2019	Dawn 5	CP5	15	15	E	N-S	<i>Nyctalus noctula</i>	CP5.2	
21.08.2019	Dawn 5	CP5	15	15	E	N-S	<i>Nyctalus noctula</i>	CP5.2	
20.08.2019	Dusk 6	CP5	5	1	E	S-N	<i>Pipistrellus pipistrellus</i>	CP5.2	Commute
20.08.2019	Dusk 6	CP5	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP5.2	Commute
20.08.2019	Dusk 6	CP5	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP5.2	Commute

B.6 CP6

Table 21 Survey Results at CP6

Survey Date	Survey Number	Location	Height from Ground (m)	Distance	Side	Direction From	Species	Surveyor Location	Notes
27.06.2019	Dusk 1	CP6	4	3.5	N	W-E	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
27.06.2019	Dusk 1	CP6	3	3.5	N	W-E	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
27.06.2019	Dusk 1	CP6	3	1.5	N	W-E	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
27.06.2019	Dusk 1	CP6	3	7	N	SW-NE	<i>Myotis sp.</i>	CP6.1	Commuting
27.06.2019	Dusk 1	CP6	3	0.5	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	2	0	S	W-E	<i>Pipistrellus sp.</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	2	1	S	SW-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	5	2	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	6	0	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	5	2	S	E-W	<i>Pipistrellus pipistrellus</i>	CP6.2	
27.06.2019	Dusk 1	CP6	5	3	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Foraging
27.06.2019	Dusk 1	CP6	5	3	S	E-W	<i>Pipistrellus pipistrellus</i>	CP6.2	Foraging
27.06.2019	Dusk 1	CP6	5	3	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Foraging
27.06.2019	Dusk 1	CP6	5	3	S	E-W	<i>Pipistrellus pipistrellus</i>	CP6.2	Foraging
27.06.2019	Dusk 1	CP6	2	0	S	E-W	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	2	0	S	E-W	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
24.07.2019	Dusk 2	CP6	1.5	3	N	NW-SE	<i>Myotis sp.</i>	CP6.1	Commuting

24.07.2019	Dusk 2	CP6	2	3	N	NW-SE	<i>Myotis sp.</i>	CP6.1	Commuting
24.07.2019	Dusk 2	CP6	2	0.5	N/A	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
24.07.2019	Dusk 2	CP6	2	1.5	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Foraging
24.07.2019	Dusk 2	CP6	2	0.5	N/A	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
24.07.2019	Dusk 2	CP6	2	1.5	S	W-E	<i>Myotis sp.</i>	CP6.2	Foraging
24.07.2019	Dusk 2	CP6	2	0.75	N/A	E-W	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
25.07.2019	Dawn 3	CP6	4	2	N	NW-W	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	3	3	N	NW-W	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	3	3	N	NW-W	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	3	3	N	SE-E	<i>Plecotus auritus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	3	3	N	SE-E	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	3	4	N	SE-E	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	2.5	1.75	N/A	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
25.07.2019	Dawn 3	CP6	2	1	N/A	E-W	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
27.06.2019	Dawn 3	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
20.08.2019	Dusk 4	CP6	3	0	S	E-W	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
20.08.2019	Dusk 4	CP6	2.5	5	N/A	S-N	<i>Myotis sp.</i>	CP6.1	Commuting
20.08.2019	Dusk 4	CP6	2.5	5	N/A	S-N	<i>Myotis sp.</i>	CP6.1	Commuting
20.08.2019	Dusk 4	CP6	3	0	N/A	SE-NW	<i>Pipistrellus pipistrellus</i>	CP6.2	
20.08.2019	Dusk 4	CP6	4	0	N/A	SE-NW	<i>Nyctalus noctula</i>	CP6.2	
20.08.2019	Dusk 4	CP6	2	0	N/A	NW-SE	<i>Myotis sp.</i>	CP6.2	
21.08.2019	Dawn 5	CP6	2	0	S	S-N	<i>Pipistrellus pipistrellus</i>	CP6.2	
21.08.2019	Dawn 5	CP6	N/A	N/A	N/A	N/A	<i>Rhinopholous hipposideros</i>	CP6.1	
25.09.2019	Dusk 6	CP6	5	2	N	W-E	<i>Myotis sp.</i>	CP6.1	
25.09.2019	Dusk 6	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.1	
25.09.2019	Dusk 6	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.1	
25.09.2019	Dusk 6	CP6	5	5	N	E-W	<i>Pipistrellus pipistrellus</i>	CP6.1	
25.09.2019	Dusk 6	CP6	5	2	N	W-E	<i>Myotis sp.</i>	CP6.1	

25.09.2019	Dusk 6	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.1	
Survey Date	Survey Number	Location	Height from Ground (m)	Distance	Side	Direction From	Species	Surveyor Location	Notes
27.06.2019	Dusk 1	CP6	4	3.5	N	W-E	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
27.06.2019	Dusk 1	CP6	3	3.5	N	W-E	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
27.06.2019	Dusk 1	CP6	3	1.5	N	W-E	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
27.06.2019	Dusk 1	CP6	3	7	N	SW-NE	<i>Myotis sp.</i>	CP6.1	Commuting
27.06.2019	Dusk 1	CP6	3	0.5	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	2	0	S	W-E	<i>Pipistrellus sp.</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	2	1	S	SW-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	5	2	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	6	0	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	5	2	S	E-W	<i>Pipistrellus pipistrellus</i>	CP6.2	
27.06.2019	Dusk 1	CP6	5	3	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Foraging
27.06.2019	Dusk 1	CP6	5	3	S	E-W	<i>Pipistrellus pipistrellus</i>	CP6.2	Foraging
27.06.2019	Dusk 1	CP6	5	3	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Foraging
27.06.2019	Dusk 1	CP6	5	3	S	E-W	<i>Pipistrellus pipistrellus</i>	CP6.2	Foraging
27.06.2019	Dusk 1	CP6	2	0	S	E-W	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	2	0	S	E-W	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
27.06.2019	Dusk 1	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
24.07.2019	Dusk 2	CP6	1.5	3	N	NW-SE	<i>Myotis sp.</i>	CP6.1	Commuting

24.07.2019	Dusk 2	CP6	2	3	N	NW-SE	<i>Myotis sp.</i>	CP6.1	Commuting
24.07.2019	Dusk 2	CP6	2	0.5	N/A	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
24.07.2019	Dusk 2	CP6	2	1.5	S	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Foraging
24.07.2019	Dusk 2	CP6	2	0.5	N/A	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
24.07.2019	Dusk 2	CP6	2	1.5	S	W-E	<i>Myotis sp.</i>	CP6.2	Foraging
24.07.2019	Dusk 2	CP6	2	0.75	N/A	E-W	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
25.07.2019	Dawn 3	CP6	4	2	N	NW-W	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	3	3	N	NW-W	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	3	3	N	NW-W	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	3	3	N	SE-E	<i>Plecotus auritus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	3	3	N	SE-E	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	3	4	N	SE-E	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
25.07.2019	Dawn 3	CP6	2.5	1.75	N/A	W-E	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
25.07.2019	Dawn 3	CP6	2	1	N/A	E-W	<i>Pipistrellus pipistrellus</i>	CP6.2	Commuting
27.06.2019	Dawn 3	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.2	Commuting
20.08.2019	Dusk 4	CP6	3	0	S	E-W	<i>Pipistrellus pipistrellus</i>	CP6.1	Commuting
20.08.2019	Dusk 4	CP6	2.5	5	N/A	S-N	<i>Myotis sp.</i>	CP6.1	Commuting
20.08.2019	Dusk 4	CP6	2.5	5	N/A	S-N	<i>Myotis sp.</i>	CP6.1	Commuting
20.08.2019	Dusk 4	CP6	3	0	N/A	SE-NW	<i>Pipistrellus pipistrellus</i>	CP6.2	
20.08.2019	Dusk 4	CP6	4	0	N/A	SE-NW	<i>Nyctalus noctula</i>	CP6.2	
20.08.2019	Dusk 4	CP6	2	0	N/A	NW-SE	<i>Myotis sp.</i>	CP6.2	
21.08.2019	Dawn 5	CP6	2	0	S	S-N	<i>Pipistrellus pipistrellus</i>	CP6.2	
21.08.2019	Dawn 5	CP6	N/A	N/A	N/A	N/A	<i>Rhinopholous hipposideros</i>	CP6.1	
25.09.2019	Dusk 6	CP6	5	2	N	W-E	<i>Myotis sp.</i>	CP6.1	
25.09.2019	Dusk 6	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.1	
25.09.2019	Dusk 6	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.1	
25.09.2019	Dusk 6	CP6	5	5	N	E-W	<i>Pipistrellus pipistrellus</i>	CP6.1	
25.09.2019	Dusk 6	CP6	5	2	N	W-E	<i>Myotis sp.</i>	CP6.1	

25.09.2019	Dusk 6	CP6	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP6.1	
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B.7 CP7

Table 22 Survey Results at CP7

Survey Date	Survey Number	Location	Height from Ground (m)	Distance	Side	Direction From	Species	Surveyor Location	Notes
27.06.2019	Dusk 1	CP7	5	1	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	1	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	1	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	1	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	3	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	1	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	6	2	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	6	2	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	1	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	3	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	6	5	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	7	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	6	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	6	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	6	0	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	6	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	6	5	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	1	Central	W-E	<i>Myotis sp.</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	1	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	

27.06.2019	Dusk 1	CP7	5	5	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	6	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	3	Central	W-E	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	3	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	6	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Eptesicus Serotine</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	3	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	E-W	<i>Pipistrellus pipistrellus</i>	CP7.1	
27.06.2019	Dusk 1	CP7	5	5	Central	W-E	<i>Myotis sp.</i>	CP7.1	
24.07.2019	Dusk 2	CP7	5	1	Central	S-N	<i>Pipistrellus pipistrellus</i>	CP7.1	Single bat commuting
24.07.2019	Dusk 2	CP7	5	4	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Commuting
24.07.2019	Dusk 2	CP7	5	5	West	S-N	<i>Pipistrellus pipistrellus</i>	CP7.1	Commuting
24.07.2019	Dusk 2	CP7	9	0.5	West	N-W	<i>Pipistrellus pipistrellus</i>	CP7.1	Commuting

24.07.2019	Dusk 2	CP7	4	1	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	1	1	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	4	1	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	5	2	West	S-N	<i>Myotis sp.</i>	CP7.1	Commuting pass
24.07.2019	Dusk 2	CP7	10	12	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	3	2	West	N-S	<i>Myotis sp.</i>	CP7.1	Commuting pass
24.07.2019	Dusk 2	CP7	4	1	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	4	1	West	S-N	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	2	2	West	N-S	<i>Myotis sp.</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	2	4	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP7.1	Heard not Seen
24.07.2019	Dusk 2	CP7	4	2	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	4	2	West	N-S	<i>Nyctalus noctula</i>	CP7.1	Feeding
24.07.2019	Dusk 2	CP7	6	4	West	S-N	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	4	4	West	N-W	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging (2 bats)
24.07.2019	Dusk 2	CP7	4	6	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	6	4	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	6	4	West	N-S	<i>Pipistrellus pipistrellus</i>	CP7.1	Foraging
24.07.2019	Dusk 2	CP7	2	3	West	N-S	<i>Myotis sp.</i>	CP7.1	Commuting down lane close to hedge
24.07.2019	Dusk 2	CP7	6	0	West	N-S	<i>Myotis sp.</i>	CP7.2	Commuting over feature
24.07.2019	Dusk 2	CP7	6	4	West	E-W	<i>Pipistrellus pipistrellus</i>	CP7.2	Commuting over feature
24.07.2019	Dusk 2	CP7	7	11	West	E-W	<i>Pipistrellus pipistrellus</i>	CP7.2	Commuting over feature
25.07.2019	Dawn 3	CP1	4	2	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging (2 bats)
25.07.2019	Dawn 3	CP1	3	2	Central	N-S	<i>Pipistrellus pipistrellus</i>	7.1	Foraging

25.07.2019	Dawn 3	CP1	6	4	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	6	5	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	4	2	Central	N-S	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	6	4	Central	N-S	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	4	8	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	6	2	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	5	8	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	3	2	Central	S-N	<i>Myotis sp.</i>	7.1	Commuting
25.07.2019	Dawn 3	CP1	4	8	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	6	2	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	4	8	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	3	8	Central	S-N	<i>Eptesicus serotinus</i>	7.1	Foraging Edge of field
25.07.2019	Dawn 3	CP1	3	8	Central	S-N	<i>Eptesicus serotinus</i>	7.1	Foraging Edge of field
25.07.2019	Dawn 3	CP1	8	8	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging (2 bats)
25.07.2019	Dawn 3	CP1	4	6	Central	N-S	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	6	4	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	4	6	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	6	2	Central	N-S	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	4	10	Central	N-S	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	2	3	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	3	6	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	4	4	Central	S-N	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
25.07.2019	Dawn 3	CP1	4	2	Central	S-N	<i>Myotis sp.</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	10	2	North	E -W	<i>Pipistrellus pipistrellus</i>	7.1	Commuting

20.08.2019	Dusk 4	Cp7	10	2	North	E -W	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	2	1	North	E -W	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	2	1	North	E -W	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	3	1	North	W -E	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	3	1	North	E -W	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	3	2	North	W -E	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	3	1	North	W -E	<i>Pipistrellus pipistrellus</i>	7.1	Commuting
20.08.2019	Dusk 4	Cp7	3	1	North	W -E	<i>Pipistrellus pipistrellus</i>	7.1	Commuting
20.08.2019	Dusk 4	Cp7	3	1	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	Commuting
20.08.2019	Dusk 4	Cp7	3	1	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	3	1	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	7.1	Heard not Seen (Sounded close)
20.08.2019	Dusk 4	Cp7	3	1	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	3	1	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	3	1	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	3	1	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	3 bats foraging
20.08.2019	Dusk 4	Cp7	3	0	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	3 bats foraging
20.08.2019	Dusk 4	Cp7	3	0	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	4 bats foraging
20.08.2019	Dusk 4	Cp7	3	0	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	2 bats foraging
20.08.2019	Dusk 4	Cp7	4	0	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	4 bats crossing
20.08.2019	Dusk 4	Cp7	4	0	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	2 bats crossing
20.08.2019	Dusk 4	Cp7	4	0	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk 4	Cp7	4	0	North	NE - SW	<i>Pipistrellus pipistrellus</i>	7.1	Foraging
20.08.2019	Dusk	Cp7	3	0	South	NE - SW	<i>Pipistrellus pipistrellus</i>	7.2	Foraging

20.08.2019	Dusk	Cp7	5	0	South	NE - SW	<i>Pipistrellus pipistrellus</i>	7.2	Foraging
20.08.2019	Dusk	Cp7	5	0	South	NE - SW	<i>Pipistrellus pipistrellus</i>	7.2	Foraging
20.08.2019	Dusk	Cp7	5	1	South	NE - SW	<i>Pipistrellus pipistrellus</i>	7.2	Foraging
20.08.2019	Dusk	Cp7	5	1	South	SW-NE	<i>Pipistrellus pipistrellus</i>	7.2	Foraging
20.08.2019	Dusk	Cp7	5	1	South	SW-NE	<i>Pipistrellus pipistrellus</i>	7.2	Foraging
20.08.2019	Dusk	Cp7	5	1	South	NE - SW	<i>Pipistrellus pipistrellus</i>	7.2	Foraging
20.08.2019	Dusk	Cp7	3	3	South	NE - SW	<i>Pipistrellus pipistrellus</i>	7.2	Foraging
20.08.2019	Dusk	Cp7	3	3	South	NE - SW	<i>Pipistrellus pipistrellus</i>	7.2	Foraging
21.08.2019	Dawn 5	CP7	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP7.1	Heard not seen but sounded in front of surveyor
21.08.2019	Dawn 5	CP7	N/A	N/A	N/A	N/A	<i>Rhinolophus hipposideros</i>	CP7.1	Heard not seen but sounded in front of surveyor
21.08.2019	Dawn 5	CP7	12	2 (Above)	N	N	<i>Nyctalus noctula</i>	CP7.1	Commuting
21.08.2019	Dawn 5	CP7	12	2 (Above)	N	N	<i>Nyctalus noctula</i>	CP7.1	Commuting
25.07.2020	Dusk	Cp7	5	3	North	W -E	<i>Pipistrellus pipistrellus</i>	7.1	Foraging along lane

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.10
Breeding Bird Survey Report

28 September 2020

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Executive Summary

The proposed A417 Missing Link scheme (hereafter referred to as 'the scheme') aims to provide a dual carriageway to a stretch of single carriageway between the Cowley roundabout and Crickley Hill in Gloucestershire; the 5.5km section is the only remaining section of single carriageway. The scheme would increase capacity by creating a free-flowing link between the Brockworth Bypass and Cowley roundabout and remove the at-grade junction with the A436, resulting in a continuous flow between the M4 Junction 15 (Swindon) and the M5 Junction 11a (Gloucester/Cheltenham).

ECOSA were commissioned by Mott MacDonald Sweco Joint Venture (MMSJV) to carry out a breeding bird survey to inform the A417 Missing Link Scheme. The breeding bird surveys were undertaken by ECOSA between April 2019 and June 2019 in order to establish the usage of the site, and adjacent habitat by breeding bird species. The main findings of the surveys are:

- The southern arm of the survey area comprises large arable fields on the Cotswold plateau, with hedgerows and small belts and copses of woodland. The western arm of the survey area includes woodland, pasture and calcareous grassland on the Cotswold scarp.
- The arable fields and their margins hold in places a high density of breeding territories of seed-eating species including skylark, linnet and yellowhammer. Woodlands and other areas with trees hold species of conservation concern such as marsh tit, song thrush, mistle thrush and bullfinch.
- The preferred scheme alignment will likely result in a loss of open fields, field boundaries and areas of tree cover and therefore impacts on breeding birds will occur through land take and disturbance, although much similar habitat exists in the wider area.

-
- Any clearance of vegetation should be undertaken between September and February, avoiding the breeding season for birds. Where this is not possible, an ecologist should be present immediately prior to vegetation clearance in order to check for nesting birds. Any active nests would need to be left in situ until chicks have fledged and left the nest.

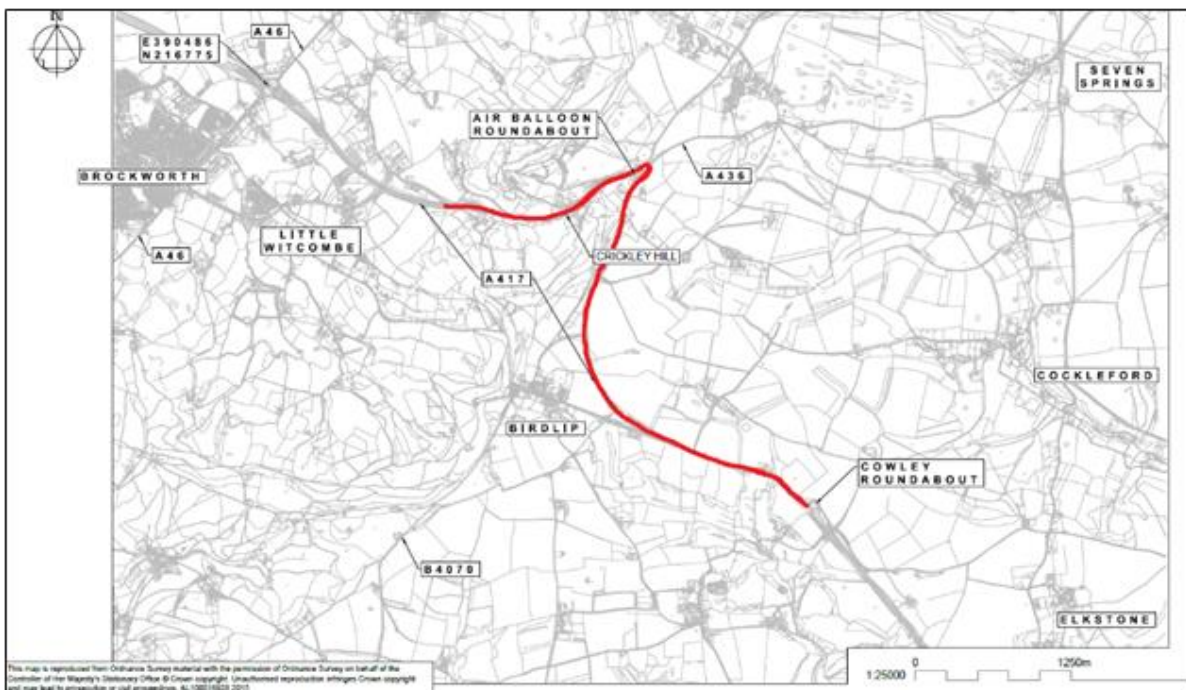
 - It is recommended that the road improvement scheme design seeks to minimise effects on breeding birds through avoidance and mitigation of visual, noise and lighting disturbance. Opportunities exist for improving and reconnecting habitats associated with sections of the existing A417 that may no longer be required for use by road traffic.

1. Introduction

1.1. Background

- 1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and as an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'missing link', forms the only section of single carriageway along the route, with an at-grade junction located at the 'Air Balloon' public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5km stretch shown on Figure 1.1 below.

Figure 1.1: A417 Missing Link Scheme Location Plan



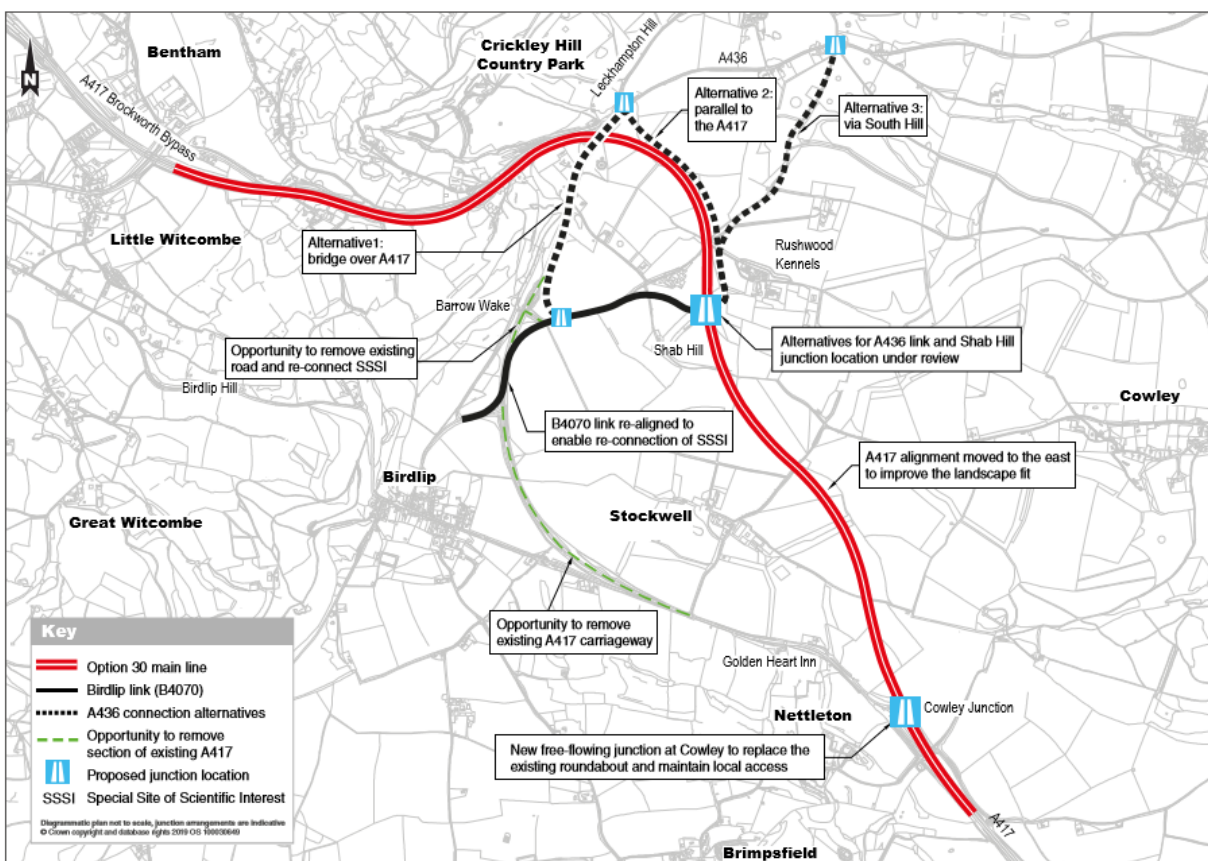
Source: GiGi GIS Portal. Crown Copyright 2016 100030649

1.2. Scheme Proposal

- 1.2.1. The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill. Any proposed scheme would aim to increase capacity by creating a free-flowing link between the Brockworth Bypass and the Cowley roundabout and remove the at-grade junction with the A436 (Air Balloon roundabout). This Missing Link will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester / Cheltenham (M5 Junction 11).

- 1.2.1 The preferred route for the Scheme was confirmed as Option 30 by the Secretary of State in March 2019 (see Figure 1.2 below). The Scheme comprises the construction of a new dual carriageway to replace the existing single carriageway section between Brockworth bypass and Cowley Roundabout. It is predominately an “offline” Scheme but approximately a third of the route follows the existing A417 route corridor at Crickley Hill.
- 1.2.2 A new link road would be built between the slip road junction at Shab Hill and the existing A417 to connect traffic to and from Birdlip and the A436 with the new A417. This new link road would end in a new roundabout near Barrow Wake.

Figure 1.2: A417 Preferred Route Announcement



- 1.2.3 Figure 1.2 above shows three A436 link road alternative connections. Alternative 2, parallel to the A417, is the option taken forward for assessment in the Environmental Statement.

1.3. Scope of Report

- 1.3.1. Ecological Survey & Assessment Limited (ECOSA) were contracted by Mott MacDonald Sweco Joint Venture (MMSJV) to undertake breeding bird surveys to inform ecological assessment of the scheme. Details of these surveys, including methods and results, are provided in the ECOSA Breeding Bird Survey Report in Appendix A.

Appendices

Appendix A A417 Breeding Bird Survey Report (ECOSA 2019)

**A417 ROAD IMPROVEMENT SCHEME, BIRDLIP,
GLOUCESTERSHIRE**

BREEDING BIRD SURVEY

Final Document (Revision 2)

December 2019

Preliminary Ecological Appraisals • Protected Species Surveys and Licensing • NVC • EclA • HRA • Management Plans
Habitats • Badger • Bats • Hazel Dormouse • Birds • Reptiles • Amphibians • Invertebrates • Riparian and Aquatic Species



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ECOSA Quality Assurance Record

This report has been produced in accordance with the CIEEM Guidelines for Ecological Report Writing 2017 (CIEEM, 2017). The survey work has been undertaken in line with references within CIEEM's Source of Survey Guidance (CIEEM, 2017).

Description:	Breeding Bird Survey
Produced For:	Mott MacDonald Sweco Joint Venture
Issue:	Final (Revision 2)
Report Reference:	4265.F2
Date of Issue:	16 th December 2019
Date of Survey Works:	April – June 2019
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**A417 ROAD IMPROVEMENT SCHEME, BIRD LIP,
GLOUCESTERSHIRE**

BREEDING BIRD SURVEY

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Appendix 1 Breeding Bird Survey Counts

Map 1 Survey Area and Transect Route

Map 2 Breeding Bird Survey Results West: Red Listed Species

Map 3 Breeding Bird Survey Results South: Red Listed Species

Map 4 Breeding Bird Survey Results West: Amber Listed Species

Map 5 Breeding Bird Survey Results South: Red Listed Species

EXECUTIVE SUMMARY

ECOSA were commissioned by Mott MacDonald Sweco Joint Venture (MMSJV) to carry out a breeding bird survey to inform the A417 Birdlip Road Improvement Scheme. The breeding bird surveys were undertaken by ECOSA between April 2019 and June 2019 in order to establish the usage of the site, and adjacent habitat by breeding bird species. The main findings of the surveys are:

- The southern arm of the survey area comprises large arable fields on the Cotswold plateau, with hedgerows and small belts and copses of woodland. The western arm of the survey area includes woodland, pasture and calcareous grassland on the Cotswold scarp.
- The arable fields and their margins hold in places a high density of breeding territories of seed-eating species including skylark, linnet and yellowhammer. Woodlands and other areas with trees hold species of conservation concern such as marsh tit, song thrush, mistle thrush and bullfinch.
- The preferred scheme alignment will likely result in a loss of open fields, field boundaries and areas of tree cover and therefore impacts on breeding birds will occur through land take and disturbance, although much similar habitat exists in the wider area.
- Any clearance of vegetation should be undertaken between September and February, avoiding the breeding season for birds. Where this is not possible, an ecologist should be present immediately prior to vegetation clearance in order to check for nesting birds. Any active nests would need to be left in situ until chicks have fledged and left the nest.
- It is recommended that the road improvement scheme design seeks to minimise effects on breeding birds through avoidance and mitigation of visual, noise and lighting disturbance. Opportunities exist for improving and reconnecting habitats associated with sections of the existing A417 that may no longer be required for use by road traffic.

1.0 INTRODUCTION

1.1 Background

Ecological Survey & Assessment Limited (ECOSA) have been contracted by Mott MacDonald Sweco Joint Venture (MMSJV) to undertake breeding bird surveys to inform the proposed route of a road improvement scheme for the A417 at Birdlip, Gloucestershire. A wintering bird survey was carried out by ECOSA during 2018/19 (ECOSA, 2019).

1.2 The Site

The survey area extends southward and westward in two ‘arms’ from approximately 500 metres north of the Air Balloon roundabout on the A417, following two branches of the A417. The area covered is approximately 2.5 kilometres from west to east and north to south and encompasses the existing road corridor and the proposed route of the road improvement scheme. The extent of the survey area is shown on **Map 1**. The surveyed area was based on the route alignment at the time of survey. The final route alignment and redline boundary may result in additional areas lying outside of the survey boundary. However, due to the similarity on habitats, these areas are likely to support similar assemblages of breeding birds.

The survey area covers 475 hectares and is characterised by arable farmland with large fields bisected by hedgerows, rural roads, and areas of calcareous grassland and broadleaved woodland. The majority of the site is on the Cotswold plateau, but in the west of the survey area, the land falls away steeply to the west.

The wider landscape consists of further areas of farmland, woodland copses and small villages. The town of Cheltenham and city of Gloucester lie approximately four kilometres to the north and west respectively.

1.3 Aims and Scope of Report

Breeding bird surveys were undertaken by ECOSA between April 2019 and June 2019 in order to establish the usage of the site by bird species associated with open farmland, grassland, hedgerow and woodland habitats found along the proposed alignment.

This report presents the findings of the breeding bird surveys carried out by ECOSA between April 2019 and June 2019.

1.4 Site Proposals

Proposals for the site are for the re-routing of the existing A417 road, and associated infrastructure. The planning application is expected to be submitted in early 2020.

2.0 PLANNING POLICY CONTEXT

2.1 Introduction

This section summarises the planning policy in relation to ecology and biodiversity within the Tewkesbury and Cotswold Council administrative areas. The west of the survey area lies within Tewkesbury, whilst the east is within Cotswold.

2.2 Planning Policy

2.2.1 National Policy

The National Policy Statement for National Networks (NPSNN) sets out the need for, and government's policies to deliver Nationally Significant Infrastructure Projects on the national road network in England.

Chapter 3 of the NPSNN identifies that in order to be sustainable and to improve people's quality of life, the need for development must be seen in the context of the Government's wider policies on economic performance, environment, safety, technology, sustainable transport and accessibility, as well as journey reliability and the experience of road - rail users. Wider policies relate to:

- Environmental and social impacts – national road networks should be designed to minimise social and environmental impacts and improve quality of life. In delivering new schemes, the Government expects applicants to avoid and mitigate environmental and social impacts in line with the principles set out in the National Planning Policy Framework (NPPF) and the Government's planning guidance.

Chapter 5 of the NPSNN outlines the possible impacts that would be relevant to any type of national networks infrastructure and sets out how these impacts should be considered. The sections include consideration of biodiversity.

The National Planning Policy Framework (NPPF) sets out the government's requirements for the planning system in England. The original document was published in 2012 with the revised NPPF published in July 2018 and updated in February 2019. A number of sections of the NPPF are relevant when taking into account development proposals and the environment. As set out within Paragraph 11 of the NPPF "*Plans and decisions should apply a presumption in favour of sustainable development*". However, Paragraph 177 goes on to state that "*The presumption in favour of sustainable development does not apply where development requiring appropriate*

assessment because of its potential impact on a habitats site¹ is being planned or determined”.

The general impetus of the NPPF in relation to ecology and biodiversity is for development proposals to not only minimise the impacts on biodiversity but also to provide enhancement. Paragraph 170 states that the planning system should contribute to and enhance the natural environment by “...*minimising impacts on biodiversity and providing net gains in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures...*”.

A number of principles are set out in Paragraph 175, including that where harm cannot be adequately avoided then it should be mitigated for, or as a last resort, compensated for. Where impacts occur on nationally designated sites, the benefits must clearly outweigh any adverse impact and incorporating biodiversity in and around developments should be encouraged. Specific reference is also made to the protection of irreplaceable habitats². Where loss to irreplaceable habitats occur planning permission would normally be refused unless there are wholly exceptional reasons and an adequate compensation strategy is in place. Paragraph 175 also states “*development whose primary objective is to conserve or enhance biodiversity should be supported; while opportunities to incorporate biodiversity improvements in and around developments should be encouraged, especially where this can secure measurable net gains for biodiversity*”. Protection of sites proposed as Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Ramsar sites or acting as compensation for SPAs, SACs and Ramsar sites, should receive the same protection as habitat sites.

In addition to the NPPF, Circular 06/05 provides guidance on the application of the law relating to planning and nature conservation as it applies in England. Paragraph 98 states “*the presence of a protected species is a material consideration when a planning authority is considering a development proposal that, if carried out, would be likely to result in harm to the species or its habitat*”. Whilst paragraph 99 states “*it is essential that the presence or otherwise of a protected species, and the extent that they may be affected by the proposed development, is established before planning permission is granted*”.

¹ The NPPF defines a habitats site as “*Any site which would be included within the definition at regulation 8 of the Conservation of Habitats and Species Regulations 2017 for the purpose of those regulations, including candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation, Special Protection Areas and any relevant Marine Sites.*”

² The NPPF defines irreplaceable habitats as “*Habitats which would be technically very difficult (or take a very significant time) to restore, recreate or replace once destroyed, taking into account their age, uniqueness, species diversity or rarity. They include ancient woodland, ancient and veteran trees, blanket bog, limestone pavement, sand dunes, salt marsh and lowland fen.*”

2.2.1 Highways England Policy

Highways England Biodiversity Plan

Highways England's Biodiversity Plan (BAP) identifies its approach to meeting the key performance indicator identified within the Roads Investment Strategy (RIS) of "no net loss of biodiversity by 2020" and that "by 2040 it must deliver a net gain in biodiversity". Biodiversity is required to be fully considered during the building of any new roads and opportunities sought to work with stakeholders and enhance the network for wildlife.

2.2.2 Local Policy

A single policy within the Cotswold District Local Plan (2011-2031) refers to ecology and biodiversity:

- **Policy EN8: Biodiversity and Geodiversity: Features, Habitats and Species.** Development will be permitted that conserves and enhances biodiversity and geodiversity, providing net gains where possible. Proposals that would result in significant habitat fragmentation and loss of ecological connectivity will not be permitted. Proposals that reverse habitat fragmentation and promote creation, restoration and beneficial management of ecological networks, habitats and features will be permitted, particularly in areas subject to landscape-scale biodiversity initiatives. Developer contributions may be sought in this regard. Development with a detrimental impact on protected species and species and habitats "of principal importance for the purpose of conserving biodiversity" will not be permitted unless adequate provision can be made to ensure the conservation of the species or habitat.

The Joint Core Strategy for Gloucester, Cheltenham and Tewkesbury (2011-2031) also considers biodiversity through policy:

- **Policy SD9 (Biodiversity and Geodiversity):** The biodiversity and geological resource of the JCS area will be protected and enhanced in order to establish and reinforce ecological networks that are resilient to current and future pressures. This will be achieved by ensuring that European Protected Species and National Protected Species are safeguarded in accordance with the law; encouraging new development to contribute positively to biodiversity and geodiversity whilst linking with wider networks of green infrastructure; encouraging the creation, restoration and beneficial management of priority landscapes, priority habitats and populations of priority species. Where there is a risk of harm as a consequence of development, this should be mitigated by integrating enhancements into the scheme that are appropriate to the location

and satisfactory to the local planning authority. If harm cannot be mitigated onsite then, exceptionally, compensatory enhancements off-site may be acceptable.

3.0 METHODS

3.1 Introduction

This section details the methods used during the breeding bird surveys undertaken at the A417 site between April 2019 and June 2019.

3.2 Survey Methodology

A walked transect survey allowing observation of all major habitat areas was undertaken on six occasions between April 2019 and June 2019 inclusive, to determine the usage of the area by breeding birds (**Map 1**).

The survey largely consisted of the surveyors scanning the site using binoculars to identify the bird species utilising the survey area. The surveys aimed to determine the presence and numbers of notable or protected wintering bird species. Due to the size of the survey area, the southern and western parcels of land were surveyed separately.

During each survey, breeding behaviour was noted and recorded, for example singing male birds, and birds carrying food or nest material. Following completion of the survey visits, the data was collated and territory maps for protected and notable (Schedule 1³ and Red⁴ and Amber⁵ Listed Birds of Conservation Concern (BoCC)) breeding species created following the British Trust for Ornithology Common Birds Census approach (Marchant, J.H., 1983).

Birds listed on Schedule 1 of the Wildlife and Countryside Act (1981 as amended) are afforded additional protection making it an offence to: Intentionally or recklessly disturb any bird while it is nest building, or is at a nest containing eggs or young; or; Intentionally or recklessly disturb the dependent young of any such bird.

The UK's birds are split in to three categories of conservation importance - red, amber and green. Red is the highest conservation priority, with species needing urgent action. Amber is the next most critical group, followed by green (Hayhow *et al.*, 2017).

³ **Schedule 1:** Birds listed on Schedule 1 of the Wildlife and Countryside Act (1981 as amended) are afforded additional protection making it an offence to: intentionally or recklessly disturb any bird while it is nest building, or is at a nest containing eggs or young; or; intentionally or recklessly disturb the dependent young of any such bird.

⁴ **Birds of Conservation Concern Red List:** The UK's birds are split in to three categories of conservation importance - red, amber and green. Red is the highest conservation priority and include species which are: globally threatened; have been subject to historical population decline in UK during 1800–1995; are in severe (at least 50%) decline in UK breeding population over the last 25 years, or longer-term period, or; subject to severe (at least 50%) contraction of UK breeding range over the last 25 years, or longer-term period.

⁵ **Birds of Conservation Concern Amber List:** Amber list criteria include species which are: in unfavourable conservation status in Europe; subject to historical population decline during 1800–1995, but recovering; subject to moderate (25-49%) decline in UK breeding population or contraction of UK breeding range over the last 25 years, or the longer-term period; subject to moderate (25-49%) decline in UK non-breeding population over the last 25 years, or the longer-term period; rare breeders (1–300 breeding pairs in UK); rare non-breeders (less than 900 individuals), or; internationally important species with at least 20% of European breeding or non-breeding population in the UK .

3.3 Survey Details

Table 1 and Table 2 provide details of each survey visit.

Table 1: Breeding bird survey details – Southern land parcels

Survey Date	Duration	Weather Conditions
1 st April 2019	06:30-10:00	Dry, 8°C, 100% cloud cover, moderate easterly breeze
7 th May 2019	07:50-10:15	Dry, 13°C, 50% cloud cover, no wind
25 th May 2019	07:20-09:30	Dry, 17°C, 50% cloud cover, no wind
2 nd June 2019	06:00-10:00	Showery, 15°C, 100% cloud cover, fresh northerly breeze
11 th June 2019	05:45-09:05	Sunny, 13°C, 25% cloud cover, light north westerly breeze
19 th June 2019	07:15-10:15	Misty, 15°C, 100% cloud cover, light westerly breeze

Table 2: Breeding bird survey details – Western land parcels

Survey Date	Duration	Weather Conditions
5 th April 2019	06:45-09:45	Dry, 8°C, 100% cloud cover, moderate north westerly breeze
14 th May 2019	05:30-09:45	Dry, 14°C, 25% cloud cover, faint north easterly breeze
27 th May 2019	05:45-09:15	Dry, 12°C, 100% cloud cover, moderate north westerly breeze
1 st June 2019	05:30-09:25	Showery, 12°C, 75% cloud cover, fresh north westerly breeze
12 th June 2019	05:30-09:45	Overcast, 13°C, 100% cloud cover, moderate south westerly breeze
17 th June 2019	05:15-09:25	Sunny, 14°C, 25% cloud cover, light westerly breeze

The breeding bird surveys were carried out by experienced ornithologists Simon Colenutt and Graeme Down of ECOSA. Bird observations were mapped using British Trust for Ornithology codes. Particular attention was paid to identifying birds actively using the survey area, rather than just flying over.

3.4 Survey Limitations

Access around Crickley Hill Farm was restricted to Public Rights of Way.

While the weather conditions on 19th June were misty, this was not significantly dense or prolonged to have negatively impacted upon the survey results.

Transect data has not been extrapolated across the whole study area and thus the report should not be interpreted as showing the total number of territories for bird species within the whole red line boundary of the project.

4.0 RESULTS

4.1 Introduction

This section details the results of the breeding bird surveys undertaken at the A417 site between April 2019 and June 2019.

4.2 Breeding Birds

A summary of notable species recorded within survey area and their respective breeding status are provided in **Table 3**, along with common species recorded. Full survey data is presented in **Appendix 1**. The territories of species listed under Schedule 1 of the Wildlife & Countryside Act and BoCC Red and Amber Listed breeding species are mapped on **Map 2**, **Map 3**, **Map 4** and **Map 5**. During the course of the surveys a total of 55 bird species were recorded.

Table 3: Summary of bird species recorded from survey area

Species	Typical Habitat	Breeding Status**	Number of Territories	Schedule 1	Red List	Amber List	Green List
Hobby <i>Falco subbuteo</i>	Parkland/heath/woodland	F	-	X			X
Red-backed shrike <i>Lanius collurio</i>	Heath/scrub	V	-	X	X		
Red kite <i>Milvus milvus</i>	Woodland	F	-	X			X
Linnet <i>Linaria cannabina</i>	Hedgerows/scrub	B	12		X		
Marsh tit <i>Poecile palustris</i>	Woodland	B	6		X		
Mistle thrush <i>Turdus viscivorus</i>	Woodland/parkland	B	4		X		
Skylark <i>Alauda arvensis</i>	Arable fields	B	23		X		
Song thrush <i>Turdus philomelos</i>	Woodland	B	13		X		
Spotted flycatcher <i>Muscicapa striata</i>	Woodland/parkland	B	1		X		
Tree pipit <i>Anthus trivialis</i>	Heaths/woodland clearings	V	1		X		
Wood warbler <i>Phylloscopus sibilatrix</i>	Woodland	V	-		X		
Yellowhammer <i>Emberiza citrinella</i>	Hedgerows	B	7		X		
Yellow wagtail <i>Motacilla flava</i>	Arable/meadows	P	-		X		
Bullfinch <i>Pyrrhula pyrrhula</i>	Woodland/parkland/orchards/scrub	B	2			X	
Common gull <i>Larus canus</i>	Open fields	V	-			X	
Dunnock <i>Prunella modularis</i>	Hedgerows/scrub	B	19			X	
Kestrel <i>Falco tinnunculus</i>	Trees/open fields	B	1			X	
Lesser black-backed gull <i>Larus fuscus</i>	Moorland/open fields	F	-			X	
Meadow pipit <i>Anthus pratensis</i>	Moorland/heaths/rough grassland	B	2			X	
Stock dove <i>Columba oenas</i>	Woodland/open fields	B	3			X	
Swift <i>Apus apus</i>	Buildings/cliffs	F	-			X	
Willow warbler <i>Phylloscopus trochilus</i>	Woodland/heathland	B	2			X	

Species	Typical Habitat	Breeding Status**	Number of Territories	Schedule 1	Red List	Amber List	Green List
Blackbird <i>Turdus merula</i>	Woodland/parkland/gardens	B	NA				X
Blackcap <i>Sylvia atricapilla</i>	Woodland/parkland/scrub	B	NA				X
Black-headed gull <i>Chroicocephalus ridibundus</i>	Open fields	V	NA				X
Blue tit <i>Cyanistes caeruleus</i>	Woodland/scrub/gardens	B	NA				X
Buzzard <i>Buteo buteo</i>	Woodland	B	NA				X
Carrion crow <i>Corvus corone</i>	Woodland/open fields	B	NA				X
Chaffinch <i>Fringilla coelebs</i>	Woodland/parkland/scrub/gardens	B	NA				X
Chiffchaff <i>Phylloscopus colybita</i>	Woodland	B	NA				X
Coal tit <i>Periparus ater</i>	Woodland/gardens	B	NA				X
Garden warbler <i>Sylvia borin</i>	Woodland	P	NA				X
Goldcrest <i>Regulus regulus</i>	Woodland	B	NA				X
Goldfinch <i>Carduelis carduelis</i>	Hedgerows/scrub	B	NA				X
Great spotted woodpecker <i>Dendrocopos major</i>	Woodland/parkland	B	NA				X
Great tit <i>Parus major</i>	Woodland/scrub/gardens	B	NA				X
Greenfinch <i>Chloris chloris</i>	Scrub	B	NA				X
Green woodpecker <i>Picus viridis</i>	Woodland/open fields	B	NA				X
Jackdaw <i>Corvus monedula</i>	Woodland/parkland/buildings	B	NA				X
Jay <i>Glandarius glandarius</i>	Woodland/parkland/scrub	B	NA				X
Lesser whitethroat <i>Sylvia curruca</i>	Scrub	P	NA				X
Long-tailed tit <i>Aegithalos caudatus</i>	Woodland/parkland/gardens	B	NA				X
Magpie <i>Pica pica</i>	Woodland/scrub/gardens	B	NA				X
Nuthatch <i>Sitta europaea</i>	Woodland	B	NA				X
Pied wagtail <i>Motacilla alba</i>	Parkland/gardens	B	NA				X
Pheasant <i>Phasianus colchicus</i>	Woodland/open fields	B	NA				X
Raven <i>Corvus corax</i>	Moorland/woodland/open fields	P	NA				X
Red-legged partridge <i>Alectoris rufa</i>	Arable fields	B	NA				X
Robin <i>Erithacus rubecula</i>	Woodland/scrub/gardens	B	NA				X
Rook <i>Corvus frugilegus</i>	Woodland/open fields/arable fields	B	NA				X
Sparrowhawk <i>Accipiter nisus</i>	Woodland	P	NA				X
Treecreeper <i>Certhia familiaris</i>	Woodland	B	NA				X
Wheatear <i>Oenanthe oenanthe</i>	Open field boundaries/arable fields	V	NA				X
Whitethroat <i>Sylvia communis</i>	Scrub/hedgerows	B	NA				X
Woodpigeon <i>Columba palumbus</i>	Woodland/scrub/gardens	B	NA				X
Wren <i>Troglodytes troglodytes</i>	Woodland/scrub/gardens	B	NA				X

** B= confirmed breeding. P= possible breeding, but unconfirmed. V= visiting only, not breeding, F = fly over only

On the 26th June 2019, whilst an invertebrate survey was being undertaken, a female red-backed shrike *Lanius collurio* was found to be present. This Schedule 1 species is extinct as a regular breeding species in England, with a few pairs breeding sporadically, mainly in Scotland. This individual was recorded as being an individual over-shooting migrant as no evidence of a pair or a nest was observed.

4.2.1 Breeding Species – Red Listed

Of the red-listed species confirmed as breeding within the survey area or possibly breeding, spotted flycatcher, tree pipit, and yellow wagtail are listed due to severe breeding population declines over 25 years. Linnet, marsh tit, mistle thrush, skylark, song thrush and yellowhammer have suffered similarly severe declines as breeding species over a longer period of time.

Yellow wagtail is a summer visitor that breeds in lowland meadow and arable habitats, and one pair was recorded within fields in the south of the site, but breeding could not be confirmed.

Spotted flycatcher is a summer visitor and is a bird of woodland edges and parkland, and one pair was found to be present associated with woodland edge habitat in the west of the survey area.

Tree pipit habitat comprises woodland with cleared areas and immature trees present. One pair of this summer visitor was located near Barrow Wake, 50-100 metres west of the existing alignment of the A417.

Marsh tit is a woodland resident, and five pairs were confirmed within the survey area, with a further pair very close by. All pairs were in the west of the survey area, with four north of the A417 and two to the south and west of the existing alignment. Two of the six pairs were located close to the existing alignment.

Song thrush and mistle thrush are resident species associated with woodland and other habitats with trees present. Thirteen pairs of song thrush were confirmed with distribution across the whole of the survey area. Four pairs of mistle thrush were similarly scattered across the survey area.

Linnet, skylark and yellowhammer are all birds of arable habitats as well as open grassland with, in the case of yellowhammer and linnet, hedgerows and scrub for breeding. Skylark is a ground nesting species. All three species are resident. Two pairs of linnet were located in the extreme west of the site, with ten other pairs confirmed in the southern survey arm, including five pairs from Castle Hill Cottage, and further south. Due to the gregarious nature of this species it is likely that more than one pair are

present at some of these locations and twelve territories should be taken as a minimum number.

Yellowhammer were located exclusively in the southern arm of the survey area, with the majority found around the southern-most fields.

Twenty-three pairs of skylark were recorded, all in the southern arm of the survey area. A particularly high density was found in the southern-most fields, but pairs were distributed across the southern area with clusters in fields east of the Air Balloon roundabout, west of Acorn House and Shab Hill Farm and south of Shab Hill.

There was a single record of hobby, this related to a flyover bird and there was no evidence of the species breeding within the survey area.

4.2.2 Breeding Species – Amber Listed

Kestrel is an amber listed species due to a moderate decline in breeding population over 25 years, whilst bullfinch, dunnock and meadow pipit have suffered similar declines over a longer period. Stock dove is amber listed due to the UK having breeding populations of international importance.

One kestrel territory was identified in the western arm of the survey area. Kestrels require open country for hunting and trees or man-made structures for nesting.

Bullfinch is a resident species primarily associated with scrub and orchards, and two pairs were confirmed in the western arm of the survey area.

Dunnock breed in scrub and hedgerow habitats and nineteen pairs were recorded across the survey area. Although amber listed, the species is still numerous, and nineteen pairs is not an unexpectedly high number for this survey.

Meadow pipit is a bird of open country, including rough grassland, and is particularly frequent in upland areas. Two pairs were identified as breeding in such habitat in the western arm of the survey area.

Stock dove rely on a mixture of woodland an open habitats for breeding and foraging and three pairs were located in the western arm of the survey area, north of the A417.

4.2.3 Breeding Species – Green Listed and No Status (non-native)

Common and widespread terrestrial species were also recorded as part of the survey work and twenty-eight of these were confirmed as breeding with four possibly breeding. The vast majority of these are birds associated with woodland/ parkland and scrub habitats. Most are resident species, with blackcap, garden warbler, lesser whitethroat, whitethroat, and chiffchaff being summer migrant warblers.

There were records of red kite from the survey area but no evidence of the species breeding within the survey area. It is likely that the species breeds in wooded areas nearby.

5.0 EVALUATION, IMPACTS AND RECOMMENDATIONS

5.1 Introduction

This section provides an overall site evaluation in relation to breeding birds. Full details of the breeding bird assessment, mitigation, compensation and enhancement measure will be considered within the Biodiversity chapter of the Environmental Statement for the project.

5.2 Site Evaluation

The southern arm of the survey area is composed of large arable fields located on the Cotswold plateau, interspersed with small copses and belts of woodland. The western arm is steeply sloped with greater woodland cover and with a greater proportion of calcareous grassland in open areas as opposed to arable land.

According to a published methodology for appraising the value of a site to breeding birds, the survey area is of Local importance to breeding birds, given that a total of 46 species are confirmed or likely to be breeding (Fuller, 1980).

Overall the diversity and numbers of birds recorded over a large survey area is considered typical of farmland, grassland and woodland habitats present within the site. These habitats are not uncommon in the wider area.

5.3 Impacts and Recommendations

Full details of ecological mitigation measures will be included within the Biodiversity chapter of the Environmental Statement for the project. Mitigation measures relevant to breeding birds should include any effects identified from:

- Habitat loss;
- Destruction of active nests during the breeding period;
- Visual disturbance;
- Noise; and
- Lighting.

Positive measures should be considered that may offer benefits to breeding birds, including habitat reconnection and enhancement.

6.0 REFERENCES

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Map 1 Survey Area and Transect Route

**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

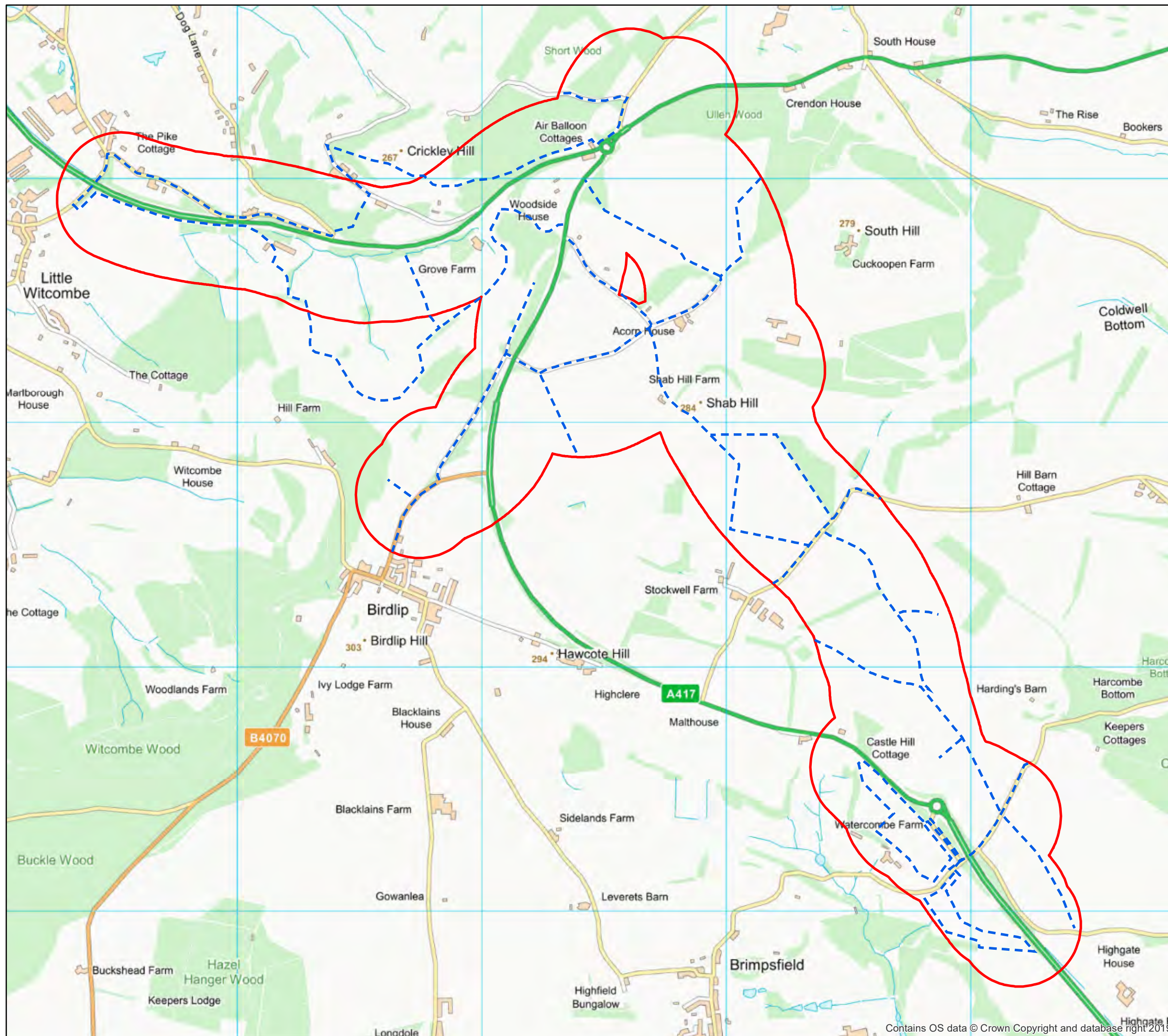
BREEDING BIRD SURVEY

Map 1 - Survey Area and Transect Route

Client:	Mott MacDonald Sweco Joint Venture
Date:	November 2019
Status:	Final

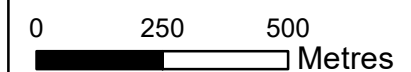
KEY

- Site Boundary
- Breeding Bird Survey Transect Route



N.B. A total of twelve survey visits were undertaken between April and June 2019 inclusive.

Scale at A3: 1:15,000



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Map 2 Breeding Bird Survey Results West: Red Listed Species

**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

BREEDING BIRD SURVEY

Map 2 - Breeding Bird Survey Results
West: Red Listed Species

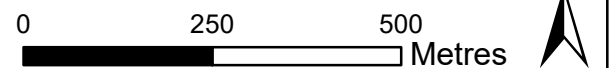
Client:	Mott MacDonald Sweco Joint Venture
Date:	November 2019
Status:	Final

KEY

-  Site Boundary
- Red Listed Bird Species Breeding Territories**
-  Linnet (LI)
-  Marsh Tit (MT)
-  Mistle Thrush (M)
-  Skylark (S)
-  Song Thrush (ST)
-  Spotted Flycatcher (SF)
-  Tree Pipit (TP)
-  Yellowhammer (Y)

N.B. Breeding territories are representative of survey data taken from across the breeding bird surveys undertaken between April and June 2019 inclusive. Species symbols represent the approximate territory centre.

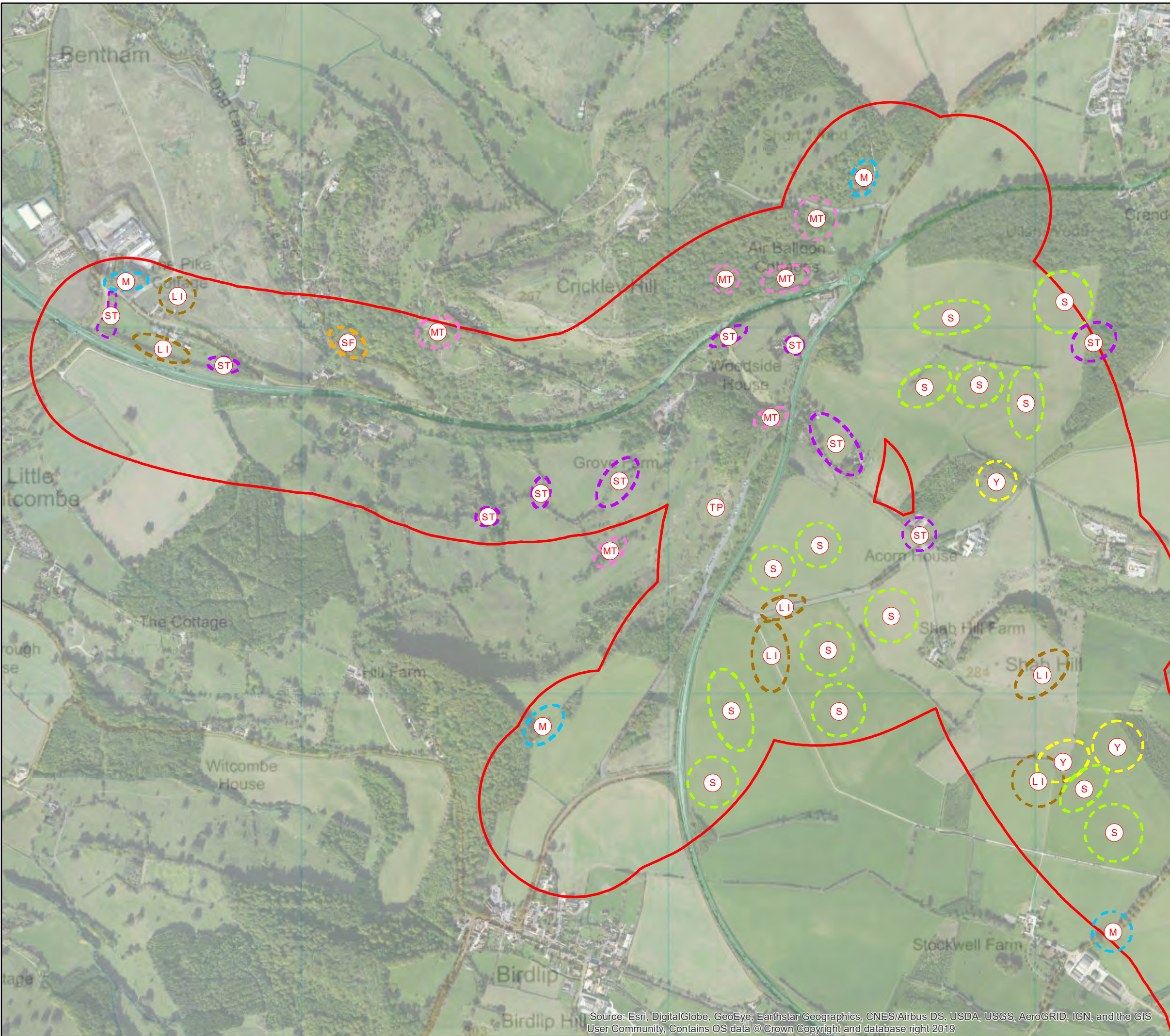
Scale at A3: 1:10,000



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Map 3 Breeding Bird Survey Results South: Red Listed Species

**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

BREEDING BIRD SURVEY






**Map 3 - Breeding Bird Survey Results
South: Red Listed Species**

Client:	Mott MacDonald Sweco Joint Venture
Date:	November 2019
Status:	Final

KEY

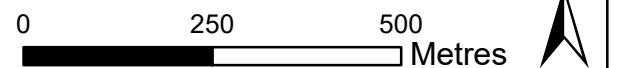
 Site Boundary

Red Listed Bird Species Breeding Territories

-  Linnet (LI)
-  Mistle Thrush (M)
-  Skylark (S)
-  Song Thrush (ST)
-  Yellowhammer (Y)

N.B. Breeding territories are representative of survey data taken from across the breeding bird surveys undertaken between April and June 2019 inclusive. Species symbols represent the approximate territory centre.

Scale at A3: 1:10,000

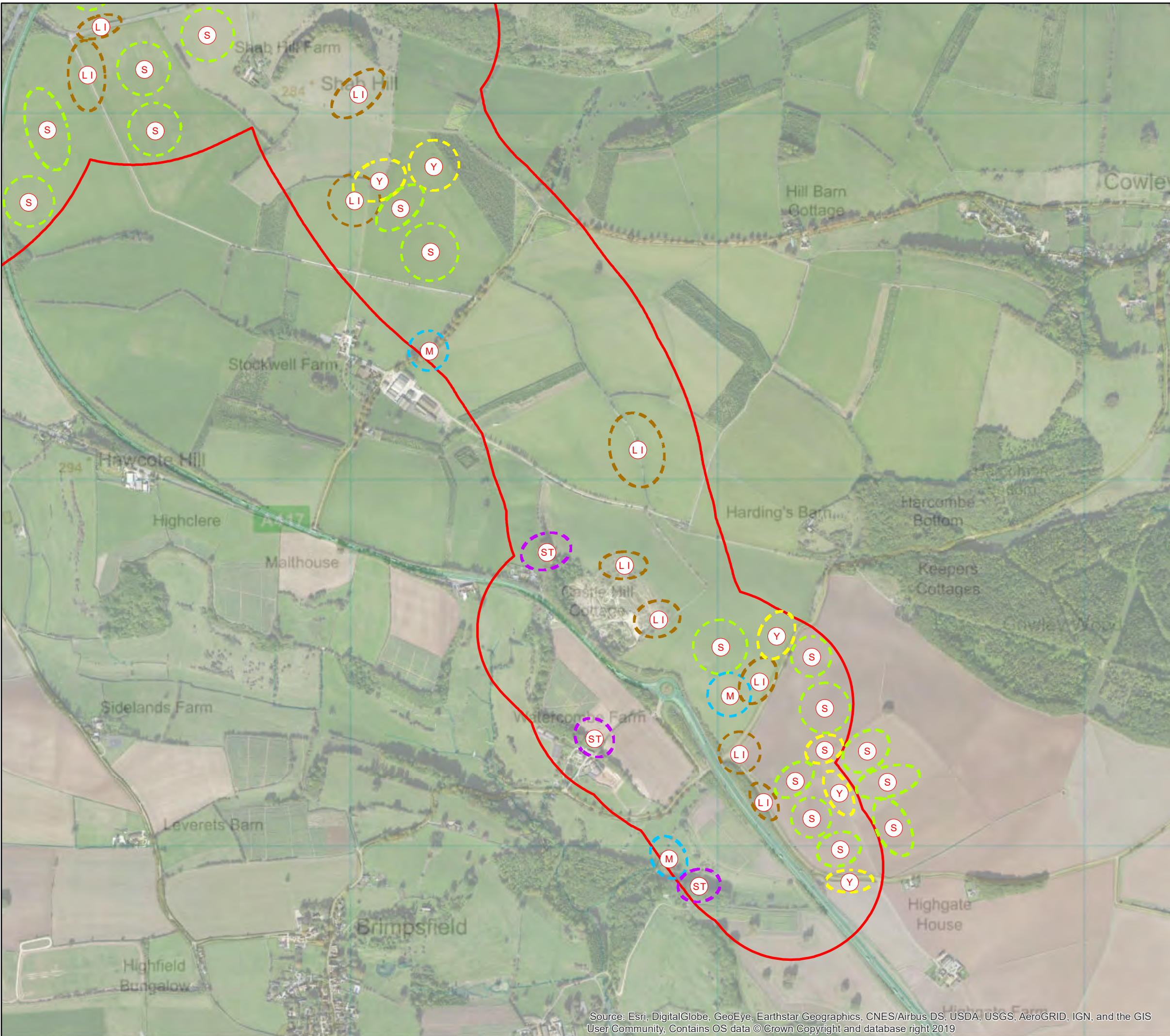


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Map 4 Breeding Bird Survey Results West: Amber Listed Species

**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

BREEDING BIRD SURVEY

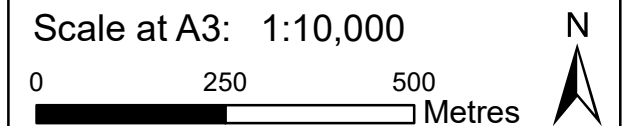
Map 4 - Breeding Bird Survey Results
West: Amber Listed Species

Client:	Mott MacDonald Sweco Joint Venture
Date:	November 2019
Status:	Final

KEY

- Site Boundary
- Amber Listed Bird Species Breeding Territories**
- Bullfinch (BF)
- Dunnock (D)
- Kestrel (K)
- Meadow Pipit (MP)
- Stock Dove (SD)
- Willow Warbler (WW)

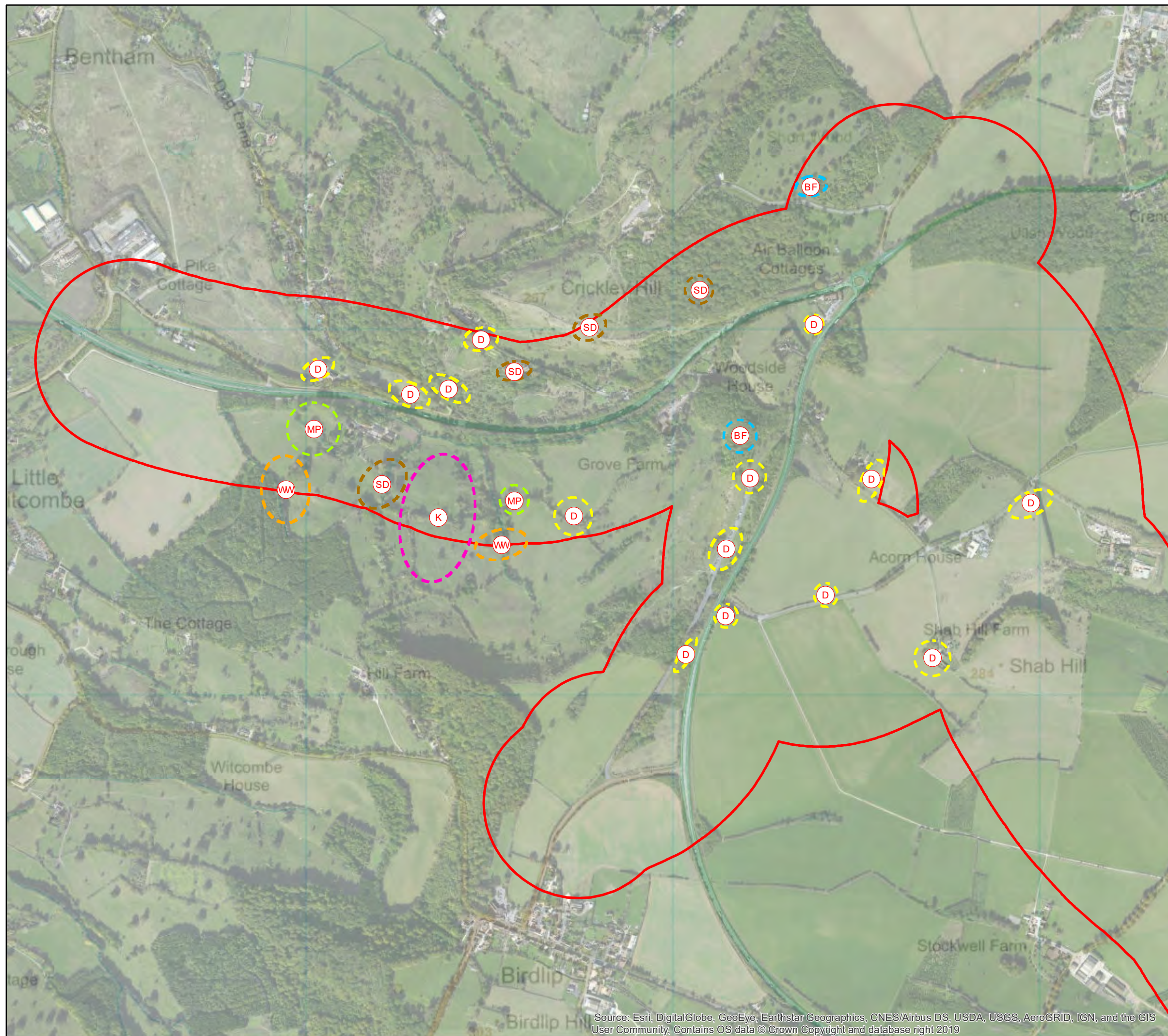
N.B. Breeding territories are representative of survey data taken from across the breeding bird surveys undertaken between April and June 2019 inclusive. Species symbols represent the approximate territory centre.



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Map 5 Breeding Bird Survey Results South: Red Listed Species



**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

BREEDING BIRD SURVEY


Map 5 - Breeding Bird Survey Results
South: Amber Listed Species

Client:	Mott MacDonald Sweco Joint Venture
Date:	November 2019
Status:	Final

KEY

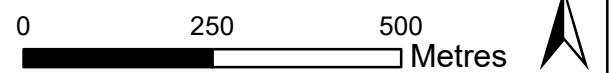
 Site Boundary

Amber Listed Bird Species Breeding Territories

 Dunnock (D)

N.B. Breeding territories are representative of survey data taken from across the breeding bird surveys undertaken between April and June 2019 inclusive. Species symbols represent the approximate territory centre.

Scale at A3: 1:10,000



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Appendix 1 Breeding Bird Survey Counts

Table 4: 2019 breeding bird records – Southern land parcels

Date	1 st April 2019		7 th May 2019		25 th May 2019		2 nd June 2019		11 th June 2019		19 th June 2019	
	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over
Blackbird	9	0	8	0	7	0	4	0	2	0	7	1
Blackcap	2	0	7	0	4	0	3	0	4	0	3	0
Blue tit	8	0	9	0	4	0	7	0	9	0	10	0
Bullfinch	0	0	0	0	1	0	1	0	0	0	1	0
Buzzard	0	0	1	0	0	0	Not counted	Not counted	Not counted	Not counted	1	0
Carrion crow	4	0	11	0	8	0	Not counted	Not counted	Not counted	Not counted	13	0
Chaffinch	5	0	8	0	3	0	7	0	4	0	1	0
Chiffchaff	4	0	4	0	3	0	7	0	5	0	1	0
Coal tit	2	0	0	0	1	0	0	0	0	0	1	0
Common gull	96	0	0	0	0	0	0	0	0	0	0	0
Dunnock	6	0	5	0	4	0	5	0	9	0	4	0

Date	1st April 2019		7th May 2019		25th May 2019		2nd June 2019		11th June 2019		19th June 2019	
Species	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over
Garden warbler	1	0	0	0	0	0	0	0	0	0	0	0
Goldcrest	0	0	4	0	1	0	2	0	2	0	2	0
Goldfinch	3	0	3	0	8	0	3	0	1	0	0	0
Great spotted woodpecker	0	0	0	0	1	0	0	0	0	0	0	0
Greenfinch	0	0	0	0	0	0	0	0	0	0	0	0
Green woodpecker	0	0	0	0	0	0	2	0	1	0	1	0
Great tit	5	0	7	0	2	0	3	0	4	0	3	0
Grey wagtail	0	0	0	0	0	0	0	0	0	0	0	0
Herring gull	0	0	0	0	0	0	0	0	0	0	0	0
Hobby	0	0	0	0	0	0	0	0	0	0	0	0
Jackdaw	0	0	0	0	0	0	0	0	0	0	1	0
Jay	1	0	0	0	1	0	0	0	0	0	0	0
Kestrel	0	0	0	0	1	0	0	0	0	0	1	0

Date	1 st April 2019		7 th May 2019		25 th May 2019		2 nd June 2019		11 th June 2019		19 th June 2019	
	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over
Lesser black-backed gull	0	125	0	0	0	0	0	0	0	0	0	2
Lesser whitethroat	0	0	0	0	0	0	0	0	0	0	0	0
Linnet	14	0	19	0	36	0	15	0	8	0	22	0
Long-tailed tit	0	0	1	0	2	0	0	0	0	0	1	0
Magpie	0	0	9	0	3	0	Not counted	Not counted	Not counted	Not counted	3	0
Marsh tit	2	0	0	0	0	0	1	0	1	0	0	0
Meadow pipit	6	0	0	0	0	0	7	0	2	0	0	0
Mistle thrush	0	0	1	0	1	0	4	0	8	0	3	0
Nuthatch	2	0	0	0	0	0	0	0	0	0	0	0
Pheasant	0	0	4	0	5	0	Not counted	Not counted	Not counted	Not counted	1	0
Pied wagtail	1	0	0	0	0	0	1	0	0	0	0	0
Raven	0	0	0	0	0	0	1	0	1	0	0	0

Date	1 st April 2019		7 th May 2019		25 th May 2019		2 nd June 2019		11 th June 2019		19 th June 2019	
Species	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over
Whitethroat	0	0	8	0	4	0	3	0	7	0	7	0
Willow warbler	0	0	4	0	3	0	1	0	1	0	1	0
Woodpigeon	0	0	13	0	13	0	Not counted	Not counted	Not counted	Not counted	20	0
Wren	12	0	10	0	9	0	14	0	16	0	9	0
Yellowhammer	8	0	7	0	5	0	5	0	4	0	6	0
Yellow wagtail	0	0	2	0	0	0	1	0	0	0	0	0

* Recorded flying over the site only

** Some species are shown as 'Not counted' usually these are common species which were present either in large numbers or were present but not showing evidence of breeding.

Date	5 th April 2019		14 th May 2019		27 th May 2019		1 st June 2019		12 th June 2019		17 th June 2019	
Species	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over
Robin	12	0	7	0	7	0	8	0	7	0	7	0
Rook	0	0	0	0	0	0	0	0	0	0	0	0
Skylark	0	0	0	0	0	0	0	0	0	0	0	0
Song thrush	7	0	6	0	7	0	4	0	5	0	5	0
Sparrowhawk	0	0	0	0	0	0	0	0	0	0	0	0
Spotted flycatcher	0	0	1	0	0	0	1	0	1	0	1	0
Stock dove	3	0	3	0	2	0	2	0	1	0	2	0
Swallow	0	0	6	0	4	0	8	0	4	0	3	0
Swift	0	0	0	0	0	0	0	0	0	30	0	5
Treecreeper	1	0	1	0	1	0	1	0	0	0	1	0
Tree pipit	0	0	0	0	0	0	0	0	1	0	1	0
Wheatear	0	0	0	0	0	0	0	0	0	0	0	0
Whitethroat	0	0	2	0	2	0	2	0	1	0	7	0
Willow warbler	0	0	2	0	2	0	1	0	1	0	2	0

Date	5 th April 2019		14 th May 2019		27 th May 2019		1 st June 2019		12 th June 2019		17 th June 2019	
Species	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over
Woodpigeon	Not counted	Not counted	Not counted	Not counted	Not counted	Not counted	Not counted	Not counted	Not counted	Not counted	Not counted	Not counted
Wood warbler	0	0	0	0	0	0	0	0	1	0	0	0
Wren	16	0	10	0	15	0	13	0	13	0	20	0
Yellowhammer	0	0	0	0	0	0	0	0	0	0	0	0
Yellow wagtail	0	0	0	0	0	0	0	0	0	0	0	0

* Recorded flying over the site only

** Although not a Schedule 1 species or Red or Amber listed, golden plover are listed on Annex 1 of the EC Birds Directive

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.11
Wintering Bird Survey Report

28 September 2020

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Executive Summary

The proposed A417 Missing Link scheme (hereafter referred to as ‘the scheme’) aims to provide a dual carriageway to a stretch of single carriageway between the Cowley roundabout and Crickley Hill in Gloucestershire; the 5.5km section is the only remaining section of single carriageway. The scheme would increase capacity by creating a free-flowing link between the Brockworth Bypass and Cowley roundabout and remove the at-grade junction with the A436, resulting in a continuous flow between the M4 Junction 15 (Swindon) and the M5 Junction 11a (Gloucester/Cheltenham).

Wintering bird surveys have been undertaken by ECOSA between October 2018 and February 2019 in order to establish the usage of the site, and adjacent habitat by wintering bird species.

The southern arm of the survey area comprises large arable fields on the Cotswold plateau, with hedgerows and small belts and copses of woodland. The western arm of the survey area includes woodland, pasture and calcareous grassland on the Cotswold scarp.

The large arable fields in the south of the survey area attract lapwing, wintering gulls, predominantly common gull, and a regular wintering flock of up to 178 golden plover.

The arable fields and their margins attract seed eating species including skylark and yellowhammer. Field and woodland edges with berry-bearing shrubs support sizeable flocks of fieldfare, redwing and starling.

The scheme alignment avoids land take of areas currently supporting lapwing and golden plover. However, loss of open fields, and field boundaries is likely and therefore impacts on other wintering birds will occur through land take and disturbance, although much similar habitat exists in the wider area.

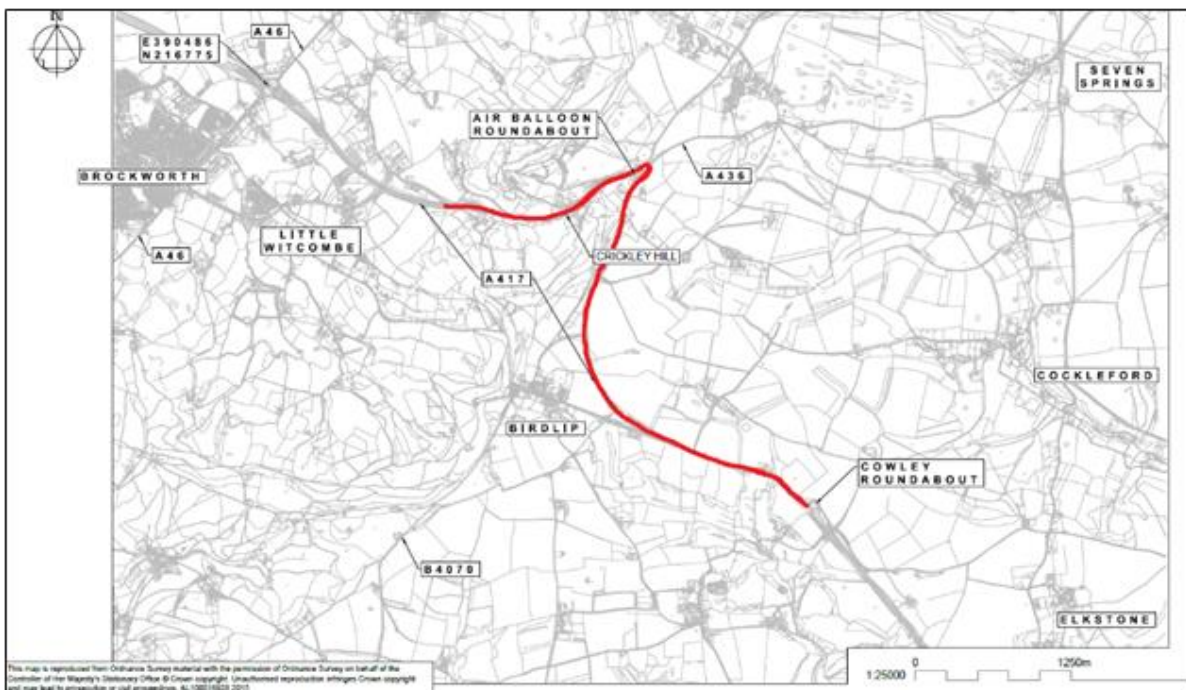
It is recommended that the road improvement scheme design seeks to minimise effects on wintering birds through avoidance and mitigation of visual, noise and lighting disturbance. Opportunities exist for improving and reconnecting habitats associated with sections of the existing A417 that may no longer be required for use by road traffic.

1. Introduction

1.1. Background

- 1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and as an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'missing link', forms the only section of single carriageway along the route, with an at-grade junction located at the 'Air Balloon' public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5km stretch shown on Figure 1.1 below.

Figure 1.1: A417 Missing Link Scheme Location Plan



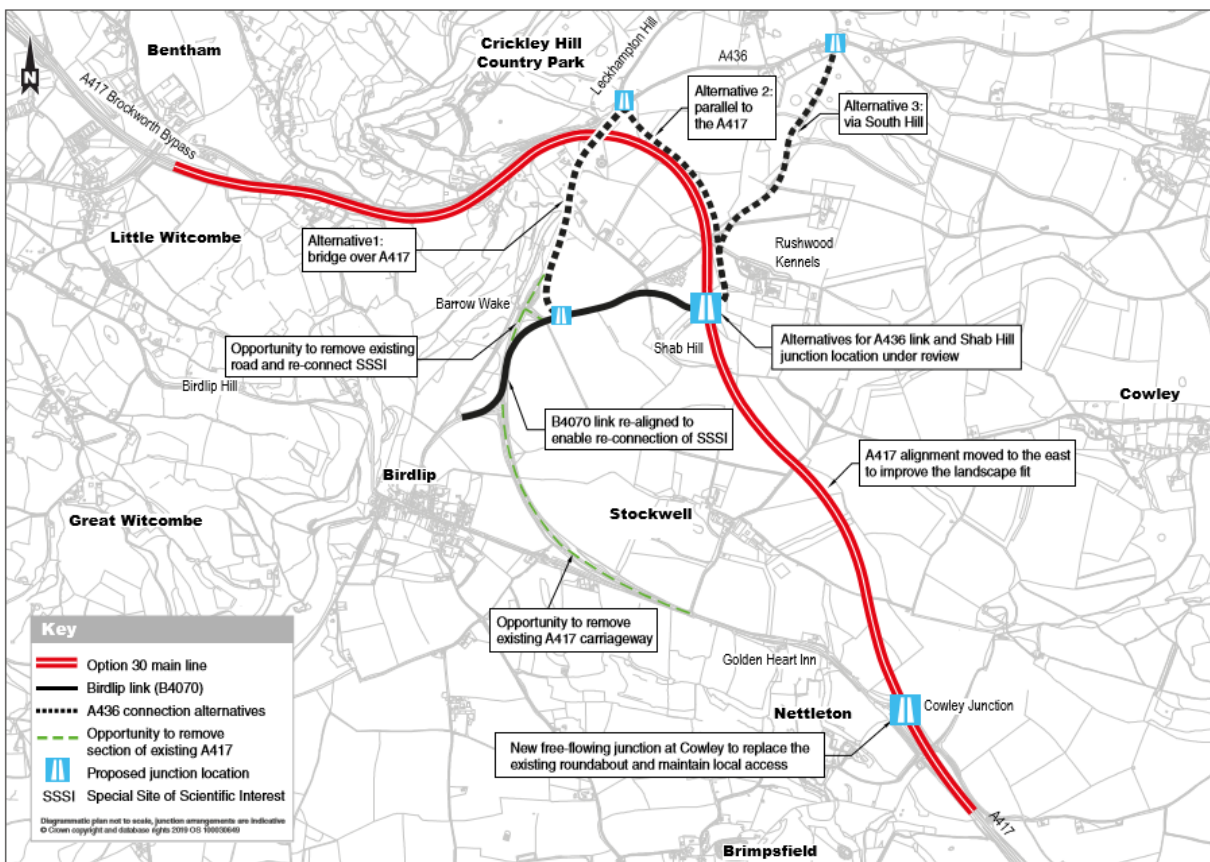
Source: GiGi GIS Portal. Crown Copyright 2016 100030649

1.2. Scheme Proposal

- 1.2.1. The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill. Any proposed scheme would aim to increase capacity by creating a free-flowing link between the Brockworth Bypass and the Cowley roundabout and remove the at-grade junction with the A436 (Air Balloon roundabout). This Missing Link will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester / Cheltenham (M5 Junction 11).

- 1.2.1 The preferred route for the Scheme was confirmed as Option 30 by the Secretary of State in March 2019 (see Figure 2.1 below). The Scheme comprises the construction of a new dual carriageway to replace the existing single carriageway section between Brockworth bypass and Cowley Roundabout. It is predominately an “offline” Scheme but approximately a third of the route follows the existing A417 route corridor at Crickley Hill.
- 1.2.2 A new link road would be built between the slip road junction at Shab Hill and the existing A417 to connect traffic to and from Birdlip and the A436 with the new A417. This new link road would end in a new roundabout near Barrow Wake.

Figure 1.2: A417 Preferred Route Announcement



- 1.2.3 Figure 1.2 above shows the three A436 link road alternative connections. Alternative 2, parallel to the A417, was the option taken forward for assessment in the Environmental Statement.

1.3. Scope of Report

- 1.3.1. Ecological Survey & Assessment Limited (ECOSA) were contracted by Mott MacDonald Sweco Joint Venture (MMSJV) to undertake wintering bird surveys to inform ecological assessment of the scheme. Details of these surveys, including methods and results, are provided in the Wintering Bird Survey Report in Appendix A.

Appendices

Appendix A A417 Wintering Bird Survey Report (ECOSA 2019)

**A417 ROAD IMPROVEMENT SCHEME, BIRDLIP,
GLOUCESTERSHIRE**

WINTERING BIRD SURVEY

Final Document

November 2019

Preliminary Ecological Appraisals • Protected Species Surveys and Licensing • NVC • EclA • HRA • Management Plans
Habitats • Badger • Bats • Hazel Dormouse • Birds • Reptiles • Amphibians • Invertebrates • Riparian and Aquatic Species



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ECOSA Quality Assurance Record

This report has been produced in accordance with the Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Report Writing 2017 (CIEEM, 2017). The report has been prepared in line with current best practice guidance and survey work has been undertaken in line with references within CIEEM's Source of Survey Guidance (CIEEM, 2017).

Description:	Wintering Bird Survey
Produced For:	Mott MacDonald Sweco Joint Venture (MMSJV)
Issue:	Final
Report Reference:	4265.D0
Date of Issue:	13 th November 2019
Date of Survey Works:	October 2018 - February 2019
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This is a technical report which does not represent legal advice. You may wish to seek legal advice if this is required.

This report may or may not be suitable to support a planning application. Should this report contain recommendations for further survey work or assessment, the results of this would be required in order to support a planning application.

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**A417 ROAD IMPROVEMENT SCHEME, BIRDIP,
GLOUCESTERSHIRE**

WINTERING BIRD SURVEY

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EXECUTIVE SUMMARY

ECOSA were commissioned by Mott MacDonald Sweco Joint Venture (MMSJV) to carry out a wintering bird survey to inform the A417 Birdlip Road Improvement Scheme. The main findings are:

- Wintering bird surveys have been undertaken by ECOSA between October 2018 and February 2019 in order to establish the usage of the site, and adjacent habitat by wintering bird species.
- The southern arm of the survey area comprises large arable fields on the Cotswold plateau, with hedgerows and small belts and copses of woodland. The western arm of the survey area includes woodland, pasture and calcareous grassland on the Cotswold scarp.
- The large arable fields in the south of the survey area attract lapwing, wintering gulls, predominantly common gull, and a regular wintering flock of up to 178 golden plover.
- The arable fields and their margins attract seed eating species including skylark and yellowhammer. Field and woodland edges with berry-bearing shrubs support sizeable flocks of fieldfare, redwing and starling.
- The preferred scheme alignment avoids land take of areas currently supporting lapwing and golden plover. However, loss of open fields, and field boundaries is likely and therefore impacts on other wintering birds will occur through land take and disturbance, although much similar habitat exists in the wider area.
- It is recommended that the road improvement scheme design seeks to minimise effects on wintering birds through avoidance and mitigation of visual, noise and lighting disturbance. Opportunities exist for improving and reconnecting habitats associated with sections of the existing A417 that may no longer be required for use by road traffic.

1.0 INTRODUCTION

1.1 Background

Ecological Survey & Assessment Limited (ECOSA) have been contracted by Mott MacDonald Sweco Joint Venture (MMSJV) to undertake wintering bird surveys to inform the proposed route of a road improvement scheme for the A417 at Birdlip, Gloucestershire.

1.2 The Site

The survey area extends southward and westward in two ‘arms’ from approximately 500 metres north of the Air Balloon roundabout on the A417, following two branches of the A417. The area covered is approximately 2.5 kilometres from west to east and north to south and encompasses the existing road corridor and the proposed route of the road improvement scheme. The extent of the survey area is shown on **Map 1**. The surveyed area was based on the route alignment at the time of survey. The final route alignment and redline boundary may result in additional areas lying outside of the survey boundary. However, due to the similarity on habitats, these areas are likely to support similar assemblages of wintering birds.

The survey area covers 475 hectares and is characterised by arable farmland with large fields bisected by hedgerows, rural roads, and areas of calcareous grassland and broadleaved woodland. The majority of the site is on the Cotswold plateau, but in the west of the survey area, the land falls away steeply to the west.

The wider landscape consists of further areas of farmland, woodland copses and small villages. The towns of Cheltenham and Gloucester lie approximately four kilometres to the north and west respectively.

1.3 Aims and Scope of Report

Wintering bird surveys were undertaken by ECOSA between October 2018 and February 2019 in order to establish the usage of the site by bird species associated primarily with open farmland and grassland such as lapwing *Vanellus vanellus* and golden plover *Pluvialis apricaria* as well as other protected and notable (Schedule 1¹ and Red² and Amber³ Listed Birds of Conservation Concern (BoCC)).

¹ **Schedule 1:** Birds listed on Schedule 1 of the Wildlife and Countryside Act (1981 as amended) are afforded additional protection making it an offence to: intentionally or recklessly disturb any bird while it is nest building, or is at a nest containing eggs or young; or; intentionally or recklessly disturb the dependent young of any such bird.

² **Birds of Conservation Concern Red List:** The UK's birds are split in to three categories of conservation importance - red, amber and green. Red is the highest conservation priority and include species which are: globally threatened; have been subject to historical population decline in UK during 1800–1995; are in severe (at least 50%) decline in UK breeding population over the last 25 years, or longer-term period, or; subject to severe (at least 50%) contraction of UK breeding range over the last 25 years, or longer-term period.

³ **Birds of Conservation Concern Amber List:** Amber list criteria include species which are: in unfavourable conservation status in Europe; subject to historical population decline during 1800–1995, but recovering; subject to moderate (25-49%) decline in UK breeding population or contraction of UK breeding range over the last 25 years, or the longer-term period; subject to moderate (25-49%) decline in UK non-breeding population over the last 25 years, or

This report presents the findings of the wintering bird surveys carried out by ECOSA between October 2018 and February 2019.

1.4 Site Proposals

Proposals for the site are for the re-routing of the existing A417 road, and associated infrastructure.

The planning application is expected to be submitted in early 2020.

the longer-term period; rare breeders (1–300 breeding pairs in UK); rare non-breeders (less than 900 individuals), or; internationally important species with at least 20% of European breeding or non-breeding population in the UK .

2.0 PLANNING POLICY CONTEXT

2.1 Introduction

This section summarises the planning policy in relation to ecology and biodiversity within the Tewkesbury and Cotswold Council administrative areas. The west of the survey area lies within Tewkesbury, whilst the east is within Cotswold.

2.2 Planning Policy

2.2.1 National Policy

The National Policy Statement for National Networks (NPSNN) sets out the need for, and government's policies to deliver Nationally Significant Infrastructure Projects on the national road network in England.

Chapter 3 of the NPSNN identifies that in order to be sustainable and to improve people's quality of life, the need for development must be seen in the context of the Government's wider policies on economic performance, environment, safety, technology, sustainable transport and accessibility, as well as journey reliability and the experience of road - rail users. Wider policies relate to:

- Environmental and social impacts – national road networks should be designed to minimise social and environmental impacts and improve quality of life. In delivering new schemes, the Government expects applicants to avoid and mitigate environmental and social impacts in line with the principles set out in the National Planning Policy Framework (NPPF) and the Government's planning guidance.

Chapter 5 of the NPSNN outlines the possible impacts that would be relevant to any type of national networks infrastructure and sets out how these impacts should be considered. The sections include consideration of biodiversity.

The National Planning Policy Framework (NPPF) sets out the government's requirements for the planning system in England. The original document was published in 2012 with the revised NPPF published in July 2018. A number of sections of the NPPF are relevant when taking into account development proposals and the environment. As set out within Paragraph 11 of the NPPF "*Plans and decisions should apply a presumption in favour of sustainable development*". However, Paragraph 177 goes on to state that "*The presumption in favour of sustainable development does not apply where the plan or project is likely to have a significant effect on a habitats site (either alone or in combination with other plans or projects), unless an appropriate*

assessment has concluded that the plan or project will not adversely affect the integrity of the habitats site⁴.

The general impetus of the NPPF in relation to ecology and biodiversity is for development proposals to not only minimise the impacts on biodiversity but also to provide enhancement. Paragraph 170 states that the planning system should contribute to and enhance the natural environment by “...*minimising impacts on biodiversity and providing net gains in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures...*”.

A number of principles are set out in Paragraph 175, including that where harm cannot be adequately avoided then it should be mitigated for, or as a last resort, compensated for. Where impacts occur on nationally designated sites, the benefits must clearly outweigh any adverse impact and incorporating biodiversity in and around developments should be encouraged. Specific reference is also made to the protection of irreplaceable habitats⁵. Where loss to irreplaceable habitats occur planning permission would normally be refused unless there are wholly exceptional reasons and an adequate compensation strategy is in place. Paragraph 175 also states “*development whose primary objective is to conserve or enhance biodiversity should be supported; while opportunities to incorporate biodiversity improvements in and around developments should be encouraged, especially where this can secure measurable net gains for biodiversity*”. Protection of sites proposed as Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Ramsar sites or acting as compensation for SPAs, SACs and Ramsar sites, should receive the same protection as habitat sites.

In addition to the NPPF, Circular 06/05 provides guidance on the application of the law relating to planning and nature conservation as it applies in England. Paragraph 98 states “*the presence of a protected species is a material consideration when a planning authority is considering a development proposal that, if carried out, would be likely to result in harm to the species or its habitat*”. Whilst paragraph 99 states “*it is essential that the presence or otherwise of a protected species, and the extent that they may be affected by the proposed development, is established before planning permission is granted*”.

⁴ The NPPF defines a habitats site as “*Any site which would be included within the definition at regulation 8 of the Conservation of Habitats and Species Regulations 2017 for the purpose of those regulations, including candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation, Special Protection Areas and any relevant Marine Sites.*”

⁵ The NPPF defines irreplaceable habitats as “*Habitats which would be technically very difficult (or take a very significant time) to restore, recreate or replace once destroyed, taking into account their age, uniqueness, species diversity or rarity. They include ancient woodland, ancient and veteran trees, blanket bog, limestone pavement, sand dunes, salt marsh and lowland fen.*”

2.2.2 **Highways England policy**

Highways England Biodiversity Plan

Highways England's Biodiversity Plan (BAP) identifies its approach to meeting the key performance indicator identified within the Roads Investment Strategy (RIS) of "no net loss of biodiversity by 2020" and that "by 2040 it must deliver a net gain in biodiversity". Biodiversity is required to be fully considered during the building of any new roads and opportunities sought to work with stakeholders and enhance the network for wildlife.

2.2.3 **Local Policy**

A single policy within the Cotswold District Local Plan (2011-2031) refers to ecology and biodiversity:

- **Policy EN8: Biodiversity and Geodiversity: Features, Habitats and Species.** Development will be permitted that conserves and enhances biodiversity and geodiversity, providing net gains where possible. Proposals that would result in significant habitat fragmentation and loss of ecological connectivity will not be permitted. Proposals that reverse habitat fragmentation and promote creation, restoration and beneficial management of ecological networks, habitats and features will be permitted, particularly in areas subject to landscape-scale biodiversity initiatives. Developer contributions may be sought in this regard. Development with a detrimental impact on protected species and species and habitats "of principal importance for the purpose of conserving biodiversity" will not be permitted unless adequate provision can be made to ensure the conservation of the species or habitat.

The Joint Core Strategy for Gloucester, Cheltenham and Tewkesbury (2011-2031) also considers biodiversity through policy:

- **Policy SD9 (Biodiversity and Geodiversity):** The biodiversity and geological resource of the JCS area will be protected and enhanced in order to establish and reinforce ecological networks that are resilient to current and future pressures. This will be achieved by ensuring that European Protected Species and National Protected Species are safeguarded in accordance with the law; encouraging new development to contribute positively to biodiversity and geodiversity whilst linking with wider networks of green infrastructure; encouraging the creation, restoration and beneficial management of priority landscapes, priority habitats and populations of priority species. Where there is a risk of harm as a consequence of development, this should be mitigated by integrating enhancements into the scheme that are appropriate to the location

and satisfactory to the local planning authority. If harm cannot be mitigated onsite then, exceptionally, compensatory enhancements off-site may be acceptable.

3.0 METHODS

3.1 Introduction

This section details the methods used during the wintering bird surveys undertaken at the A417 site between October 2018 and February 2019.

3.2 Survey Methodology

A walked transect survey allowing observation of all major habitat areas was undertaken monthly between October 2018 and February 2019 inclusive, to determine the usage of the area by wintering birds (**Map 1**).

The survey largely consisted of the surveyors scanning the site using binoculars to identify the bird species utilising the survey area. The surveys aimed to determine the presence and numbers of notable or protected wintering bird species.

3.3 Survey Details

A total of six survey visits were undertaken between October 2018 and February 2019. In December, January and February the survey was undertaken by one surveyor on a single day. In October the same surveyor undertook the survey over two consecutive days. In November, two surveyors were present on one single date. **Table 1** provides details of each survey visit.

Table 1: Wintering bird surveys details

Survey Date	Duration	Weather Conditions
26 th October 2018	08:00-13:30	Dry, 10°C, 75% cloud cover, light northerly breeze
27 th October 2018	08:00-12:45	Dry, 6°C, 75% cloud cover, light southerly breeze
21 st November 2018	10:15-12:30	Snow showers, 1°C, 100% cloud cover, light north-westerly breeze
21 st December 2018	09:30-13:30	Dry, 12°C, 75-100% cloud cover, moderate south-westerly breeze
28 th January 2019	10:00-13:45	Sunny, 3°C, 25-50% cloud cover, moderate north-westerly breeze
22 nd February 2019	07:30-14:00	Sunny, 14°C, 0-25% cloud cover, light south-westerly breeze

The wintering bird surveys were carried out by experienced ornithologist Simon Colenutt of ECOSA, with Graeme Down, also an experienced ornithologist of ECOSA present and covering half of the transect route on 21st November 2018. During the survey the surveyors were equipped with 10x42 Leica or Swarovski binoculars and a detailed plan of the site. Bird observations were plotted on the plan using British Trust for Ornithology codes. Particular attention was paid to identifying birds actively using the survey area, rather than just flying over.

3.4 Survey Limitations

Access around Crickley Hill Farm was restricted to Public Rights of Way, however, given the nature of the habitat which consists largely of a cycletrack, hedgerows and improved pasture it was considered unlikely that significant numbers of wintering birds would have been present and overlooked during the current survey.

The surveys were undertaken across the entirety of the wintering bird survey season from October through to February and spaced across evenly across the season. Therefore, it is considered that a robust assessment of the wintering bird activity at the survey area has been undertaken across the 2018 to 2019 winter.

4.0 RESULTS

4.1 Introduction

This section details the results of the wintering bird surveys undertaken at the A417 site between October 2018 and February 2019.

4.2 Wintering Birds

A summary of notable species recorded within survey area and their respective maximum counts are provided in **Table 2**. Full survey data is presented in **Table 3**. A total of 53 species were recorded during the winter bird surveys. The survey visits are mapped on **Map 2, Map 3 Map 4 Map 5** and **Map 6**.

Table 2: Summary of notable bird species recorded from survey area

Species	Maximum Count	Schedule 1	Red List	Amber List
Black-headed gull <i>Chroicocephalus ridibundus</i>	67			X
Bullfinch <i>Pyrrhula pyrrhula</i>	8			X
Common gull <i>Larus canus</i>	184			X
Dunnock <i>Prunella modularis</i>	6			X
Fieldfare <i>Turdus pilaris</i>	557		X	
Golden plover** <i>Pluvialis apricaria</i>	178			
Goshawk <i>Accipiter gentilis</i>	1*	X		
Grey wagtail <i>Motacilla cinerea</i>	2			X
Herring gull <i>Larus argentatus</i>	20*		X	
Kestrel <i>Falco tinnunculus</i>	4			X
Lapwing <i>Vanellus vanellus</i>	72		X	
Lesser black-backed gull <i>Larus fuscus</i>	1			X
Linnet <i>Linaria cannabina</i>	12		X	
Marsh tit <i>Poecile palustris</i>	6		X	
Meadow pipit <i>Anthus pratensis</i>	4			X
Mistle thrush <i>Turdus viscivorus</i>	4		X	
Red kite <i>Milvus milvus</i>	2*	X		
Redshank <i>Tringa totanus</i>	4		X	
Redwing <i>Turdus iliacus</i>	412		X	
Skylark <i>Alauda arvensis</i>	63		X	
Song thrush <i>Turdus philomelos</i>	8		X	
Starling <i>Sturnus vulgaris</i>	135		X	
Stock dove <i>Columba oenas</i>	10			X
Woodcock <i>Scolopax rusticola</i>	1		X	
Yellowhammer <i>Emberiza citrinella</i>	18		X	

* Recorded flying over the site only

** Although not a Schedule 1 species or Red or Amber listed, golden plover are listed on Annex 1 of the EC Birds Directive

Common and widespread (introduced species and BoCC Green Listed Species) species were also recorded as part of the survey work and included blackbird *Turdus*

merula, blue tit *Cyanistes caeruleus*, buzzard *Buteo buteo*, carrion crow *Corvus corone*, chaffinch *Fringilla coelebs*, coal tit *Periparus ater*, collared dove *Streptopelia decaocto*, cormorant *Phalacrocorax carbo*, goldcrest *Regulus regulus*, goldfinch *Carduelis carduelis*, great spotted woodpecker *Dendrocopos major*, great tit *Parus major*, green woodpecker *Picus viridis*, jackdaw *Corvus monedula*, jay *Garrulus glandarius*, long-tailed tit *Aegithalos caudatus*, magpie *Pica pica*, nuthatch *Sitta europaea*, pied wagtail *Motacilla alba*, pheasant *Phasianus colchicus*, raven *Corvus corax*, red-legged partridge *Alectoris rufa*, robin *Erithacus rubecula*, rook *Corvus frugilegus*, sparrowhawk *Accipiter nisus*, woodpigeon *Columba palumbus* and wren *Troglodytes troglodytes*.

Table 3: 2018 / 2019 notable wintering bird records (Maximum Counts in Green)

Date	26th and 27 th October 2018		21st November 2018		21st December 2018		28th January 2019		22nd February 2019		Maximum Count On Site
	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	On Site	Flying Over	
Black-headed gull	67	0	18	0	17	0	14	0	15	0	67
Bullfinch	8	0	3	0	0	0	2	0	4	0	8
Common gull	78	0	47	2	20	0	184	8	159	0	184
Dunnock	4	0	4	0	0	0	4	0	6	0	6
Fieldfare	2	0	56	21	557	5	290	30	143	0	557
Golden plover**	0	0	0	43	178	0	65	0	75	0	178
Goshawk	0	0	0	0	0	0	0	1	0	0	1*
Grey wagtail	0	0	0	0	2	0	1	0	1	0	2
Herring gull	0	0	0	0	0	0	0	6	0	20	20*
Kestrel	1	0	4	0	0	0	1	1	1	1	4
Lapwing	0	0	0	0	72	0	0	0	0	0	72
Lesser black-backed gull	0	0	0	0	0	0	1	0	0	0	1
Linnet	4	2	0	0	0	0	7	0	12	0	12
Marsh tit	1	0	2	0	5	0	5	0	6	0	6
Meadow pipit	2	0	0	0	4	0	0	0	0	0	4
Mistle thrush	0	0	0	0	4	0	4	0	2	0	4
Red kite	0	2	0	0	0	0	0	0	0	0	2*
Redshank	0	0	0	0	4	0	0	0	0	0	4
Redwing	37	0	150	6	412	15	100	0	194	0	412
Skylark	37	0	34	3	48	0	24	0	63	0	63
Song thrush	1	0	8	0	1	0	7	0	7	0	8
Starling	48	87	75	0	135	0	19	1	0	0	135
Stock dove	1	0	0	0	0	8	8	0	10	0	10
Woodcock	0	0	0	0	0	0	1	0	0	0	1
Yellowhammer	10	0	0	0	18	0	0	0	6	0	18

* Recorded flying over the site only

** Although not a Schedule 1 species or Red or Amber listed, golden plover are listed on Annex 1 of the EC Birds Directive

5.0 EVALUATION, IMPACTS AND RECOMMENDATIONS

5.1 Introduction

This section presents the conclusions of the assessment and wintering bird survey. It provides an initial assessment of the likely ecological constraints to the proposed development in relation to wintering birds and detailed recommendations for any further survey work or mitigation measures considered necessary.

5.2 Site Evaluation

The southern arm of the survey area is composed of large arable fields located on the Cotswold plateau, interspersed with small copses and belts of woodland. The western arm is steeply sloped with greater woodland cover and with a greater proportion of calcareous grassland in open areas as opposed to arable land.

On 21st December 2018, a flock of 72 lapwing *Vanellus vanellus* was present in the large arable fields in the south of the survey area. Golden plover were also found to be using these fields from November-February. Although not currently considered a species of conservation concern (Hayhow *et al.*, 2017), it is notable that a flock of up to 178 birds was regularly recorded.

The network of open fields and hedgerows also attracts wintering flocks of seed-eating species in particular skylark *Alauda arvensis*, where up to 63 birds were recorded and yellowhammer *Emberiza citrinella*, with a maximum of 18 present.

The fields also attract gulls, mainly common gull *Larus canus*, numbers of which peaked in January and February 2019, with greatest numbers occurring in fields also used by golden plover and lapwing, but with flocks also present in fields further north.

Large numbers of berry-feeding species – fieldfare *Turdus pilaris*, redwing *Turdus iliacus* and starling *Sturnus vulgaris* - were recorded throughout the winter with a combined total of over 1,000 birds on 21st December 2018. These species are frequenting field and woodland edges where shrubs are located.

Overall the diversity and numbers of birds recorded over a large survey area is considered typical of farmland, grassland and woodland habitats present within the site. These habitats are not uncommon in the wider area.

5.3 Potential Impacts of Development

Full details of ecological mitigation measures will be included within the ecology and nature conservation chapter of the Environmental Statement for the project. Mitigation measures relevant to breeding birds should include any effects identified from:

- Habitat loss;

- Destruction of active nests during the breeding period;
- Visual disturbance;
- Noise; and
- Lighting.

Positive measures should be considered that may offer benefits to breeding birds, including habitat reconnection and enhancement.

5.4 Recommendations

The detailed design of the road improvement scheme should consider options to minimise visual and noise disturbance of birds during construction and operation. These considerations should include visually screening the route from surrounding fields and where elevated noise levels are predicted, the use of vegetation or fencing to present sound barriers. Lighting of the construction and operational phases of the scheme will also need to be carefully considered to ensure no light spill from the development to retained wintering bird habitat.

It is recommended that a Construction Environmental Management Plan (CEMP) be implemented during the construction phase of the scheme in order to minimise potential disturbance to over wintering birds.

Where the existing A417 can be removed from operation, it is recommended that opportunities are explored to maximise the reconnection of habitats currently severed by the road – in particular tree lines and hedgerows.

The impact assessment will be updated once the design of the scheme is finalised.

6.0 REFERENCES

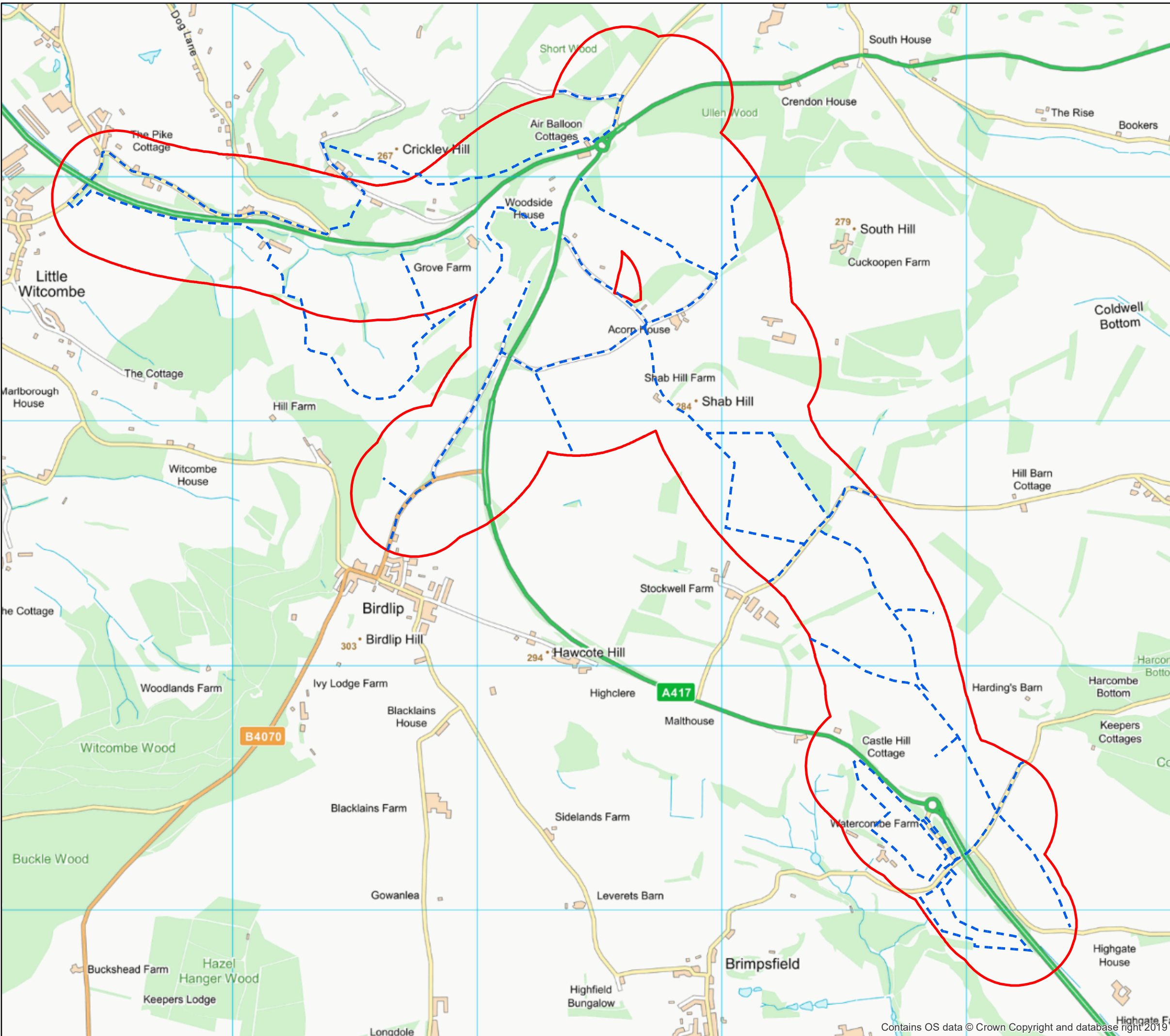
CIEEM, 2017. Chartered Institute of Ecology and Environmental Management Website.
[Online]

Available at: www.cieem.net

CIEEM, 2017. *Guidelines for Ecological Report Writing*. 2nd ed. Winchester: Chartered Institute of Ecology and Environmental Management.

Hayhow DB, Ausden MA, Bradbury RB, Burnell D, Copeland AI, Crick HQP, Eaton MA, Frost T, Grice PV, Hall C, Harris SJ, Morecroft MD, Noble DG, Pearce-Higgins JW, Watts O, Williams JM, 2017. *The State of the UK's Birds*. The RSPB, BTO, WWT, DAERA, JNCC, NE and NRW, Sandy, Bedfordshire.

Map 1 Survey Area and Transect Route



**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

WINTERING BIRD SURVEY

Map 1 - Survey Area and Transect Route

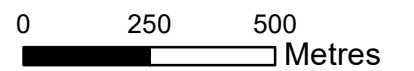
Client:	Mott MacDonald Sweco Joint Venture
Date:	November 2019
Status:	Final

KEY

- Site Boundary
- Wintering Bird Survey Transect Route

N.B. A total of six survey visits were undertaken between October 2018 and February 2019.

Scale at A3: 1:15,000



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Map 2 October 2018 Survey Results

**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

WINTERING BIRD SURVEY

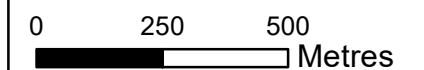
Map 2 - October 2018 Survey Results

Client:	Mott MacDonald Sweco Joint Venture
Date:	November 2019
Status:	Final

KEY

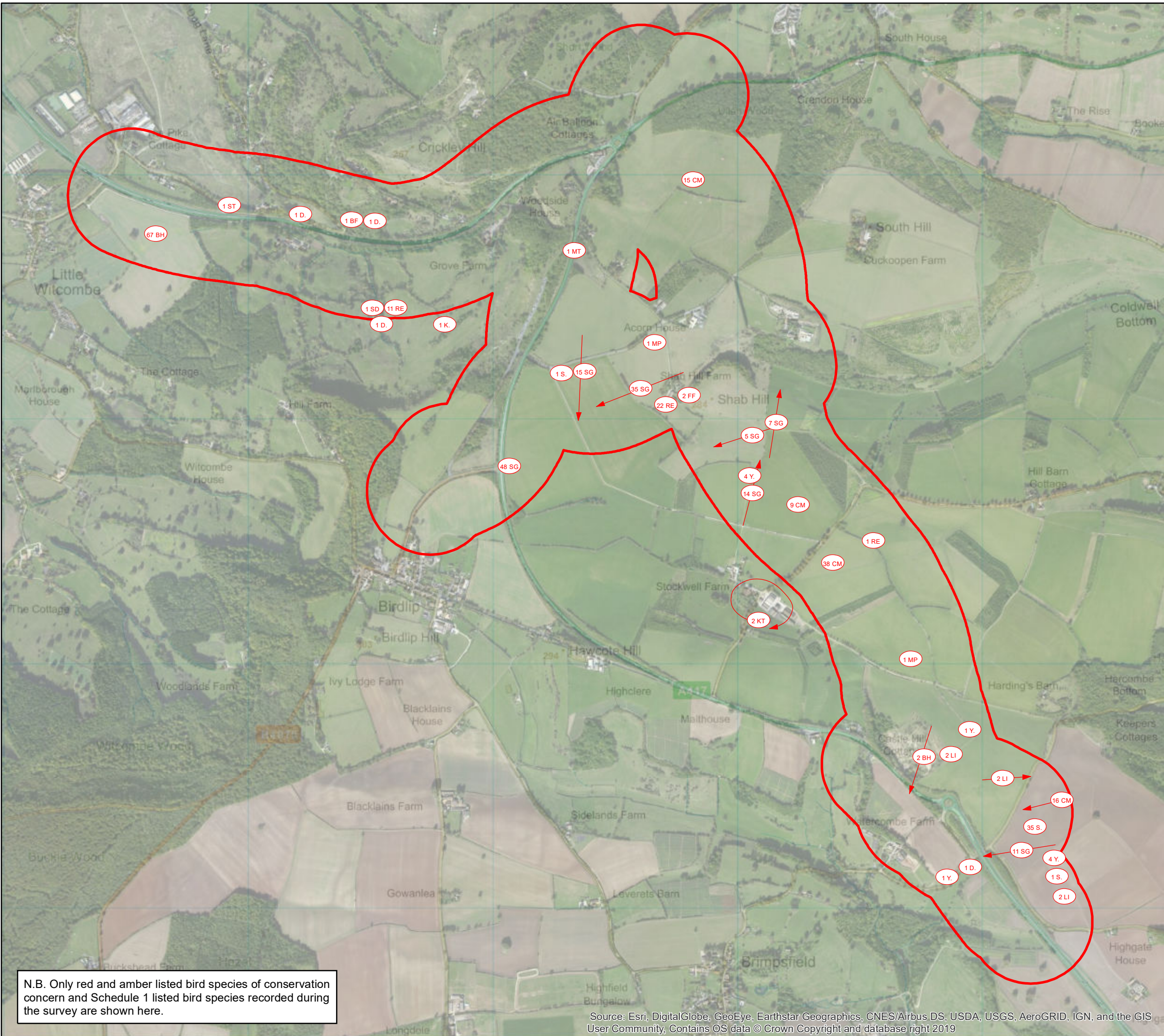
- Site Boundary
- Direction of flight (where bird species seen in flight)
- BH Black-headed Gull
- BF Bullfinch
- CM Common Gull
- D Dunnock
- FF Fieldfare
- K Kestrel
- LI Linnet
- MT Marsh Tit
- MP Meadow Pipit
- KT Red Kite
- RE Redwing
- S Skylark
- ST Song Thrush
- SG Starling
- SD Stock Dove
- Y Yellowhammer
- #BH Number of birds and species recorded

Scale at A3: 1:15,000



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N.B. Only red and amber listed bird species of conservation concern and Schedule 1 listed bird species recorded during the survey are shown here.

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Map 3 November 2018 Survey Results

**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

WINTERING BIRD SURVEY

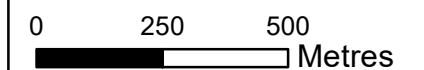
Map 3 - November 2018 Survey Results

Client:	Mott MacDonald Sweco Joint Venture
Date:	November 2019
Status:	Final

KEY

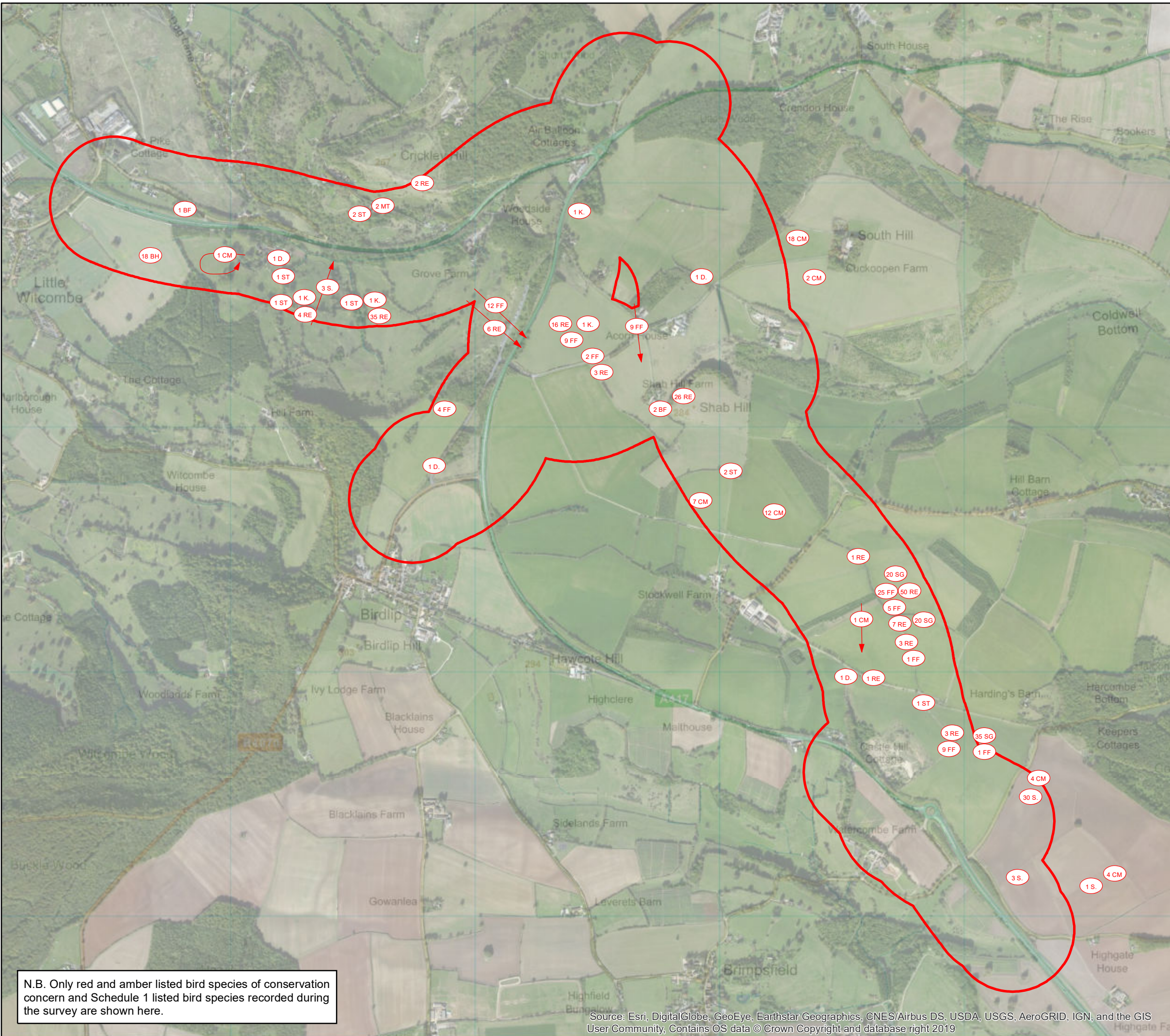
- Site Boundary
- Direction of flight (where bird species seen in flight)
- BH Black-headed Gull
- BF Bullfinch
- CM Common Gull
- D Dunnock
- FF Fieldfare
- K Kestrel
- MT Marsh Tit
- RE Redwing
- S Skylark
- ST Song Thrush
- SG Starling
- #BH Number of birds and species recorded

Scale at A3: 1:15,000



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N.B. Only red and amber listed bird species of conservation concern and Schedule 1 listed bird species recorded during the survey are shown here.



Map 4 December 2018 Survey Results

**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

WINTERING BIRD SURVEY

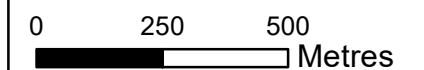
Map 4 - December 2018 Survey Results

Client:	Mott MacDonald Sweco Joint Venture
Date:	November 2019
Status:	Final

KEY

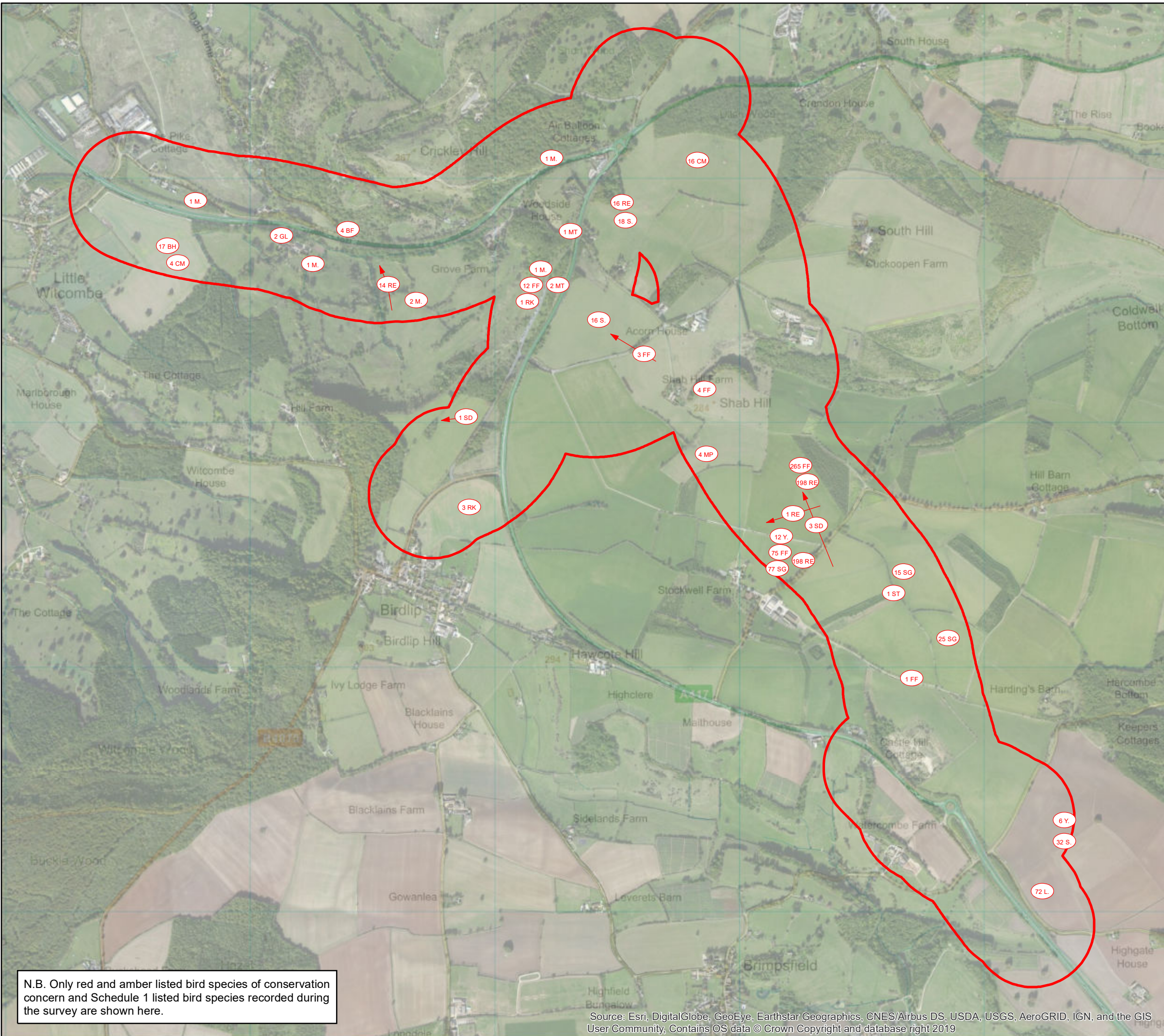
- Site Boundary
- Direction of flight (where bird species seen in flight)
- BH Black-headed Gull
- BF Bullfinch
- CM Common Gull
- FF Fieldfare
- GL Grey Wagtail
- L Lapwing
- MT Marsh Tit
- MP Meadow Pipit
- M Mistle Thrush
- RK Redshank
- RE Redwing
- S Skylark
- ST Song Thrush
- SG Starling
- SD Stock Dove
- Y Yellowhammer
- #BH Number of birds and species recorded

Scale at A3: 1:15,000



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Map 5 January 2019 Survey Results

**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

WINTERING BIRD SURVEY

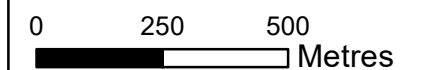
Map 5 - January 2019 Survey Results

Client:	Mott MacDonald Sweco Joint Venture
Date:	November 2019
Status:	Final

KEY

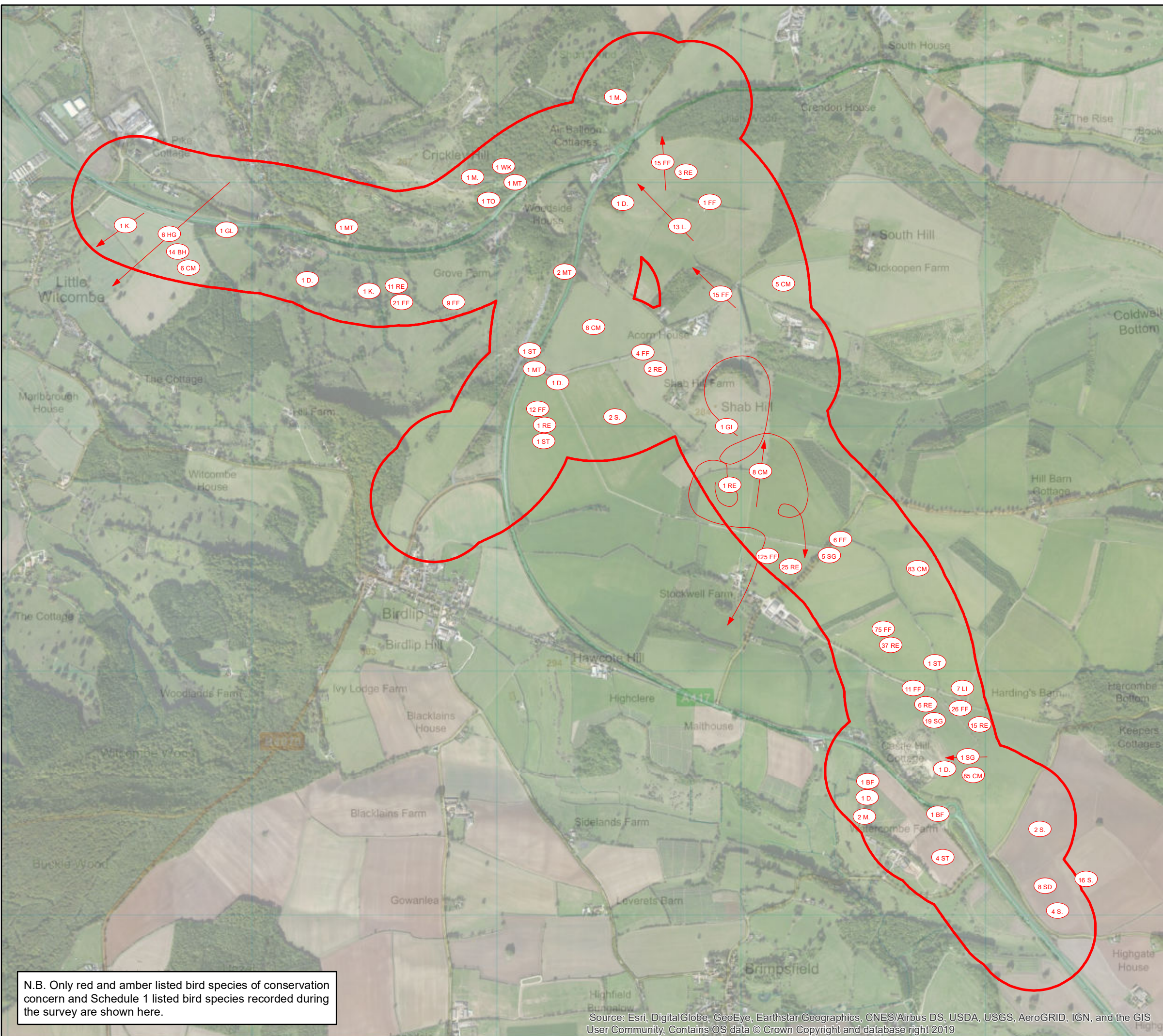
- Site Boundary
- Direction of flight (where bird species seen in flight)
- BH Black-headed Gull
- BF Bullfinch
- CM Common Gull
- D Dunnock
- FF Fieldfare
- GI Goshawk
- GL Grey Wagtail
- HG Herring Gull
- K Kestrel
- L Lapwing
- LI Linnet
- MT Marsh Tit
- M Mistle Thrush
- RE Redwing
- S Skylark
- ST Song Thrush
- SG Starling
- SD Stock Dove
- TO Tawny Owl
- WK Woodcock
- #BH Number of birds and species recorded

Scale at A3: 1:15,000



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Map 6 February 2019 Survey Results

**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

WINTERING BIRD SURVEY

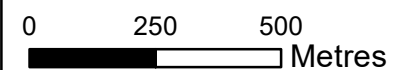
Map 6 - February 2019 Survey Results

Client:	Mott MacDonald Sweco Joint Venture
Date:	Novmeber 2019
Status:	Final

KEY

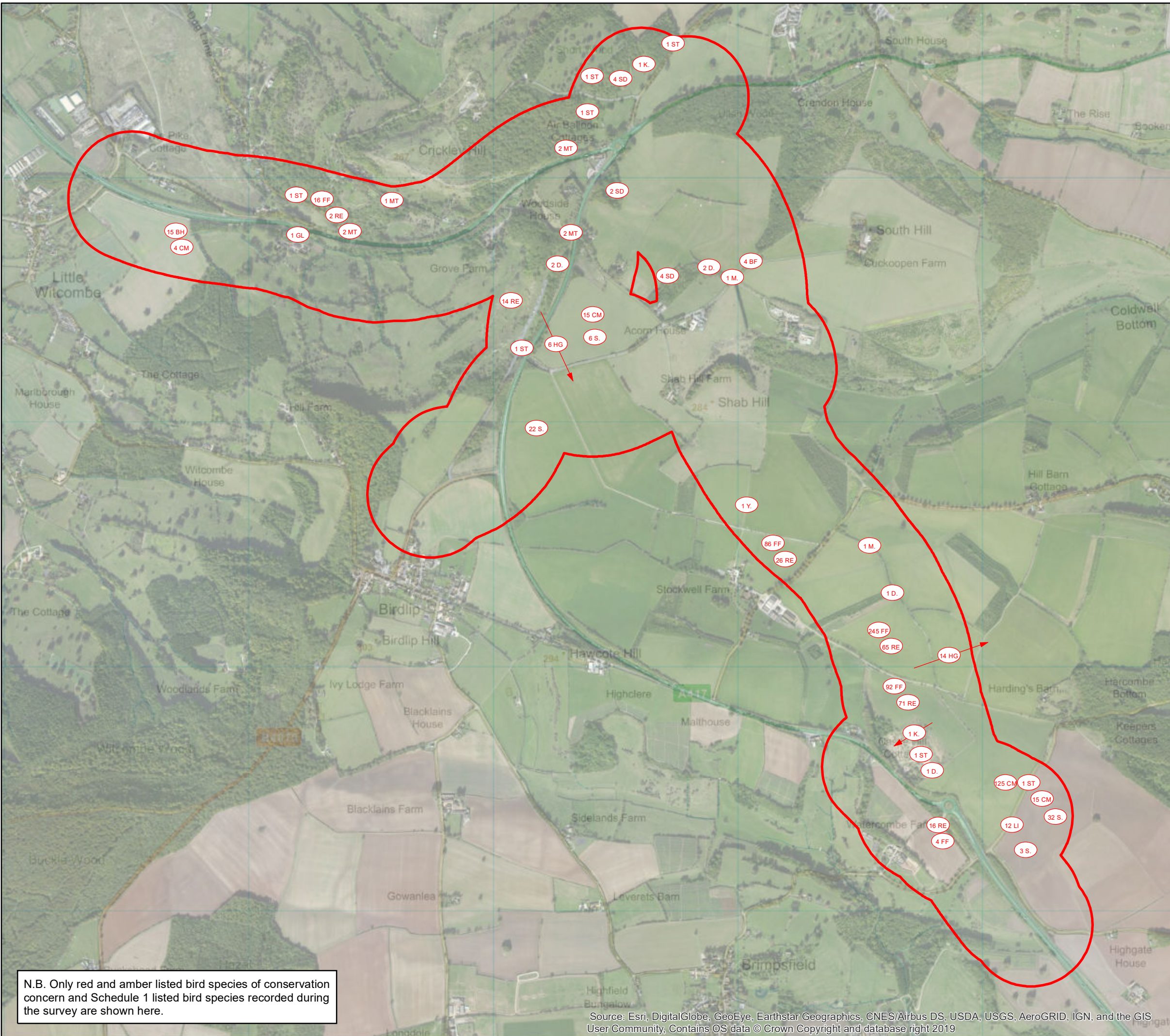
- Site Boundary
- Direction of flight (where bird species seen in flight)
- BH Black-headed Gull
- BF Bullfinch
- CM Common Gull
- D Dunnock
- FF Fieldfare
- GL Grey Wagtail
- HG Herring Gull
- K Kestrel
- LI Linnet
- MT Marsh Tit
- M Mistle Thrush
- RE Redwing
- S Skylark
- ST Song Thrush
- SD Stock Dove
- Y Yellowhammer
- # BH Number of birds and species recorded

Scale at A3: 1:15,000



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A417 Missing Link Preliminary Environmental Information Report

Appendix 8.14
Dormouse Survey Report

28 September 2020

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Executive Summary

The proposed A417 Missing Link scheme aims to provide a dual carriageway to a current stretch of single carriageway between the Cowley roundabout and Crickley Hill. The scheme would increase capacity by creating a free-flowing link between the Brockworth Bypass and Cowley roundabout, resulting in a continuous flow between the M4 Junction 15 (Swindon) and the M5 Junction 11a (Gloucester/Cheltenham).

Suitable hazel dormouse habitat was identified whilst undertaking an extended Phase 1 habitat survey in 2017. A further habitat suitability assessment was undertaken in April/May 2018 which identified 13 areas of potential dormouse habitat within 250 metres of the two scheme options under consideration at the time. These 13 sites were assigned as survey areas 1, 2, 2A, 3, 4, 5, 6, 7, 8, 9, 9a, 10, 10a and 11 and dormouse nest tube surveys set up in each of these areas.

Hazel dormouse surveys were carried out between May 2018 and September 2019. Set up dates were dependent on access agreements being in place and therefore varied across the different sites. The survey on half of site 1 was halted due to health and safety reasons due to the growth of vegetation too close to the A417 carriageway; however, as the site comprised 100 tubes the remaining half of the site still provides a valid survey in connected habitat. Following the preferred route announcement (PRA) in March 2019, the survey effort at sites 7 and 8 were also stopped as they are no longer within 250 metres of the scheme with no potential for impacts to this habitat.

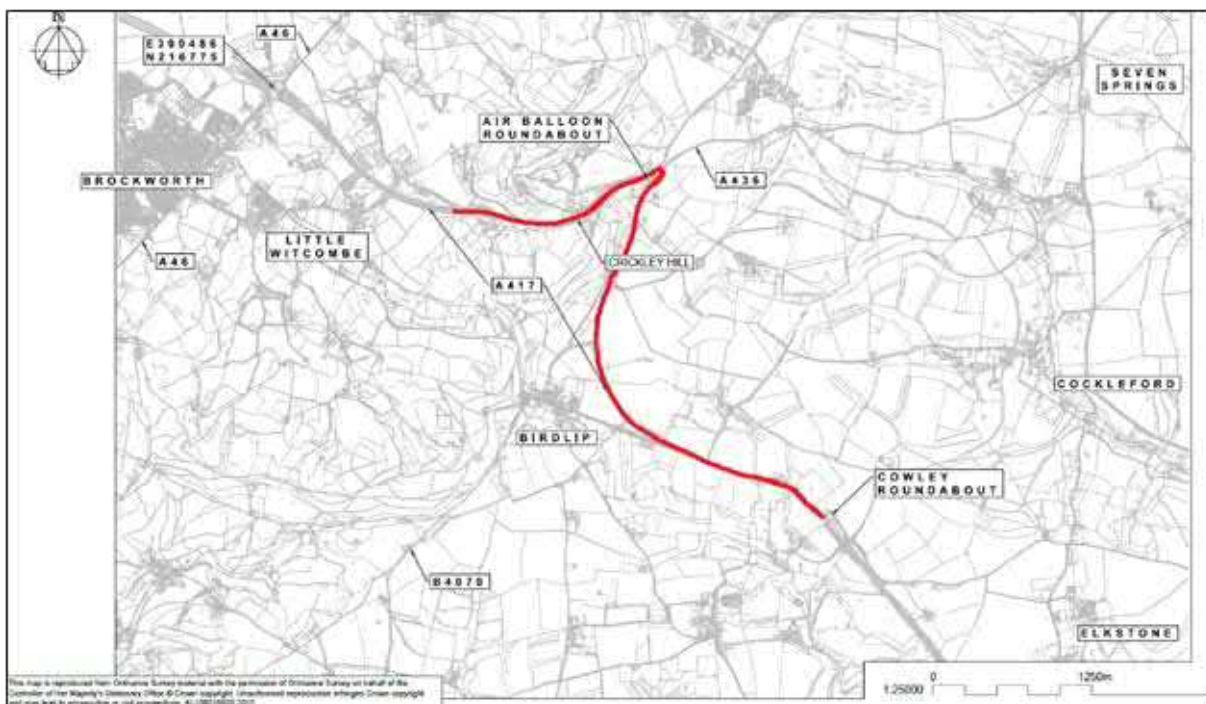
All surveyed sites within 250 metres of Option 30 scored sufficient points to conclude likely absence of dormouse. One site was not accessible for surveys, Emma's Grove woodland and it is therefore not possible to conclude likely absence for this site. However, a lack of evidence from surveys in adjacent habitats would indicate a low likelihood of Emma's Grove supporting a dormouse population as the woodland itself is too small in extent to support a viable population.

1. Introduction

1.1. Background

- 1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and is an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'missing link', forms the only section of single carriageway along the route, with an at-grade junction located at the 'Air Balloon' public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5kilometres stretch shown on Figure 1.1 below. The proposals are known as the A417 Missing Link scheme, hereafter referred to as 'the scheme'.

Figure 1.1 Current A417 route and scheme extent



1.2. Purpose of the report

- 1.2.1. This Stage 3 Hazel Dormouse Technical Report has been prepared during Stage 3 of Highways England's Project Control Framework (PCF). This Technical Report provides an overview of the dormouse survey results for the 2018 and 2019 survey period. The report provides the methods, constraints and results of the dormouse surveys undertaken for the scheme.

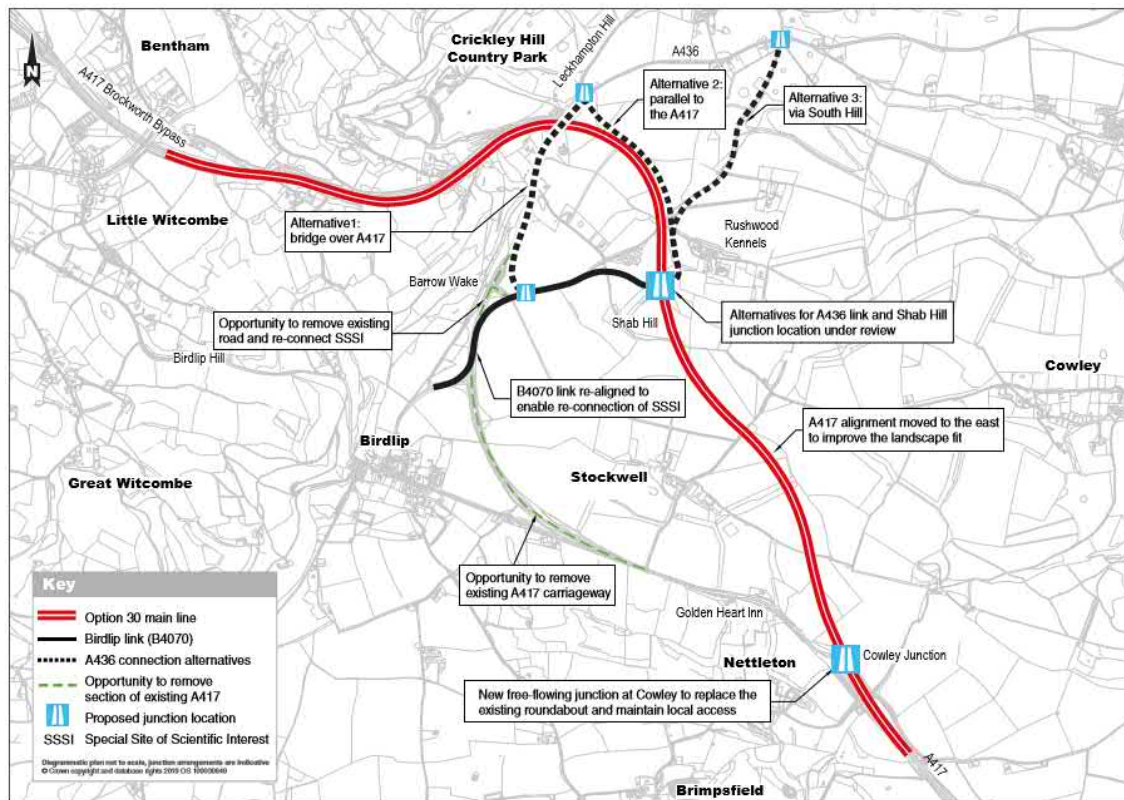
1.3. Overview of the Scheme

- 1.3.1. The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill.
- 1.3.2. The proposed scheme would aim to increase capacity by creating a free-flowing link between the Brockworth Bypass and the Cowley roundabout and remove the at-grade junction with the A436 (Air Balloon roundabout). This Missing Link will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester / Cheltenham (M5 Junction 11a). The current road and the extent of any proposed scheme is illustrated in Figure 1.1.

Preferred Route Announcement

- 1.3.1. Option 30 is the chosen preferred route option as of March 2019. Option 30 is a 5.5 kilometres long surface route following the route of existing A417 at Crickley Hill, but with less of a slope. A new section of road would be built through Shab Hill to the east of the existing A417, re-joining the existing road near Cowley roundabout, shown in figure 1.2 below. Option 30 would include 2 new slip road junctions:
- a slip road junction at Shab Hill for local and A436 traffic to join or leave the A417 by way of a new link road
 - a slip road junction to replace the existing Cowley roundabout for traffic to Nettleton Bottom, Cowley, Elkstone and other local destinations
- 1.3.2. A new link road would be built between the slip road junction at Shab Hill and the existing A417 to connect traffic to and from Birdlip and the A436 with the new A417. This new link road would end in a new roundabout near Barrow Wake.
- 1.3.3. If Option 30 was constructed a section of the existing A417 could be closed to traffic and be demolished. Refer to figure 1.2 below.

Figure 1.2 A417 Missing link proposed option 30



1.4. Scope of the Report

1.4.1. The objectives of this report are:

- to present the methodology, constraints and results of the presence/absence and population estimate surveys for hazel dormouse
- to present the relative abundance of hazel dormouse populations, if any

1.4.2. Guidance on ecological assessment recommends that all ecological features that occur within a zone of influence (Zoi) for a proposed scheme are investigated (CIEEM, 2016)¹. All areas within 250 metres of the proposed scheme footprint were assessed for hazel dormouse habitat suitability.

1.5. Legislation

Legal Protection

1.5.1. The hazel dormouse is fully protected by the *Conservation of Habitats and Species Regulations 2017*, which transposes the Council Directive 92/43/ECC (known as the Habitats Directive) on the conservation of natural habitats and of

¹ Chartered Institute of Ecology and Environmental Management (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal

wild fauna and flora into UK law. Dormice are also protected under the *Wildlife and Countryside Act 1981* (as amended).

- 1.5.2. Under Regulation 43 of the Conservation of Habitats and Species Regulations it is illegal to:
- intentionally or deliberately injure, kill or take any wild dormouse
 - intentionally or deliberately damage, destroy or obstruct any access to any structure or place used for shelter, breeding, or protection by a dormouse
 - or to intentionally or recklessly disturb a dormouse whilst it is using such a structure or place
 - possess or advertise / sell / exchange a dormouse (dead or alive) or any part of a dormouse
- 1.5.3. Under Schedule 5 of the Wildlife and Countryside Act 1981 it is illegal to:
- Intentionally or deliberately kill, injure or take any wild hazel dormice
 - intentionally or deliberately damage, destroy or obstruct any access to any structure or place used for shelter, breeding, or protection by a dormouse
 - or to intentionally or recklessly disturb a dormouse whilst it is using such a structure or place
 - possess or advertise / sell / exchange a dormouse (dead or alive) or any part of a dormouse
- 1.5.4. The hazel dormouse is a European Protected Species under Annex IV of the Habitats Directive and under the Bern Convention 2 III and is on the IUCN Red List.
- 1.5.5. The *UK Biodiversity Action Plan* (UKBAP) 1994 – 2010 has been superseded by the *UK Post-2010 Biodiversity Framework* covering the period 2011 - 2020. UKBAP priority habitats and species were used to form the basis for the statutory list of habitats and species of 'principal importance for the conservation of biodiversity in England' under Section 41 of the *Natural Environment and Rural Communities (NERC) Act 2006*.
- 1.5.6. Section 40 of the NERC Act 2006 requires public bodies, including local authorities, 'to have regard to the conservation of biodiversity in England' when carrying out their normal functions. The local planning authority therefore must consider the impact on biodiversity of the proposed development. The NERC Act identifies species of 'principal importance for the conservation of biodiversity in England' (Section 41) to guide public bodies in implementing their duty. This priority list includes dormice. The strategic direction for biodiversity policy for the next decade is set out in the national strategy for *England Biodiversity 2020*.

1.6. Status of hazel dormouse at a national level

- 1.6.1. Hazel dormice are native to the UK but are nationally rare and vulnerable to extinction, largely due to habitat loss. They are a species of principal importance for the conservation of biodiversity in England under the NERC Act (2006). Although the exact size of the UK population is unknown, there has been a long-term decline in both number of individuals and the geographical range.
- 1.6.2. Their distribution is predominantly confined to southern England and southern Wales and is fragmented throughout. Dormouse monitoring programmes have recently provided an indication that the decline is slowing and as part of an ongoing hazel dormouse reintroduction programme, the current range is slowly being extended².

1.7. Status of hazel dormouse at a county level

- 1.7.1. Gloucestershire Council describe the status of hazel dormice within the county as rare. However, there are large areas of suitable habitat which 'may house populations currently unknown to us'³.
- 1.7.2. Dormice are rarely recorded in South Gloucestershire. To date no specific, comprehensive survey of the area has been carried out, so it's not known whether dormice are very localised or if they are just under recorded.

1.8. Hazel dormouse ecology

- 1.8.1. Dormice are highly arboreal preferring to move between understory, hedgerows, woodlands and scrub during the active season (April to November).
- 1.8.2. They are reluctant to cross open ground and are believed to rarely descend to ground level except for when hibernating over the winter.
- 1.8.3. They have complex structural habitat requirements including connective habitat to forage and for dispersal, presence of a range of different tree and scrub species that will provide suitable food year-round, and nesting habitat for shelter, breeding and hibernation⁴. They are primarily associated with deciduous

² People's trust for endangered species (2018) *Hazel (or Common) dormouse* [online] available at: <https://ptes.org/get-informed/facts-figures/hazel-common-dormouse-muscardinus-avellanarius/> (last accessed November 2018).

³ Gloucestershire County Council (Unknown) *The South Gloucestershire Biodiversity Action Plan, Species Action Plans*. [online] available at: <https://www.southglos.gov.uk/documents/pte080091.pdf> (last accessed November 2018)

⁴ Highways England (2001) *Design Manual for Roads and Bridges, Volume 10, Section 4, Part 5 HA 97/01 Nature Conservation Advice in Relation to Dormice* [online] available at: <http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol10/section4.htm> (last accessed April 2018).

woodland (containing oak, hazel, honeysuckle and bramble) and species-rich hedgerows⁵, although they have been found in a range of other habitats such as coniferous woodland, scrub and heathland.

- 1.8.4. Research has shown that dormice tend to prefer well established hedges over 3.5 metres in height ⁶.

⁵ Bright, P. W., Morris, P. A., and Mitchell-Jones, A., (2006) *Dormouse Conservation Handbook*. English Nature.

⁶ Gloucestershire County Council (Unknown) *The South Gloucestershire Biodiversity Action Plan, Species Action Plans*. [online] available at: <https://www.southglos.gov.uk/documents/pte080091.pdf> (last accessed November 2018)

2. Methodology

2.1. Desk Study

- 2.1.1. A detailed biological records search was requested from Gloucestershire Centre for Environmental Records Centre (GCERC) in 2017, within a 2 kilometre radius of the scheme. All records for protected species, priority habitats and designated sites were returned. The results for dormice showed there were no records of dormice within 2 kilometres of the scheme.
- 2.1.2. All potentially suitable habitats with potential to be impacted by the two scheme options under consideration at the time (Option 12 and Option 30), were identified using the Defra Multi Agency Geographic Information for the Countryside (MAGIC) online viewer tool (Defra, 2017), the use of 1:10,000 Ordnance Survey Mapping and aerial photography. These were recorded and given a unique identifier (Appendix A).
- 2.1.3. At the time of the desk study and subsequent surveys, there were two options under consideration; therefore all potentially suitable habitat within 250 metres of the two options (as of May 2018) were subject to further survey, until the preferred route announcement (PRA) of option 30 in Spring 2019.

2.2. Habitat Assessment

- 2.2.1. An extended Phase 1 habitat survey was undertaken in May 2017 and suitable habitat for dormice was identified within 250 metres of the proposed scheme. The habitats identified during the desk study were subject to a 'ground-truthing' exercise, capturing additional habitats and scoping out areas that were not, or were no longer, suitable for dormice.
- 2.2.2. Hedgerows, woodland and scrub within 250 metres of the scheme, were assessed further for its suitability to support dormice using the following criteria:
- age range of trees and shrubs
 - level of diversity of trees and shrubs
 - level of suitability of trees and shrubs
 - availability of key food sources
 - connectivity to wider landscape via suitable habitats
 - signs of dormice present for example, open nuts, nests

2.3. Field Survey

- 2.3.1. The dormouse survey methodology followed the *Dormouse Conservation Handbook* ⁴. The guidelines recommend that a minimum of 50 nest tubes are

deployed in suitable and connected habitat in order to determine the presence or likely absence of dormice. The nest tubes should be checked monthly during the active season (April to November inclusive).

2.3.2. The *Dormouse Conservation Handbook* suggests an index of probability of finding dormice for each month outside of the dormouse hibernation season (Table 2.1). This is used as a basis to calculate the necessary survey effort to make a robust conclusion of presence or likely absence. The table below assumes that 50 tubes have been placed in suitable habitat.

2.3.3. It is recommended that absence should not be assumed on a score of less than 20. It is not possible to wholly prove the absence of dormice from areas of suitable habitat; however, an adequate survey will give confidence that significant populations have not been overlooked.

Table 1 Index of probability of finding hazel dormice present in nest tubes in any one month.

Month	Index of probability
April	1
May	4
June	2
July	2
August	5
September	7
October	2
November	2

2.3.4. Two route options were originally scoped for suitable dormouse habitat. The habitat identified as being suitable for dormice within 250 metres of the scheme consisted of woodland and hedgerows. Within these distinct areas of suitable habitat (Appendix A) thirteen survey sites were identified within 250 metres of the scheme (Appendix B). Due to the extent of some of the connected suitable habitat more than one survey site was established within certain connected areas, with multiple survey sites set up to ensure robust results.

2.3.5. Dormouse nest tubes were set up across the 13 survey sites from the end of May 2018 through until August 2018. Set up dates varied as land access was not granted to all areas at the start of the survey season. A minimum of 50 tubes were deployed at each site.

2.3.6. In order to achieve a points score of 20, the tubes were checked for evidence of dormice once in each month between May 2018 to September 2019 until a minimum of 20 points had been achieved. All surveys were carried out in suitable weather conditions (dry and no strong winds) and by competent ecologists, with surveys led by a Natural England class licence holder and all potential nests checked and verified by a Natural England class survey licence

holder. The dates and weather conditions for each survey undertaken are detailed in Appendix C.

2.4. Site Status Assessment

2.4.1. Following the completion of the surveys, an assessment of the status of the project site as a whole was then made. The importance of the site takes into account the population estimate but also several other factors:

- The quality and rarity of the habitat and population,
- How connected the population is to the wider area,
- The local significance of the population and
- The estimated size of the population.

2.5. Survey constraints

2.5.1. Access was granted to the majority of identified dormouse survey areas, with one main exception, Emma's Grove woodland. This area of broadleaved woodland was observed from adjacent areas to support mature hazel coppice along with a good diversity of tree and shrub species, and appears to provide high quality dormouse habitat. This area of woodland is partially connected to Ullen Wood and survey site 4, with a stock fence which is partially vegetated with bramble scrub and rough grassland providing some linear connectivity, although full arboreal connectivity is not possible. There is potential that a population associated with this woodland may have been missed by the surveys. However, the woodland itself is too small to support a viable dormouse population alone, and any population would have to be associated with connected hedgerows and woodland.

2.5.2. Although access was granted for all other survey sites with suitable dormouse habitat, access to some was not granted until later in the 2018 survey window. For this reason, surveys continued into 2019 to gain sufficient points. Surveys continued until September 2019 to ensure the sites reached a survey effort score of at least 20 (see section 2.3). Table 2 summarises the set-up dates for all survey sites as well as the survey effort scores for each month.

2.5.3. The suitability of some dormouse sites changed during the surveying period for various reasons. Some sites were managed e.g. hedgerows cut either by farmers of the local highways management authority. Other sites were vulnerable to public interference with some tubes interfered with.

2.5.4. Where sites were made unsuitable surveys were stopped and tubes removed. To compensate for public interference an extra 10 tubes were put up in sites that

were publicly accessible and where possible survey tubes were placed well away from footpaths and other regularly accessed areas.

- 2.5.5. A small number of nest tubes were destroyed by livestock and/or by hedge trimming. However, these were replaced as soon as they were discovered and so is not considered to have impacted on the survey results.
- 2.5.6. Surveys at half of site 1 were stopped due to health and safety concerns over the proximity to the A417. This site was originally comprised of 100 tubes and therefore surveying the remaining 50 safely still enabled a valid survey to be undertaken within connected habitat.
- 2.5.7. Following the PRA of Option 30 in March 2019, surveys on sites 7 and 8 were halted. As these sites are no longer within 250 metres of the scheme no further survey effort was required. However, the data recorded at these sites up to March 2019 is presented in Appendix C for completeness and to give additional context for the status of dormice within the wider area.

Table 2 Site names, set up dates and survey effort score

Dormouse Site	Site set up date	Survey Effort Score
1	12 May 2018	20
2	1 May 2018	20
2A	24 July 2018	20
3	12 June 2018	23
4	12 June 2018	22
5	21 June 2018	23
6 & 6A	4 June 2018	22
7	4 June 2018	10.5
8	6 June 2018	2
9	30 May 2018	27
9A	25 July 2018	24
10	4 July 2018	20
11	21 August 2018	23

3. Results

3.1. Desk Study results

3.1.1. The data search results from GCERC revealed no records of dormice within a 2 kilometre radius of the scheme. However, there are large areas of suitable habitat and to date no specific, comprehensive survey of the area has been carried out. Therefore, it is possible that dormice are very localised or under recorded in Gloucestershire. The nearest record to the site, as identified on the National Dormouse Database (Peoples Trust for Endangered Species) is approximately 2.6 kilometres north of the scheme with a record dating from 2017.

3.2. Habitat Assessment

3.2.1. All habitat within 250 metres of the scheme was assessed for its suitability to support dormice. Ten distinct habitat areas were determined as having suitable dormouse habitat; these were broken up into 13 survey sites for the nest tube surveys.

3.2.2. Surveys were undertaken at all survey sites in 2018; however, after PRA in March 2019, surveys at sites 7 and 8 were discontinued and not carried on into the 2019 survey season. These two sites are still described in further detail below for completeness.

Description of Habitats

3.2.3. The 13 survey sites are described in more detail in the sections below. Appendix B shows the locations of the dormouse tubes within the 13 survey sites.

Site 1

3.2.4. Site 1 (Fly up) consists mainly of mature native hedgerows and young trees with connecting woodland edges, all bordering recreational fields. Half of the site is within a recreational facility and the other half connects to the A417 verge. Due to access issues the second half of site 1 was not set up until June 2018. The hedgerows have good connectivity to the surrounding landscape and other areas of suitable dormice habitat. This site is made up of 1.43 hectares of woodland and 1.9 kilometres of linear hedgerow habitat. The woodland canopy consists of hawthorn *Crataegus monogyna*, ash *Fraxinus excelsior*, willow *Salix sp.*, elder *Sambucus nigra* and hazel *Corylus avellana*. Hedgerow species present include hawthorn, blackthorn *Prunus spinosa* bramble *Rubus fruticosus*, dogwood *Cornus sanguinea* and field maple *Acer campestre*.

3.2.5. Figure 3.1 below demonstrates the type of habitat present at site 1.

Figure 3.1 Site 1 habitat examples



Site 2

3.2.6. Site 2 (Dog Lane) consists of a small broadleaved woodland covering 2.12 hectares and 350 metres of hedgerow running along a quiet lane. It is made up of frequent hawthorn, hazel and dogwood together with occasional bramble and ivy *Hedera helix*.

3.2.7. Figure 3.2 below demonstrates an example of the habitat present at site 2.

Figure 3.2 Site 2 habitat example



Site 2A

3.2.8. Site 2A (Crickley Hill) is part of Crickley Hill and Barrow Wake SSSI. It is a mature broadleaved woodland with a sparse understorey in parts, however large areas display strong understorey connectivity. The site is set on a steep hillside covering an area of 13.3 hectares with linear hedgerows to providing connectivity to surrounding areas. There is an abundant availability of food sources within the site and connect surrounding habitat. Woodland species

present include pedunculate oak *Quercus robur*, ash, field maple, hawthorn and mature coppiced hazel.

3.2.9. Figure 3.3 below demonstrates an example of the habitat present at site 2A.

Figure 3.3 Site 2A habitat example



Site 3

3.2.10. Site 3 is connected to Crickley Hill and Barrow Wake SSSI and site 5. It is a mature broadleaved woodland set on the side of a hill close to Crickley Hill and Barrow Wake SSSI covering approximately 4.8 hectares. Strong connectivity to the surrounding landscape through connected hedgerows and sections of woodland. Woodland species present include field maple, hawthorn, blackthorn and mature coppiced hazel.

3.2.11. Figure 3.4 below demonstrates an example of the habitat present at site 3.

Figure 3.4 Site 3 habitat example



Site 4

3.2.12. Site 4 (Ullen Wood) is a mature ancient semi-natural broadleaved woodland covering an area of 23.5 hectares with 350 metres of hedgerow linking site 3 to site 11 (Shab Hill) as well as surrounding coppiced hazel and oak woodland.

Woodland species present include ash, field maple, hawthorn, hazel and blackthorn.

3.2.13. Figure 3.5 below demonstrates an example of the habitat present at site 4.

Figure 3.5 Site 4 habitat example



Site 5

3.2.14. Site 5 (Barrow Wake) is in 2.3 hectares of continuous, dense scrub with frequent mature trees bordering the existing A417, within the Crickley Hill and Barrow Wake SSSI. The site starts in Barrow wake carpark along the Highways boundary and moves north towards a woodland section linked with site 3. This site is connected to a wider area of suitable dormouse habitat, via hedgerows to the west and woodland to the south. Species include frequent blackthorn, hawthorn, hazel, oak, elm *Ulmus* sp., crab apple *Malus sylvestris* and dog wood.

3.2.15. Figure 3.6 below demonstrates an example of the habitat present at site 5.

Figure 3.6 Site 5 habitat example



Site 6

3.2.16. Site 6 is located in a 3-hectare section of broadleaved and coniferous woodland. The site is predominately a coniferous plantation surrounded by a broadleaved-woodland edge. The woodland is surrounded by arable fields and grazed farmland. Dense continuous hedgerows connect the site to a large number of surrounding woodland areas including 57.2 hectares of Cally Hill Plantation and Ullen Wood to the North. Site 6 has hedgerow connections to site 4 and 11. There are 16 extra tubes located to the east of the main site in half a hectare of broadleaved woodland separated by a narrow farm track from site 6. This was a supplementary site to site 6. Due to the small size of habitat present and distance from the scheme (with no likely impacts), this additional area was not set-up as a distinct site, but additional tubes were placed to sample this habitat.

3.2.17. Figure 3.7 below demonstrates an example of the habitat present at site 6.

Figure 3.7 Site 6 habitat example



Site 7

3.2.18. Site 7 consists of native hedgerows around the edge of a field put to pasture and includes the edge of a broadleaved woodland. The hedgerows also border the A417. The site comprises 1500 metres of hedgerow and 4 hectares of broadleaved woodland. The hedgerows are largely comprised of hawthorn interspersed with field maple, dogwood and blackthorn with occasional ash, holly, elder, hazel and beech. The woodland section is dominated by ash, alder *Alnus glutinosa*, beech and hawthorn.

3.2.19. Figure 3.8 below demonstrates an example of the habitat present on at site 7.

Figure 3.8 Site 7 example habitat



Site 8

3.2.20. Site 8 is located within mature native hedgerows surrounding agricultural fields. To the north of the site is the A417 and connected to the south is small sections of broadleaved woodland. The site consists of 2300 metres of hedgerow and 6.9 hectares broadleaved woodland. The species composition comprises hazel, hawthorn, field maple, blackthorn, elm, elder, hornbeam, ash, wayfaring tree *Viburnum lantana* and dogwood. The hedgerows present are well managed; however, the woodland section does not appear to be subject to regular management.

3.2.21. Figure 3.9 below shows an example of habitat present at site 8.

Figure 3.9 Site 8 example habitat



Site 9

3.2.22. Site 9 is located within the soft estate of the A417, to the west of the southern end of the scheme. It is comprised of 1.06 hectares of semi natural broadleaved woodland and a 323 metres of native species rich hedgerow. The hedgerows run between the A417 carriageway and grazed farmland. The highways verge

woodland and hedgerows are well managed and allow a diverse range of flora species including; hawthorn and hazel, interspersed with beech, ash, field maple and sycamore *Acer pseudoplatanus*, with very occasional holly *Ilex aquifolium* and pedunculate oak.

3.2.23. Figure 3.10 below demonstrates an example of the habitat present at site 9.

Figure 3.10 Site 9 example habitat



Site 9A

3.2.24. Site 9A comprises 1.2 kilometres of species poor hedgerow and 1.1 hectares of broadleaved woodland. The northern section of this site has a wide section of hedgerow which is dominated by mature coppiced hazel. The hedgerows surround arable and pasture fields and are connected to site 9. The hedgerows and woodland consist of hawthorn, hazel and blackthorn, interspersed with beech, ash, field maple, pedunculate oak and dogwood.

3.2.25. Figure 3.11 below demonstrates an example of the habitat present at site 9A.

Figure 3.11 Site 9A example habitat



Site 10

- 3.2.26. Site 10 comprises of 1.02 hectares of both semi natural and broadleaved plantation woodland and 183 metres of intact species poor hedgerow. The hedgerow and woodland margin surround pasture fields grazed by livestock. This site is linked to suitable surrounding habitat, including sporadic woodland areas, via hedgerows.
- 3.2.27. Figure 3.12 below demonstrates an example of the habitat present at site 10.

Figure 3.12 Site 10 example habitat



Site 11

- 3.2.28. Site 11 (Shab Hill) consists of 8.56 hectares of semi natural broadleaved woodland and 797 metres of species poor hedgerow. The hedgerows and woodland margin surround poor semi-improved grassland and semi-improved calcareous grassland. Site 12 is linked to site 4 by dense continuous hedgerows. The hedgerows are comprised of hawthorn and blackthorn, interspersed with elder, hazel and field maple. The woodland area includes frequent mature beech with an understorey layer of hawthorn, elder and holly on the fringes of the woodland.
- 3.2.29. Figure 3.13 below demonstrates an example of the habitat present at site 11.

Figure 3.13 Site 11 example habitat



3.3. Nest Tube Surveys

3.3.1. Following the completion of the dormouse surveys in 2018 and 2019 no dormice or evidence of dormouse have been identified. A small number of potential started nests were discovered at sites 1,2,5,6 and 9. These lacked the structure or confirmed dormouse signs such as stripped bark. Some of these nests comprised collections of green leaves, indicating possible use by dormice. Subsequent surveys found these did not develop into dormouse nests, with either no further use of the tube or evidence of wood mouse *Apodemus sylvaticus* identified, including feeding signs, individuals and nests characteristic of this species. Survey summary information for each site is provided in Appendix C, including photographs of potential started nests.

3.3.2. A summary of the survey effort for each site is provided in table 3 below.

Table 3 Nest Tube Survey Summary

Dormouse Site	Number of Tubes	Site set up date	Survey Months	Survey Effort Score
1	100	12 May 2018	July, August, September, October, May	20
2	50	1 May 2018	July, August, September, October, May	20
2A	50	24 July 2018	August, September, May, June, September	20
3	50	12 June 2018	July, September, October, April, May, September	23
4	50	12 June 2018	July, October, April, May, June, August, September	22
5	50	21 June 2018	July, September, October, April, May, September	23
6 & 6A	50 (+16 at 6A)	4 June 2018	July, August, September, October, May	22
7	75	4 June 2018	August, September, October – discontinued as outside of Option 30 buffer	10.5
8	100	6 June 2018	October - discontinued as outside of Option 30 buffer	2

9	50	30 May 2018	July, August, September, October, May, September	27
9A	50	25 July 2018	August, September, October, April, May, August	24
10	50	4 July 2018	July, August, September, October, May	20
11	50	21 August 2018	September, October, April, May, June, July, August	23

3.3.3. A minimum of 20 points was achieved for all sites, with the exception of sites 7 and 8 which were discontinued after the PRA as they fell well outside of the Option 30 survey buffer. Therefore, due to the robust level of survey effort, the results give confidence that significant populations of hazel dormouse have not been overlooked within the surveyed areas or nearby connected habitat. Therefore, the likely absence of hazel dormouse from the works footprint can be assumed. However, consideration should be given to the lack of survey undertaken within the high-quality habitat at Emma’s Grove due to the lack of access here.

3.4. Site Status

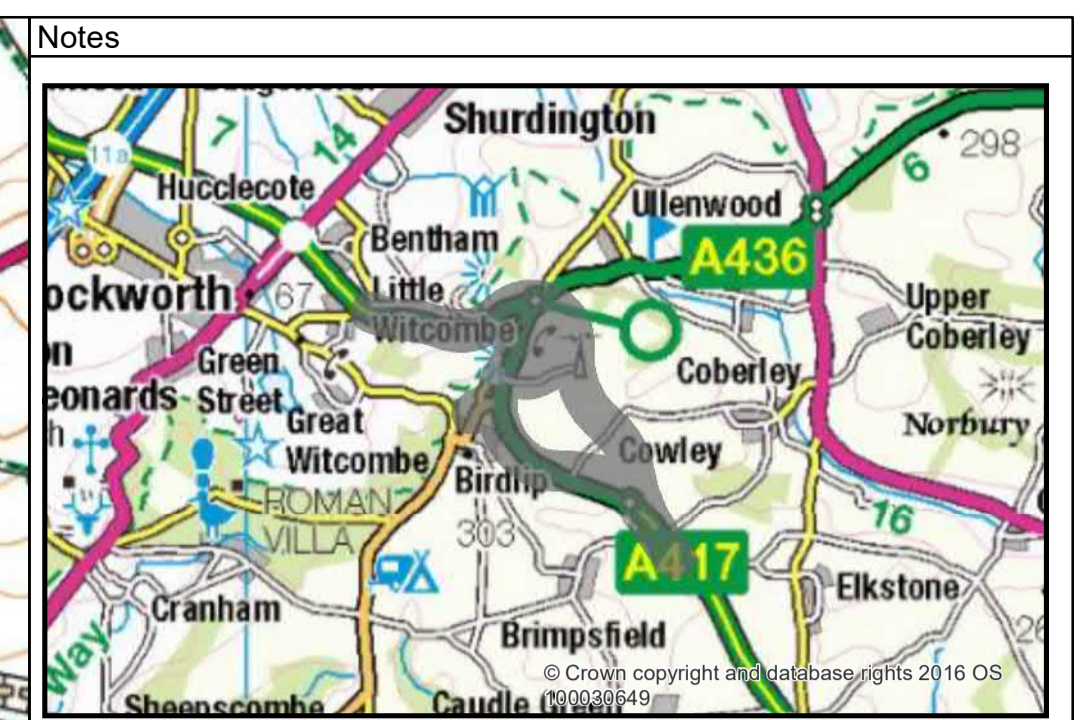
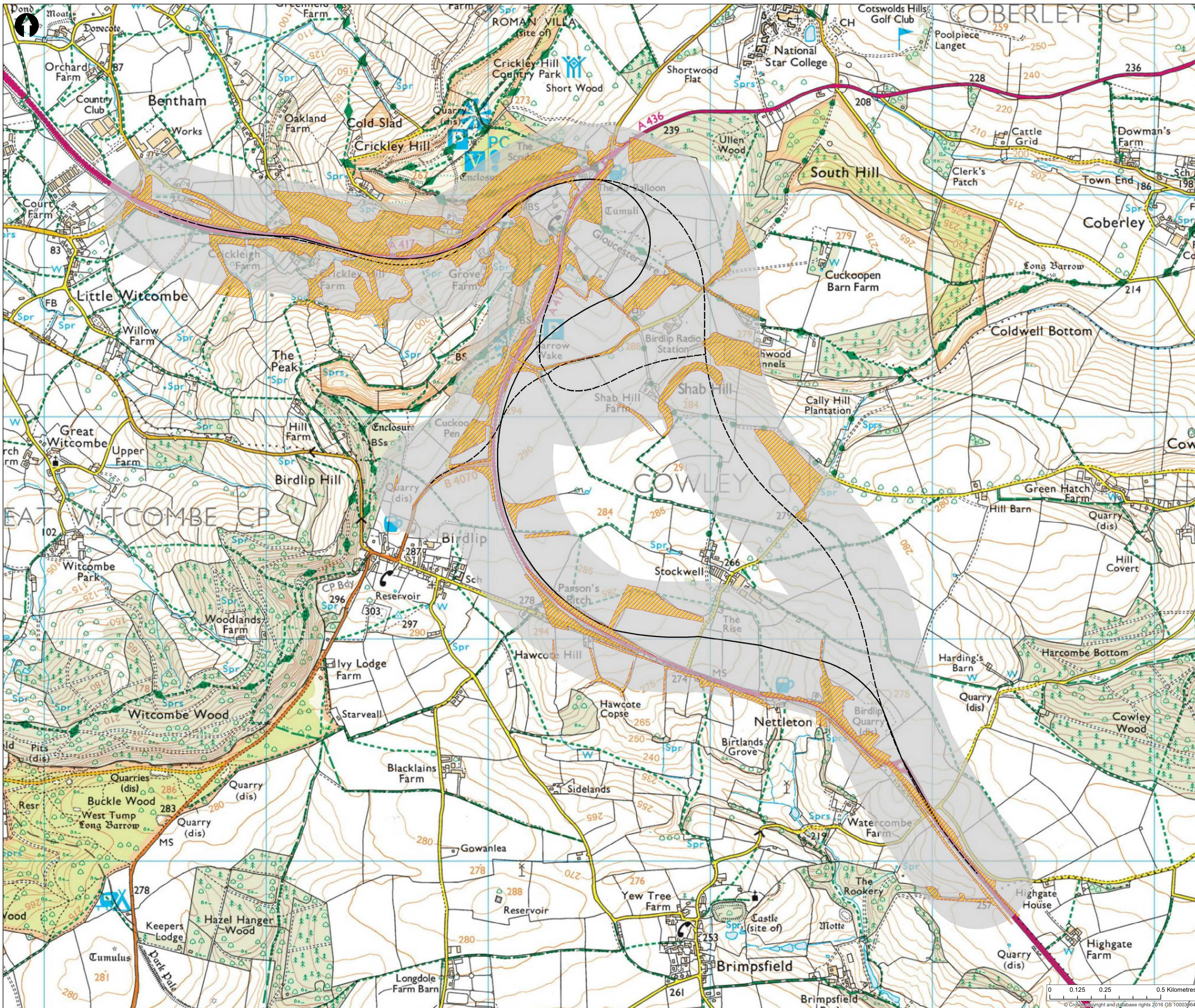
3.4.1. Dormice are not known to be widespread in Gloucestershire. Whilst the nest tube surveys concluded the likely absence of dormice within 250 metres of the scheme, several areas of habitat within the scheme footprint are considered suitable for dormice and one area of woodland, Emma’s Grove, could not be surveyed.

3.4.2. Due to the small size of suitable dormouse habitat within the scheme footprint, the low county wide population count for hazel dormouse and the considerable amount of suitable habitat present within the wider area, the project site is considered to be of low conservation value for dormice.

4. Conclusion

- 4.1.1. The nest tube surveys concluded the likely absence of dormice within 250 metres of the scheme. One area of high-quality habitat was not accessible during the 2018 and 2019 surveys, Emma's Grove. Consideration should be given to the potential for dormice to be present within this area of woodland. However, the lack of evidence within the adjacent surveyed areas would indicate that the likelihood of this woodland supporting a population is low.
- 4.1.2. However, due to the high suitability of habitats for this species within the wider landscape, the availability of connectivity to suitable habitat within the scheme footprint, and the mobile nature of hazel dormouse, it is possible that dormice could colonise these habitats in future years and updating surveys may be required if construction is not commenced by September 2021.

Appendix A – Suitable dormouse habitat within 250 metres of the scheme

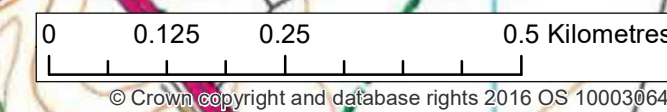


- Notes
- SUITABLE DORMOUSE HABITAT WITHIN BUFFER
 - OPTION 12 CENTRELINE
 - OPTION 30 CENTRELINE
 - OPTIONS 12 AND 30 250 M BUFFER
- (Option centrelines correct at time of survey)

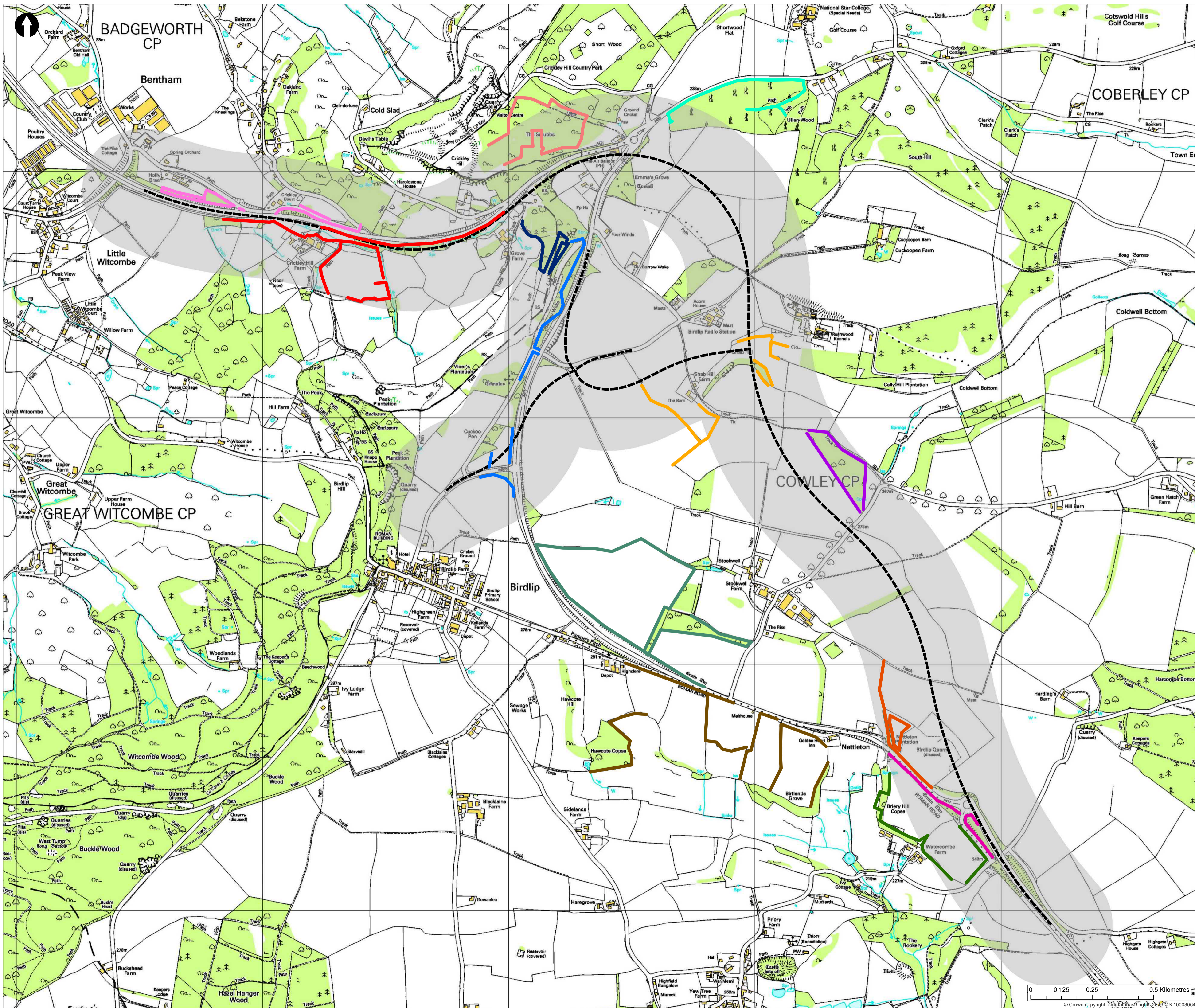
Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	20/11/19	Minor Amendments	NB	SW	SM
P01	03/09/19	FIRST REVISION	NB	SW	SM

Mott MacDonald Sweco					

S02						FOR INFORMATION					
A417 MISSING LINK											
SUITABLE DORMOUSE HABITAT WITHIN 250 METRES OF OPTION 12 AND 30											
Scale	1:8,000	Designed	NB	Drawn	NB	Checked	SW	Approved	SM		
Original Size	A1	Date	03/09/2019	Date	03/09/2019	Date	03/09/2019	Date	03/09/2019		
Drawing Number	HE.P14	Originator	551505 - MMSJV	Volume	- VOL -	Project Ref. No.			551505		
000	- DR -	LB -	00058			Revision			P01		



Appendix B – Dormouse nest tube locations



Notes

SURVEY SITES

- 1
- 2
- 2A
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 9A
- 10
- 11

OPTION 30 CENTRELINE (at time of survey)

OPTION 30 250 METRE BUFFER

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	20/11/19	Minor Amendments	NB	SW	SM
P01	03/09/19	FIRST REVISION	NB	SW	SM

Mott MacDonald Sweco




Client: **FOR INFORMATION**




Project Title: **A417 MISSING LINK**


Drawing Title: **DORMOUSE NEST TUBE SURVEY SITES**

Scale	1:7,214	Designed	NB	Drawn	NB	Checked	SW	Approved	SM
Original Size	A1	Date	03/09/2019	Date	03/09/2019	Date	03/09/2019	Date	03/09/2019
Drawing Number	551505 - MMSJV - VOL -	Originator	DR	Volume	LB	Project Ref. No.	551505		
Location	000 - DR - LB -	Role	00059	Revision	P02				


Appendix C – Nest tube survey results summary



Site	Number of Tubes	Date	Start/Finish Time	Weather	Summary	Points	Photographs
1	100	03/07/18	12:09 - 14:45	Optimal. Sunny, no cloud and gentle breeze	No dormice	2	
		15/08/18	10:30-12:00	Light rain before. Mild and muggy.	No dormice	5	
		10/09/18	14:15-15:30	Overcast with light wind.	Tube 38 had some green leaves in, although mainly dead leaves. No structure.	7	


		17/10/18	11:30-12:10	Cloudy with intermittent sun, light breeze, w arm.	Tube 1,2, 38 and 42 possible beginnings of nest w with some green leaves, but mainly dead leaves. No structure.	2	  
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		28/05/19	17:00-18:00	Dry, scattered cloud. Rain earlier in day. Muggy, warm with light breeze.	No dormice	4		
		TOTAL : 20						
2	50	05/07/18	12:00-13:30	Very hot and sunny	No dormice	2		
		15/08/18	12:30-13:30	Light rain before. Mild and muggy.	No dormice	5		
		11/09/18	10:00-11:00	Overcast (stratus), calm.	One potential starter nest tube 16 with collection of green hazel leaves but no structure.	7		
		17/10/18	10:30-11:00	Sunny, warm, light breeze	Tube 41 active wood mouse	2		
		15/05/19	10:20-11:10	Sunny, warm, light breeze	No dormice	4		
		TOTAL : 20						
2A	50	28/08/18	14:30-15:30	Warm, cloudy, approx. 20°C	No dormice	5		
		16/10/18	10:10-11:20	Damp, cool, cloudy	No dormice	2		
		10/05/19	10:15-11:45	Still, mild, dry	Tube 7 cache of beech nuts	4		
		19/06/19	14:20-15:30	Overcast, mild.	No dormice	2		
		18/09/19	10:00-12:00	Hot and muggy	No dormice	7		



		TOTAL : 20					
3	50	25/07/18	17:25-18:15	Warm and sunny 20°C	No dormice	2	
		06/09/18	11:00-14:00	Dry	No dormice	7	
		16/10/18	11:30-13:30	Damp, dry and cool	No dormice	2	
		17/04/19	09:00-12:30	Warm and dry	No dormice	1	
		16/05/19	12:15-13:00	Warm, some hazy cloud, light w inds	No dormice	4	
		18/09/19	10:00-12:00	Warm and dry	No dormice	7	
		TOTAL : 23					
4	50	04/07/18	12:23-13:00	Warm and cloudy	No dormice	2	
		16/10/18	14:15-16:00	Damp, cloudy, cool	No dormice	1 (half not accessed)	
		16/04/19	13:00-16:30	Warm and dry	No dormice	1	
		16/05/19	10:55-12:05	Sunny w ith hazy cloud w arm	Blue tit nest tube 19,	4	
		20/06/19	15:00-16:15	Warm and cloudy	No dormice	2	
		19/08/19	15:30-16:00	Sunny w ith scattered cloud	Start of w ood mouse nest	5	
		23/09/19	12:00-13:30	Raining just before.	No dormice	7	
		TOTAL : 22					
5	50	24/07/18	08:30-10:00	Temp 18°C, no rain, 2% cloud cover/sunny, no wind	No dormice	2	

		04/09/18	11:00-13:00	Dry	No dormice	7		
		17/10/18	12:20-13:00	Sunny, w arm, light breeze	Tube 29 dead leaves w ith a couple of fresh oak leaves w ith no structure.	2		
		11/04/19	10:30-11:00	Dry	No dormice	1		
		09/05/19	10:30-11:15	Sunny, clouds, w arm, dry	No dormice	4		
		17/09/19	15:00-17:00	Sunny, clouds, w arm, dry	No dormice	7		
		TOTAL : 23						
6	50	05/07/18	12:10-13:45	Optimal, sunny no cloud gentle breeze	No dormice	2		
		15/08/18	12:00-15:30	Optimal, sunny no cloud gentle breeze	No dormice	5		

		12/09/18	09:30-11:30	Overcast	Tube 28 dead leaves and moss with no structure.	7		
		23/10/18	11:30-12:15	Windy and cold but dry	No dormice	2		
		09/05/19	10:00-11:30	Overcast, still	No dormice	4		
		TOTAL : 20						
9	50	04/07/18	10:50-11:50	Warm and cloudy 20°	No dormice	2		
		16/08/18	11:00-12:00	Rained before survey. Warm and cloudy 20°	No dormice	5		
		04/09/18	11:00-13:30	Dry	Tube 16 and 33 wood mouse nut cache, Tube 34 and 37 collection of green leaves no structure.	7		

								
		24/10/18	11:00-12:00	Dry and breezy, 5°	6 tubes w with small collection of leaves but no structure, and one with a berry cache.	2		
		09/05/19	09:45-10:45	Cloudy and cool	No dormice	4		
		23/09/19	13:00 – 14:00	Overcast, still	No dormice	7		
		TOTAL : 27						
9A	50	16/08/18	12:00-13:00	Rained before survey. Warm and cloudy 20°	No dormice	5		
		05/09/18	12:00-13:00	Warm and dry	No dormice	7		
		25/10/18	12:00-13:20	Sunny and dry	No dormice	2		
		19/04/19	09:00-12:00	Warm and dry	No dormice	1		
		16/05/19	11:00-12:00	Sunny and dry	Active birds nests tube 8 and 11	4		
		28/08/19	13:00-13:30	Dry	No dormice	5		
		TOTAL : 24						
10	50	23/07/18	15:30-17:30	27°, no rain, , 40% cloud cover, light breeze	No dormice	2		

		16/08/18	13:30-15:00	Rain in morning, sunny spells, dry during survey.	No dormice	5	
		11/09/18	11:40-12:25	overcast (stratus), light rain at start	No dormice	7	
		23/10/18	14:00-15:50	Chilly, strong breeze, no rain	Tube 10 and 11 small mammal nests. Tube 22 nut cache.	2	 

		20/05/18	11:30-13:00	Warm and sunny	Tube 42, moss nest found. unclear what constructed the nest unlikely dormouse	4		
		TOTAL : 20						
11	50	11/09/18	13:40-14:30	Overcast with light wind	Fresh leaves in tube 36	7		
		25/10/18	10:00-11:35	Overcast with light wind	Tube 36, 47, 48, 48 and 50 wood mouse nests	2		
		18/04/19	15:00-17:00	Warm and dry	No dormice	1		
		17/05/19	09:30-11:00	Cloudy and mild	No dormice	4		
		19/06/19	14:00-15:00	Damp and mild	Tube 14 and 19 cache of nuts	2		
		16/07/19	12:00-13:30	Hot and muggy	No dormice	2		

A417 Missing Link
Bat Roost Surveys Technical Report



		20/08/19	15:30-17:00	Warm, light breeze and cloudy. 23 ^C	8 tubes with wood mouse nut caches	5	
		TOTAL : 23					

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.15
Great Crested Newt Survey Report

28 September 2020

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Executive Summary

The proposed A417 Missing Link scheme (hereafter referred to as ‘the scheme’) aims to provide a dual carriageway to a stretch of single carriageway between the Cowley roundabout and Crickley Hill in Gloucestershire; the 5.5km section is the only remaining section of single carriageway. The scheme would increase capacity by creating a free-flowing link between the Brockworth Bypass and Cowley roundabout and remove the at-grade junction with the A436, resulting in a continuous flow between the M4 Junction 15 (Swindon) and the M5 Junction 11a (Gloucester/Cheltenham).

Great crested newts (GCN) are afforded full protection under the Conservation of Habitats and Species Regulations 2017 and the Wildlife and Countryside Act 1981 (as amended). Great crested newts are widely distributed throughout the lowland areas of Great Britain but are absent from Ireland. Their populations have declined over the last century across Europe, including Britain, mainly as a result of pond loss and deterioration.

Mott Macdonald have undertaken GCN surveys in the 2018 and 2019 survey seasons to assess the presence or likely absence of this European protected species from within the Zone of Influence of the scheme. Surveys in 2018 included Habitat Suitability Index (HSI) surveys, to assess suitability of waterbodies to support GCN. These HSI surveys were followed up by eDNA surveys of suitable waterbodies in June 2018. Further HSI surveys and eDNA surveys were undertaken in May 2019 on additional ponds that could not be accessed in 2018. In addition, population estimate surveys were undertaken on two ponds during the 2019 season.

The surveys identified the presence of GCN within three ponds. Pond 2a is located 227m from the construction footprint of Option 30. This pond had a positive eDNA result and population estimate surveys identified a small population, with a maximum of 2 GCN. Positive eDNA results were also returned for Pond 15 and Pond 26a. Pond 26a is located 668 meters from the construction footprint of Option 30 and Pond 15 is located 500 metres from the construction footprint. Due to the distance of these ponds from the scheme, no population estimate surveys were undertaken.

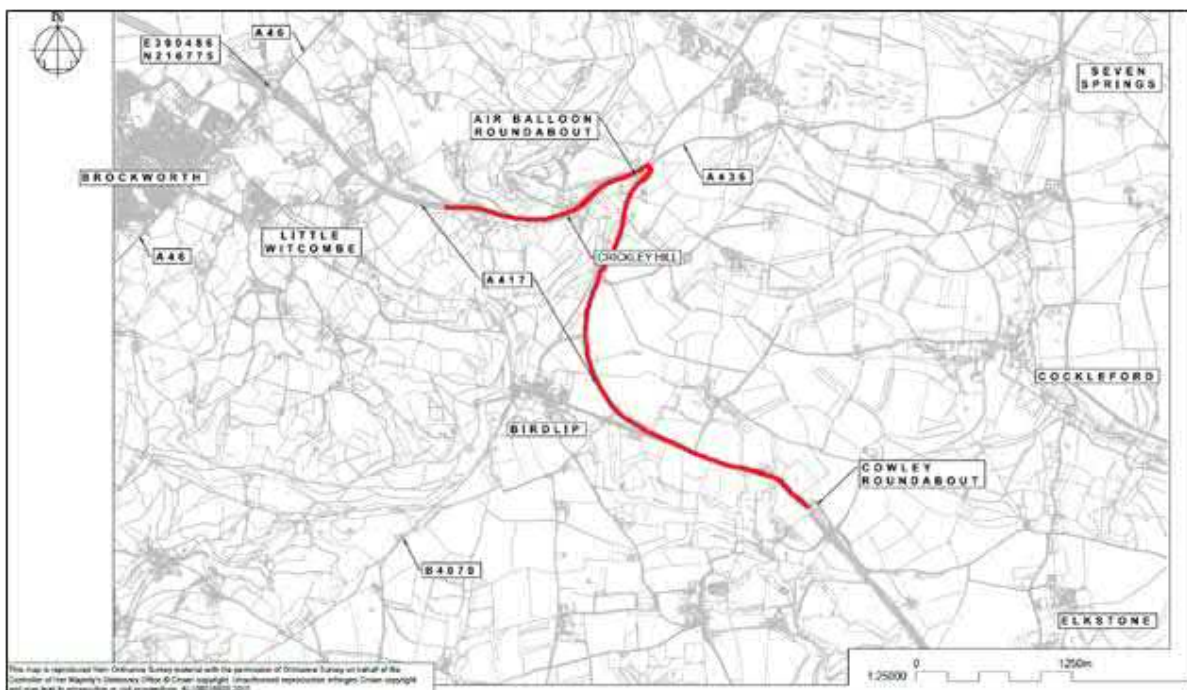
At the time of writing, the project is still within the design phase. Therefore, the full extent of potential impacts of the Scheme on the badger populations is yet to be confirmed. Impacts and mitigation to alleviate them will be detailed within the ecology and nature conservation chapter of the project Environmental Statement, when published.

1. Introduction

1.1. Background

- 1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and as an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'missing link', forms the only section of single carriageway along the route, with an at-grade junction located at the 'Air Balloon' public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5km stretch shown on Figure 1.1 below.

Figure 1.1: A417 Missing Link Scheme Location Plan



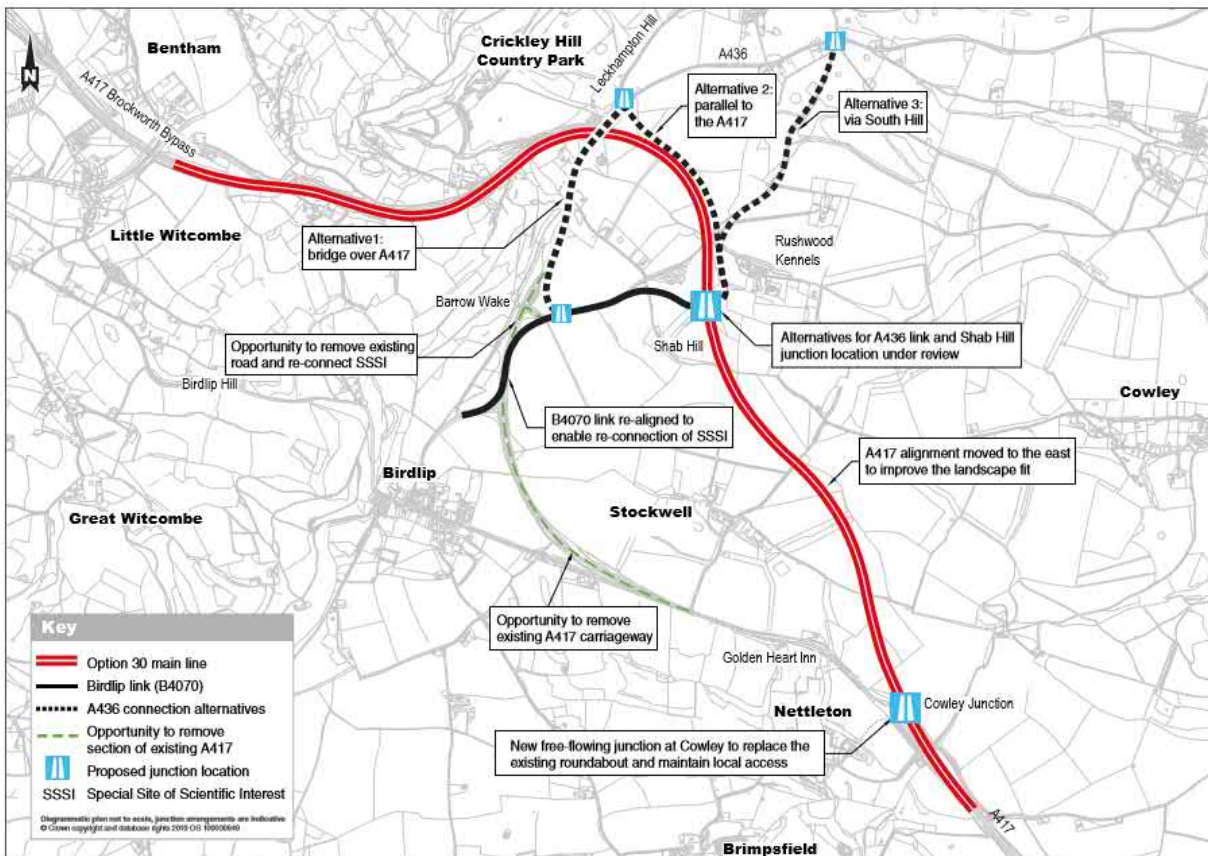
Source: GiGi GIS Portal. Crown Copyright 2016 100030649

1.2. Scheme Proposal

- 1.2.1 The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill.
- 1.2.2 Any proposed scheme would aim to increase capacity by creating a free-flowing link between the Brockworth Bypass and the Cowley roundabout and remove the at-grade junction with the A436 (Air Balloon roundabout). This Missing Link will provide a free flowing journey between Swindon (M4 Junction 15) and Gloucester / Cheltenham (M5 Junction 11a).

1.2.3 The preferred route for the Scheme was confirmed as Option 30 by the Secretary of State in March 2019 (see Figure 2.1 below). The Scheme comprises the construction of a new dual carriageway to replace the existing single carriageway section between Brockworth bypass and Cowley Roundabout. It is predominately an “offline” Scheme but approximately a third of the route follows the existing A417 route corridor at Crickley Hill.

Figure 1.2: A417 Preferred Route Announcement



1.2.4 Figure 1.2 above shows three A436 link road alternative connections. Alternative 2, parallel to the A417, is the option taken forward for assessment in the Environmental Statement.

1.3. Scope of report

1.3.1. The objectives of the report are:

- to present the methodology used and any identify any constraints during the GCN surveys
- to present the results of the Habitat Suitability Index (HSI) assessment for all ponds and other potentially suitable waterbodies
- to present the results of the eDNA and presence/absence and population assessment surveys

- to present the relative abundance of the GCN populations
- to provide a high-level initial assessment of the potential impacts of the scheme on GCN

1.3.2. The report does not provide any detailed impact assessment or recommendations for mitigation as this aspect will be developed by Arup during PCF Stage 3 of the scheme.

1.4. Legislation

1.4.1. Great crested newts (GCN) are afforded full protection under the Conservation of Habitats and Species Regulations 2017 (as amended) and the Wildlife and Countryside Act 1981 (as amended).

1.4.2. Under Regulation 43 of the Conservation of Habitats and Species Regulations it is illegal to:

- Deliberately capture, injure or kill a GCN
- Deliberately disturb a GCN (in particular, disturbance which is likely to impair their ability to survive, to breed or reproduce, or to rear or nurture their young, to hibernate or migrate or to affect significantly the local distribution or abundance of the species to which they belong)
- Deliberately take or destroy the eggs of GCN
- Damage or destroy a breeding site or resting place of GCN

1.4.3. Under Schedule 5 of the Wildlife and Countryside Act 1981 it is illegal to:

- Intentionally or deliberately kill, injure or take any GCN
- Possess or control any live or dead specimen or anything derived from GCN
- Intentionally or recklessly damage, destroy or obstruct access to any structure or place used for shelter or protected by GCN
- Intentionally or recklessly disturb GCN whilst they are occupying a structure or place used for that purpose

1.4.4. Great crested newt are also listed as an Annex II species of the EU Habitats Directive, meaning they meet the criteria for site selection of Special Areas of Conservation to specifically conserve this species. Site selection is based on evidence of a large and robust population of GCN.

1.5. Status of great crested newt at national level

- 1.5.1. Great crested newts are widely distributed throughout the lowland areas of Great Britain but are absent from Ireland. Their populations have declined over the last century across Europe, including Britain, mainly because of habitat loss and deterioration.
- 1.5.2. Historically, GCN were listed as a UK Biodiversity Action Plan (BAP) species and are now listed as a species of 'principal importance for the conservation of biodiversity in England' under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006. Following the production of Biodiversity 2020, the national strategy for England, actions were identified by experts to help in the recovery of populations of the S41 listed species. Actions identified for the recovery of GCN include the following:
- I. Create, restore and manage ponds to provide breeding sites for Great Crested Newts, and manage surrounding terrestrial habitats sympathetically
 - II. Develop and implement methods and policies to remedy reversible adverse impacts at the population level, notably introduction of fish and invasive plants
 - III. Develop and implement a surveillance plan to meet data needs at all spatial scales, for all appropriate stakeholders
 - IV. Review land use regulation and propose changes to improve outcomes for great crested newts

1.6. Status of great crested newt at county level

- 1.6.1. The Amphibian and Reptile Conservation Group (ARG) UK describe the status of GCN within the county as widespread, with South Gloucestershire as a stronghold for the species¹.

1.7. Great crested newt ecology

- 1.7.1. The GCN annual cycle commences on emergence from hibernation. They will move from their hibernation sites between February and April toward breeding ponds. Great crested newt breed, and live during breeding season, in a wide range of natural, semi-natural and man-made aquatic habitats including marshes, reed beds, wet ditches and ponds. They spend the spring and summer

¹ The South Gloucestershire Biodiversity Action Plan. (2006).
(<https://www.southglos.gov.uk/documents/pte080091.pdf>)

moving between water and land to satisfy feeding and shelter needs, as well as to find mates. Most adult newts move away from ponds and into terrestrial habitat between May and July. Suitable terrestrial habitat typically includes woodland, scrub, hedgerows and less intensively managed grassland. They seek out crevices and holes in the ground to spend the autumn, and regularly emerge to disperse and forage in warmer, wetter conditions. They will hibernate over winter once temperatures regularly fall below 5°C overnight.

- 1.7.2. Great crested newts are known to range typically up to 500m from breeding ponds in search of feeding and hibernation sites. Some great crested newts have been found to move over considerable distances (up to 1.3km from breeding sites) however the majority inhabit an area much closer to the pond. The quality of the terrestrial habitat near to breeding ponds is important, as are the lack of barriers to dispersal (such as watercourses or busy roads).
- 1.7.3. Great crested newts often exist in metapopulations. A metapopulation is a group of associated populations. That is, a metapopulation is made up from newts which breed in, and live around, a cluster of ponds. There will be some interchange of newts between ponds, although most adults consistently return to the same pond to breed. Metapopulations are much less vulnerable to habitat changes than populations based on single breeding ponds².

² Langton, T.E.S., Beckett, C.L. and Foster, J.P. (2001). Great Crested Newt Conservation Handbook, Froglife, Halesworth.

2. Methodology

2.1. Desk Study

- 2.1.1. A desk study was undertaken to identify records of GCN within the study area and wider surrounds up to a distance of two kilometres from the route options. At the time of the desk study and subsequent surveys, there were two scheme options under consideration (Option 12 and Option 30). Records were acquired from the Gloucestershire Centre for Environmental Records (GCER) in 2017. The results can be found within Appendix A.
- 2.1.2. A similar A417 scheme was subject to environmental assessment in 2006. The 2006 Stage 2 Assessment³ included GCN surveys including detailed surveys of three ponds (referenced as Pond 9, Pond 13 and Pond 14 in 2018/19 surveys). No evidence of GCN was identified during these surveys.
- 2.1.3. All ponds and other potentially suitable waterbodies within 500m of both scheme options were identified using the MAGIC online viewer tool (Defra, 2017) and the use of 1:10,000 Ordnance Survey Mapping and aerial photography. These were recorded and given a unique identifier. Additional ponds were also identified during initial scoping walkovers of land parcels. These were typically small ponds that were not shown on Ordnance Survey Mapping. Appendix B details the locations of all waterbodies.

2.2. Habitat suitability index assessment

- 2.2.1. All ponds and potentially suitable water bodies identified within the desk study were assessed for their potential to support GCN using the standardised Habitat Suitability Index (HSI) methodology (Oldham et al, 2000). The HSI is a measure of suitability and incorporates ten indices, all of which are environmental factors known to affect this species.
- 2.2.2. The results are expressed as an HSI score between 0 and 1, with 0 being unsuitable habitat and 1 representing optimal habitat, as shown in Table 2.1. It is considered that ponds with a higher overall HSI score are more likely to support GCN than those with a lower score. The method is not sufficiently precise to conclude that ponds with a high score will support newts, or that any pond with a low score will not. It is therefore a tool to support, rather than a substitute for, GCN surveys.

³ WSP (March 2006) A417 Cowley to Brockworth Bypass Improvement Scheme Stage 2 Ecology and Nature Conservation Report

Table 2.1 Habitat Suitability Index Score

HSI Score	HSI Category	Predicted presence
<0.50	Poor	3%
0.50 – 0.59	Below Average	20%
0.60 – 0.69	Average	55%
0.70 – 0.79	Good	79%
>0.80	Excellent	93%

2.3. eDNA Survey

- 2.3.1. Following the HSI surveys, suitable waterbodies were then subject to eDNA survey. The eDNA survey was undertaken on all waterbodies which supported suitable habitat to support GCN. This included waterbodies with HSI scores between Poor and Excellent, i.e. the HSI score was not used to rule out any waterbodies. Waterbodies that were not subject to eDNA included those that were either dry or otherwise unsuitable to support breeding GCN. Unsuitable waterbodies included ephemeral springs with little or no water, wells with no surface water and swimming pools.
- 2.3.2. When Great Crested Newts (GCN) inhabit a pond, cells containing their DNA are continually sloughed off into the water. The eDNA survey involves the collection of 20 water samples from around the perimeter of a waterbody, which are then subject to laboratory analysis of the environmental DNA present in the water column to assess presence or absence of GCN.
- 2.3.3. eDNA test kits were obtained from SureScreen Scientific Ltd in order to collect water samples to enable tests to be carried out of the waterbodies to determine the presence of Great Crested Newt. The methods used for water sample collection and eDNA analysis were those described by Biggs et. al. 2014⁴.
- 2.3.4. eDNA surveys were undertaken in June 2018 and May 2019. Detailed survey dates are provided in Appendix D. Surveys were undertaken by experienced ecologists holding a Natural England GCN Class Licence (Level 1 CL08).
- 2.3.5. The location of waterbodies which were subject to eDNA survey is shown in Appendix D.

⁴ Biggs J, Ewald N, Valentini A, Gaboriaud C, Griffiths RA, Foster J, Wilkinson J, Arnett A, Williams P and Dunn F (2014). Analytical and methodological development for improved surveillance of the Great Crested Newt. Appendix 5. Technical advice note for field and laboratory sampling of great crested newt (*Triturus cristatus*) environmental DNA. Freshwater Habitats Trust, Oxford.

2.4. Population Estimate Survey

2.4.1. Following a positive eDNA survey result in May 2019, pond 2a was subject to population estimate surveys in the same month. Additionally, pond 2 was subject to further surveys due to its proximity to pond 2a, despite a negative eDNA survey result. The surveys were undertaken in accordance with the guidelines outlined in the Great Crested Newt Mitigation Guidelines (English Nature, 2001). Each survey was undertaken by a Natural England GCN Class Licence holder and assistant. At least three survey methods were utilised for each visit. These included:

- I. *Bottle trapping*: bottle traps are 2 litre plastic bottles with inverted funnels, which are set in the water at approximately 2m intervals all around the pond's edge using canes. They are set in the evening ensuring an air bubble is present and left overnight to allow amphibians to explore and get caught inside. They are removed the next morning after no more than 17 hours (English Nature, 2001).
- II. *Torching*: shortly after dusk, the pond is systematically searched from the bank using a high power (1000,000 candle power) torch and counts made of any newts present.
- III. *Egg searching*: examination of potential egg laying substrate such as marginal vegetation, dead leaves and litter. Great crested newts lay their eggs singularly in folds of substrate and can be identified by their colour and size. Once a confirmed GCN egg is identified (confirming the presence of a breeding pond) no more egg searching is undertaken.
- IV. *Netting*: Using a long-handled dip-net, great crested newts can be captured by sampling the area around the pond edge. The edge of the pond is systematically sampled, with at least 15 minutes of netting per 50m of shoreline. Netting is not a suitable indication of population size.

In accordance with the Great Crested Newt Mitigation Guidelines, Pond 2a was subject to a total of 6 surveys. Surveys of Pond 2 were stopped after 4 surveys as no evidence of GCN was recorded. Surveys of Pond 2a and 2 were undertaken between 9th May 2019 and 30th May 2019. Details of survey dates and weather conditions are shown in table 2.2.

Table 2.2 Great crested newt survey dates

Pond Surveyed	Date	Weather Conditions	Methods
2a, 2	09.05.2019	Dry, Still, 6-10°C	Bottle Trap, Torch (2 only), Egg Search, Refuge Search (2a only)
2a, 2	15.05.2019	Dry, Still, 8-13°C	Bottle Trap, Torch (2 only), Egg Search, Refuge Search (2a only)
2a, 2	20.05.2019	Occasional light rain, humid with almost complete cloud cover, 7-12°C	Bottle Trap, Egg Search, Netting (2 only), Refuge Search
2a, 2	23.05.2019	Dry, Still, 11-15°C	Bottle Trap, Torch (2 only), Egg Search, Refuge Search (2a only)
2a	28.05.2019	Dry, Still, 10-15°C	Bottle Trap, Egg Search, Refuge Search
2a	30.05.2019	Dry, Still, 8-13°C	Bottle Trap, Egg Search, Refuge Search

2.5. Estimating population size class

2.5.1. Population size class estimates were calculated according to the Great Crested Newt Mitigation Guidelines (2001). It is the peak adult count per survey visit that is significant, with juveniles not included for population estimates. Although these are very broad classifications, they can inform licensing and mitigation requirements. Table 2.3 summarises its application.

Table 2.3 Population size class estimates

Peak adult count in a single survey visit	Population size class
Maximum counts up to 10	Small
Maximum counts between 11 and 100	Medium
Maximum count >100	Large

2.6. Site status assessment

2.6.1. Following the completion of the surveys an assessment of the status of the site was then made. The importance of the site takes into account the population size class estimate but also several other factors:

- The quality and rarity of the habitat and population
- How connected the population is to the wider area
- The local significance of the population

- The size of the meta-population

2.7. Survey constraints

- 2.7.1. Where GCN were not identified as occupying a pond or pond cluster, this does not guarantee their absence. There is always the risk of GCN being over-looked due to timing of surveys and scarcity of GCN on site.
- 2.7.2. Estimating population can be fraught with issues due to the detectability of GCN, the complex population dynamics and mobility between ponds amongst other factors. As a result, where licensing is required a maximum estimate is implemented.
- 2.7.3. All suitable ponds within the 500m buffer of the scheme had HSI surveys completed. Ponds 1,1a,3,4,5,6,7,10,11,12,17,19,21a,22,23,25,26,27,28,30,32 and 34 were deemed unsuitable for HSI surveys; they were either entirely desiccated or man-made structures such as swimming pools. However, this is not considered to be a constraint as waterbodies that dry regularly during the breeding season are unlikely to support breeding populations of GCN.
- 2.7.4. Population surveys of Pond 2a were not commenced until 9th May due to access restrictions. Natural England's Standing Advice for GCN surveys recommend that for population surveys, at least 3 of the 6 surveys should be undertaken in peak season (usually mid-April to mid-May). Two of the surveys of Pond 2a were undertaken in this peak season, with the third survey undertaken on the 20th May, just outside the typical peak season. However, this is not considered to have had a significant impact on the results.
- 2.7.5. A pond marked on the OS at SO 95345 12613 is located 460 meters southeast of the extent of the Option 30. However, there are no works affecting potentially suitable terrestrial habitat within 500 metres of this pond. Therefore, this pond was not subject to any surveys. However, this is not considered a constraint due to the lack of impact on terrestrial habitat within 500 metres of this pond.

3. Results

3.1. Desk study results

3.1.1. The data search results from GCER returned four records of great crested newt within 2km of the scheme, three of which are in the Bentham area, with the closest pond 530 metres north of the scheme and one in Brockworth 1.36 kilometres west of the scheme to the southwest of the Brockworth roundabout. A map of these results is provided in Appendix A. No GCN were found during the 2006 Stage 2 Assessment surveys (ponds 9, 13 and 14).

3.2. Description of waterbodies

3.2.1. A description of the waterbodies identified within the Zone of Influence (Zoi) of the scheme along with their distance from the proposed construction footprint is provided in Appendix B. The waterbodies consist mainly of garden ponds; there are also ponds within woodland habitat and ponds within arable and grazed farmland. One waterbody consisted of a large concrete trough with palmate newts visible at the time of HSI survey. Many of the waterbodies identified during the desk study were ephemeral springs which held little or no standing water at the time of the surveys.

3.3. Habitat suitability index

3.3.1. A total of 43 waterbodies were identified within 500m of Options 12 and 30. Of these waterbodies 33 are located within 500m of Option 30. A total of 21 had an HSI survey completed, the others were assessed as unsuitable for supporting breeding GCN due to either being dry ephemeral springs with no suitable standing water, or manmade features such as swimming pools. No HSI was undertaken where a waterbody was assessed as unsuitable.

3.3.2. The detailed results of the HSI surveys can be found within Appendix C. Ponds 1, 1a, 3, 4, 5, 6, 7, 10, 11, 12, 17, 19, 21a, 22, 23, 25, 26, 27, 28, 30, 32 and 34 did not receive an HSI assessment as detailed above (Section 2.7.3).

3.4. eDNA Presence/ likely absence

3.4.1. Following the HSI surveys, 16 of the 21 that received an HSI were deemed suitable for eDNA surveys. Ponds 8 and 21 did not have enough water in at the time of eDNA survey to collect enough samples; pond 21 was also heavily disturbed by cattle. Pond 16 was over 500m from the scheme alignment, having originally been inside one of the option boundaries when the HSI was undertaken. Ponds 33 and 37 are small ornamental ponds with pond 33 being very small with vertical sides and was deemed unsuitable. Pond 37 was stocked with many large

carp and assessed as being unsuitable for GCN. A summary of eDNA surveys is presented in table 3.1.

- 3.4.2. Three ponds resulted in positive eDNA results; ponds 2a, 15, and 26a. Pond 15 is 500 meters from Option 30 and so no further population estimate surveys were carried out. Pond 26a is over 668 metres from Option 30 and so no further surveys were carried out. The results for the eDNA surveys can be viewed in Appendix D.

Table 3.1 Summary of eDNA results.

Pond number	Land parcel	Distance from Option 30 (metres)	eDNA result
2	GR95689	185m	Negative
2a	GR95689	227m	Positive
9	GR329311	63m	Negative
13	GR159309	436m	Negative
14	GR159562	345m	Negative
15	GR308763	500m	Positive
18	GR405759	480m	Negative
20	U00120	420m	Negative
24	GR136598	470m	Negative
29	GR383328	128m	Negative
31	GR159309	620m	Negative
35	GR354154	366m	Negative
35a	GR346313	90m	Negative
36	U00125	190m	Negative
38	GR138283	180m	Negative
26a	U00112	668m	Positive

3.5. Population class size and metapopulations

- 3.5.1. Pond 2a was subject to 6 great created newt surveys using three survey methods to provide an estimate of population size. The maximum number of GCN found during any one survey was two female adults. The lowest maximum count for any one pond was one male adult. These were found in the bottle trap surveys. No GCN eggs were found during the surveys. The population class size is classified as small. A map showing the results of these surveys is provided in Appendix E and detailed survey results are provided in Appendix F.
- 3.5.2. Pond 2 had no GCN recorded however it is close to pond 2a with suitable connecting habitat between the two ponds and there is potential that this waterbody may be used by GCN in the future. Only 4 surveys were undertaken at pond 2 due to the negative results of the first 4 surveys.

- 3.5.3. In addition to GCN, the surveys found populations of palmate newt *Lissotriton helveticus* in ponds 2 and 2a and smooth newt *Lissotriton vulgaris* in pond 2a. A common frog *Rana temporaria* was also found on pond 2a.
- 3.5.4. A second population of GCN has been identified within the Birdlip area, associated with Pond 15 and Pond 26a (identified through eDNA surveys), both of which are within 500m of each other and likely to be associated with the same metapopulation. This population is over 500m from Option 30.
- 3.5.5. A third metapopulation has been identified from desk study records within the Bentham area. The records indicate that there is a medium population associated with three ponds, the closest of which is 530 metres north of the scheme.

3.6. Site status

South Gloucestershire is a strong hold for GCN¹ and they are widespread across the county; therefore, populations may be defined as locally important. However, the surveys found only one pond with a small population within 500m of scheme. Two additional populations are located just over 500m from the scheme, indicating that the species is relatively widespread in the local area.

4. Potential Impacts

- 4.1.1. The impact assessment will be covered within the ecology and nature conservation chapter of the Environmental Statement for the project. At the time of writing, the Scheme is still being designed and firm conclusions on impacts will be detailed in the aforementioned document.

5. Mitigation and enhancement recommendations

- 5.1.1. Full details of ecological mitigation measures will be included within the ecology and nature conservation chapter of the Environmental Statement for the project.
- 5.1.2. Positive measures should be considered that may offer benefits to Great crested newts including habitat reconnection and enhancement.

6. Conclusion

- 6.1.1. A small population of great crested newts has been identified within 250m of Option 30. Impacts on terrestrial habitat associated with this population are likely to be relatively minor and not anticipated to have an impact on the viability of the population. Two other GCN populations have been identified within proximity of the scheme, but both of which are over 500m from the footprint of the works and are not anticipated to be adversely affected by the scheme.
- 6.1.2. The impact assessment and any mitigation measures required will be fully detailed within the Scheme Environmental Statement.

Appendix A – Biological Records



Notes

Legend

Records

- amphibian, Common Frog
- amphibian, Common Toad
- amphibian, Great Crested Newt
- amphibian, Smooth Newt

P01	26/06/19	FIRST REVISION	SB	VH	SM
Rev	Date	Amendment Details	Drawn	Chk'd	App'd

**Mott MacDonald
Sweco**

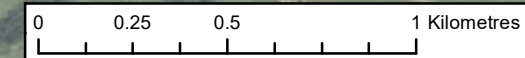


Drawing Status	S01	Suitability	S4
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Project Title
A417 MISSING LINK

Drawing Title
Previous Biological Records - Amphibians and Reptiles

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Original Size	A3	Date	26/06/2019	Date	26/06/2019	Date	26/06/2019	Date	26/06/2019



Drawing Number	HE PIN	Originator	MMSJV	Volume	EBD	Project Ref. No.	551505
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Location	Type	Role	Number				

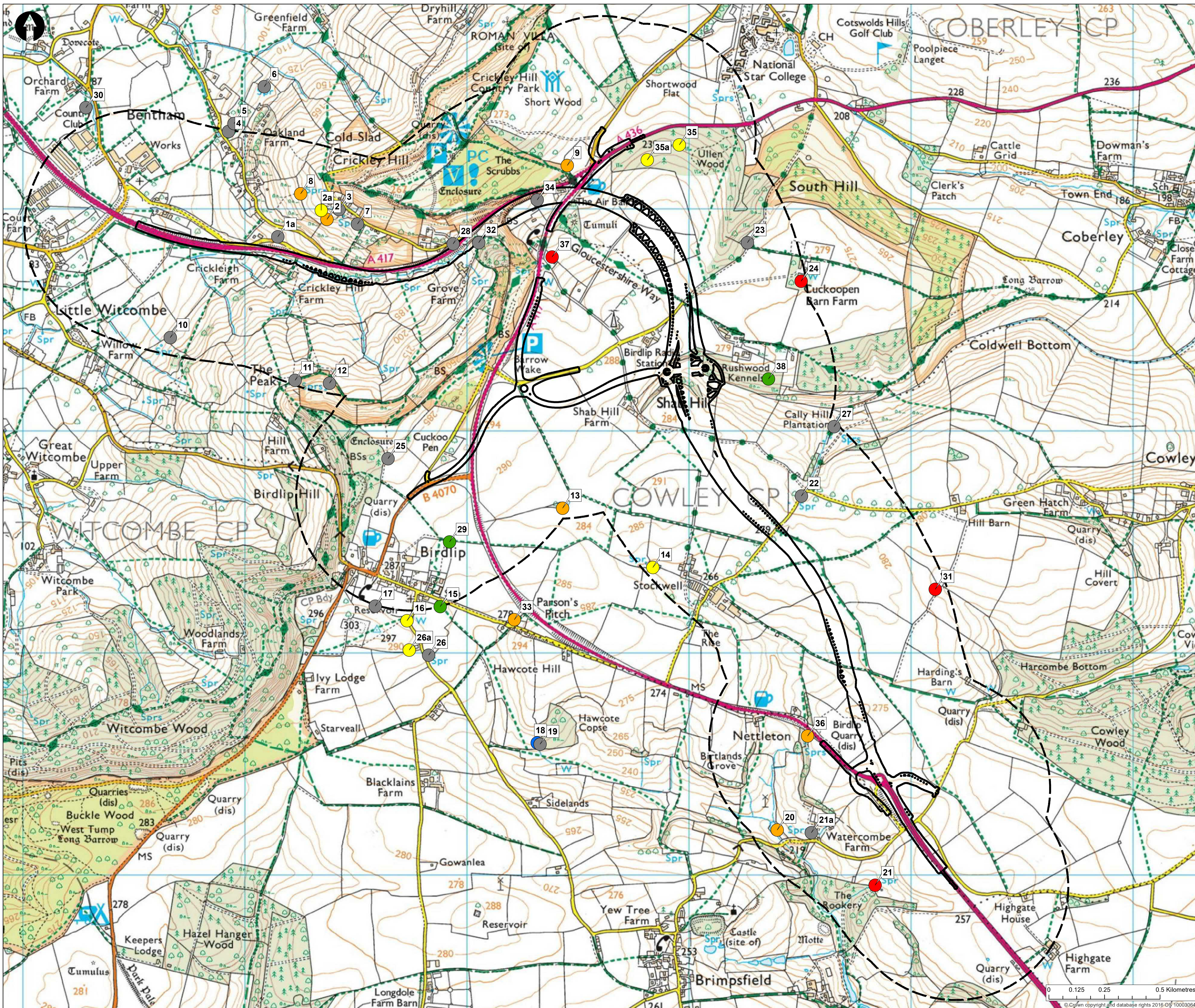
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Appendix B - Description of waterbodies

Pond reference	Description of waterbody	Distance from Option 30 (metres)
1	Swimming pool	45.5
2	Man-made pond with lining, woodland and grassland habitat, low water level.	185
2a	Pond with lining, high level of duckweed cover. Fed by spring, habitat is woodland and garden.	227
3	Spring - no pooling of water, no suitable GCN habitat	214
4	Spring - no pooling of water, no suitable GCN habitat	528
5	Spring - no pooling of water	543
6	Spring - no pooling of water, no suitable GCN habitat	530
7	Spring - no pooling of water	303
8	Pond with very little water, heavily shaded, log piles nearby for terrestrial refuge	263
9	Small pond next to Wildlife Trust reserve including woodland and grassland. Plenty of egg laying vegetation.	63
10	Spring - no pooling of water, no suitable GCN habitat	476
11	Spring - no pooling of water, no suitable GCN habitat	489
12	Spring - no pooling of water	493
13	Pond in arable land area, complete duckweed cover, terrestrial refuge areas in form of log piles present	436
14	Old storage pond, tall vegetation with tree shading in surrounding habitat	345
15	Garden pond with lining, mown grassland surrounding pond	500
16	Over 500m from scheme	55
17	Dry pond – over 500m from scheme	561
18	Large pond with suitable surrounding habitat for GCN	480
19	An old drainage field pond, currently muddy and used by livestock	497
20	A series of pools that join in winter to be one large pond. Surrounded by woodland	420
21	Spring emptying onto concrete pan and free flowing out of field. Heavily disturbed by cattle.	435
21a	Dry swimming pool	283
22	Spring - some rushes indicate damp ground but no pond and no standing water	684
23	Dry - no sign of pond within dry broadleaved woodland	500
24	Garden pond surrounded by amenity grassland, woodland and arable land	470
25	Pond very dry - no signs of recently holding	226
26	Spring not visible on surface, no water.	469
27	Dry - Becoming scrubbed over	1070
28	Very small spring	17
29	Shallow pond lined surrounded with decking	128
30	Over 500m from scheme - no survey required	717









31	Pond with vegetation present that is suitable for egg laying. Surrounded by mixed woodland	620
32	Dry pond	44
33	Small garden pond, surrounded by amenity grassland, hedgerow and arable land	709
34	Dry reed bed	15
35	New pond created in winter of 2017, pond located in woodland with log piles present for terrestrial refuge area.	366
35a	Recently constructed pond in woodland	90
36	Small garden pond with stone base, surrounded by mown lawn, arable land and woodland nearby	190
37	Small ornamental garden pond, high numbers of large fish observed, no egg laying material, no macrophyte cover, pond pump present.	20
38	Woodland pond with stone wall on banks, some suitable egg laying material present, surrounded by woodland	283
1a	Dry pond	469
21a	Dry swimming pool	45
26a	Concrete lined reservoir, palmate newts observed during HSI	668

Appendix C - HSI Results



Notes

Legend

-  Option 30 Scheme Outline (at time of survey)
-  500m Scheme Buffer
- HSI Score**
-  Average
-  Below Average
-  Excellent
-  Good
-  Poor
-  Unsuitable

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	28/10/19	Minor amendments	JW	VH	SM
P01	26/06/19	First Revision	TW	VH	SM

Mott MacDonald Sweco

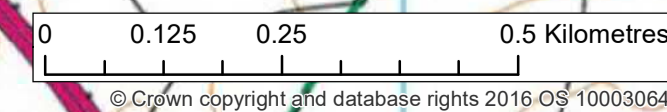


Drawing Status	For Information	Suitability	S2
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Project Title
A417 Missing Link

Drawing Title
Great Crested Newt Ponds HSI Score

Scale	Designed	Drawn	Checked	Approved
1:8,000	TW	TW	VH	SM
Original Size	Date	Date	Date	Date
A1	12/06/19	28/10/19	28/10/19	28/10/19
Drawing Number	Originator	Volume	Project Ref. No.	
551505 - MMSJV	- VOL	- EBD	551505	
Location	Type	Role	Revision	
000 - DR	- LB	- 00043	P02	



Pond No.	Distance from Option 30	Description of waterbody	Pond area (m ²)	Permanence	Water quality	Shade	Waterfowl	Fish	Pond Count	Terrestrial Habitat	Macrophytes	HIS Score	Category
1	45.5	Swimming pool											
2	185	Pond	28.26	Frequently	Moderate	45	Absent	Absent	5	Good	85	0.56	Below average
2a	227	Pond	16.9	Rarely	Moderate	30	Absent	Absent	5	Good	20	0.67	Average
3	214	Dry spring											
4	528	Dry spring											
5	543	Dry spring											
6	530	Dry spring											
7	303	Dry spring											
8	263	Pond	30	Frequently	Good	55	Absent	Absent	5	Good	5	0.53	Below average
9	63	Pond	9.42	Sometimes	Good	100	Absent	Absent	2	Good	70	0.55	Below average
10	476	Dry spring											
11	489	Dry spring											
12	493	Dry spring											
13	436	Pond	50	Sometimes	Poor	60	Minor	Possible	12	Moderate	70	0.59	Below average
14	345	Pond	500	Rarely	Moderate	80	Minor	Absent	3	Poor	10	0.69	Average
15	500	Pond	50	Never	Moderate	70	Absent	Absent	5	Moderate	70	0.73	Good
16	55	Pond	<50	Rarely	Good	10	Absent	Absent	2	Moderate	25	0.63	Average
17	561	Dry pond											
18	480	Pond	200	Never	Good	40	Absent	Possible	2	Good	50	0.8	Excellent
19	497	Dry pond											
20	420	Pond	50	Rarely	Moderate	100	Absent	Absent	1	Good	95	0.59	Below average
21	435	Spring	50	Never	Bad	100	Absent	Absent	1	Poor	0	0.32	Poor
21a	283	Dry swimming pool											
22	684	Dry pond											
23	500	Dry pond											

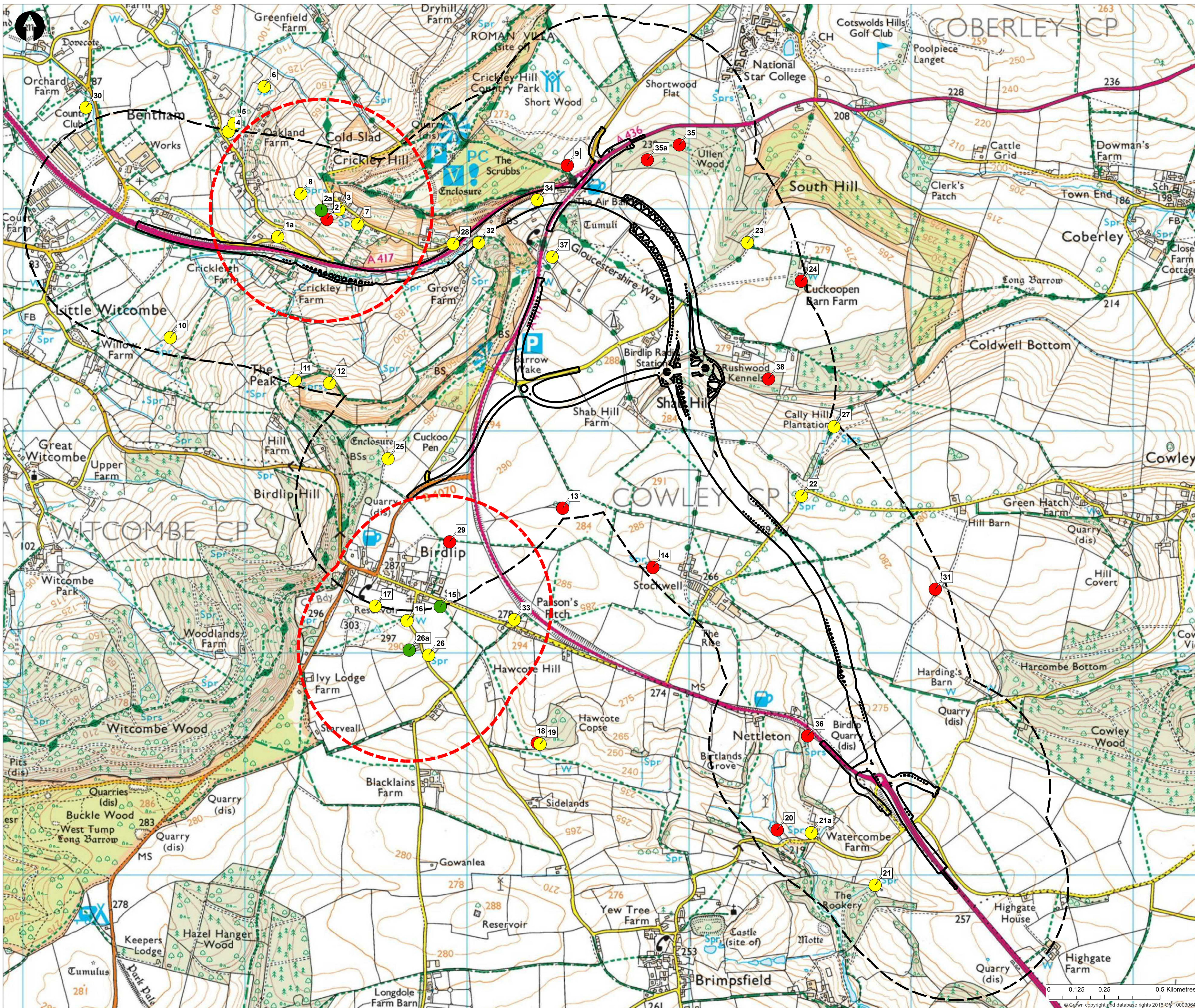
24	470	Pond	50	Never	Good	50	Minor	Possible	0	Poor	40	0.5	Poor
25	226	Dry pond											
26	469	Dry spring											
27	1070	Dry pond											
28	17	Dry pond											
29	128	Pond	50	Never	Good	10	Absent	Absent	7	Good	75	0.79	Good
30	717	Not surveyed – over 500m											
31	620	Pond	40	Frequently	Poor	90	Minor	Absent	1	Good	40	0.41	Poor
32	44	Dry pond											
33	709	Pond	<50	Never	Good	100	Absent	Absent	4	Poor	40	0.52	Below average
34	15	Dry pond											
35	366	Pond	16	Never	Moderate	50	Absent	Absent	4	Good	20	0.63	Average
35a	90	Pond	<50	Rarely	Good	75	Absent	Absent	4	Good	30	0.66	Average
36	190	Pond	<50	Never	Poor	30	Absent	Possible	1	Moderate	40	0.54	Below average
37	20	Pond	<50	Never	Poor	0	Absent	Major	1	Poor	0	0.3	Poor
38	283	Pond	5.5	Sometimes	Good	50	Minor	Absent	2	Good	10	0.74	Good
1a	469	Dry pond											
21a	45	Dry swimming pool											
26a	668	Pond	121	Never	Good	20	Minor	Absent	5	Moderate	75	0.68	Average

Appendix D - eDNA Results

Pond Number	Land Parcel	Distance from Scheme (m) Option 30	Date HSI Undertaken	HSI Score	eDNA Survey Required Y/N	Date of eDNA Survey	eDNA surveyors	eDNA lab reference	eDNA Result
1	GR387647	45.5	06/05/2018	Swimming pool	N				
2	GR95689	185.1	29/03/2019	0.56	Y	13.05.2019	NB & DL	2140	Negative
2a	GR95689	227.1	29/03/2019	0.67	Y	13.05.2019	NB & DL	2149	Positive
3	GR95689	213.9	29/03/2019	Spring - no pooling of water and no suitable GCN habitat	N				
4	GR265344	528.1	Over 500m - not required	Spring - no pooling of water and no suitable GCN habitat	N				
5	GR265344	543.3	Over 500m - not required	Spring - no pooling of water and no suitable GCN habitat	N				
6	Gr274497	530.5	06/05/2018	Spring - no pooling of water and no suitable GCN habitat	N				
7	GR95689	303.4	29/03/2019	Spring - no pooling of water and no suitable GCN habitat	N				
8	GR95689	263.3	09/05/2019	0.53	N - not enough water				

9	GR329311	63.1	06/05/2018	0.55	Y	06/06/2018	JD & JDD & RW	1921	Negative
10	GR168463	475.8	06/05/2018	Spring - no pooling of water and no suitable GCN habitat	N				
11	GR382246	489.2	06/05/2018	Spring - no pooling of water and no suitable GCN habitat	N				
12	GR382246	492.8	06/05/2018	Spring - no pooling of water and no suitable GCN habitat	N				
13	GR159309	436.5	04/05/2017	0.67	Y	05/06/2018	JD & AC	1926	Negative
14	GR159562	344.9	05/06/2018	0.69	Y	05/06/2018	JD & AC	1925	Negative
15	GR308763	514.8	27/06/2018	0.73	y	27/06/2018	CD JDD	3110	Positive
16	U00014	552.2	07.06.2017	0.63	N – over 500m				
17	GR223691	561.1	03.08.2018	0.52	N – over 500m				
18	GR405759	480	07.06.2017	0.8	Y	27/06/2018	JD & AC	3741	Negative
19	GR405759	496.8	27/06/2018	N/A-Dry & Unsuitable	N				
20	U00120	420.3	26/06/2018	0.59	Y	26/06/2018	CD & TS	1920	Negative
21	U00123	435.3	27/06/2018	0.31	N – very poor water quality				
22	GR159309	684.1	03.05.2017	N/A - Dry & Unsuitable	N				
23	GR199134	500.3	03.05.2017	N/A - Dry & Unsuitable	N				
24	GR136598	470	27/06/2018	0.5	Y	27/06/2018	JD & AC	3750	Negative

25	U00053/U00054	226.5	19.04.2017	N/A - Dry & Unsuitable	N				
26	GR175821	469.3	27/06/2018	N/A - Dry & Unsuitable	N				
27	GR159309	1070.8	03.05.2017	N/A - Dry & Unsuitable	N				
28	U00037	16.8	23/05/2018	N/A - no pond - small spring with minor pooling of water in woodland	N				
29	GR383328	128	27/06/2018	0.79	Y	27/06/2018	CD & JDD	1927	Negative
30	GR109711	717.6		N/A - over 500m from scheme	N				
31	GR159309	620	05/06/2018	0.41	Y	06/06/2018	CD & JDD	1929	Negative
32	GR170711	44.6	01/07/2018	Dry and Unsuitable	N				
33	GR201299	709	19/07/2018	0.52	N – over 500m				
34	GR237479	15	01/07/2018	Dry and Unsuitable	N				
35	GR354154	366	24/07/2018	0.63	y	16/05/2019	JD PN	1649	Negative
35a	GR346313	90	17/05/2019	0.66	Y	17/05/2019	JD PN DL	2143	Negative
36	U00125	190	24/07/2018	0.54	y	16/05/2019	JD PN DL	1645	Negative
37	GR150931	20	08/08/2018	0.3	N – small ornamental pond with significant fish presence.				
38	GR138283	180	15/05/2019	0.74	Y	29/05/2019	JD JDD	1644	Negative
1A	GR387647		06/05/2018	0.51	N				
21a	U00120	283	26/06/2018	N/A Dry and Unsuitable swimming pool	N				
26a	U00112	500	27/06/2018	0.68	y	27/06/2018	CD & JDD	1910	Positive



Notes

Legend

- Option 30 Scheme Outline (at time of survey)
- 500m Scheme Buffer
- Positive eDNA Result 500m Buffer

eDNA Result

- No result yet
- Negative
- None
- Positive

PO2	28/10/19	Minor amendments	JW	VH	SM
P01	26/06/19	First Revision	TW	VH	SM
Rev	Date	Amendment Details	Drawn	Chk'd	App'd

Mott MacDonald Sweco



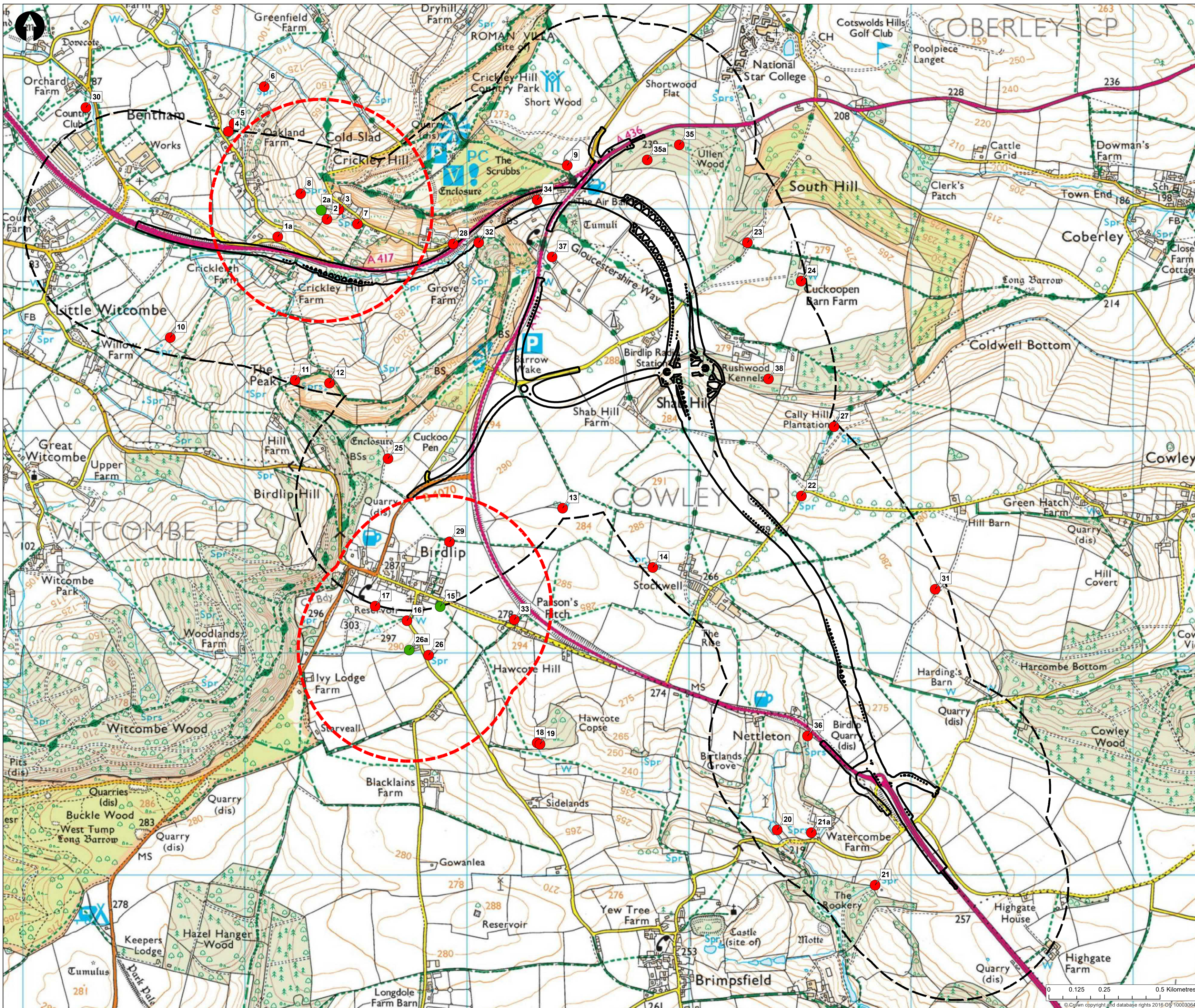
Drawing Status	For Information	Suitability	S2
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Project Title
A417 Missing Link

Drawing Title
Great Crested Newt Ponds eDNA Survey




Scale	1:8,000	Designed	TW	Drawn	JW	Checked	VH	Approved	SM
Original Size	A1	Date	12/06/19	Date	28/10/19	Date	28/10/19	Date	28/10/19
Drawing Number	HE P19	Originator	551505 - MMSJV - VOL - EBD	Volume	000 - DR - LB - 00044	Project Ref. No.	551505	Revision	P02
Location		Type		Role		Number			

Appendix E - Presence/Absence Survey Results Map




Notes

Legend

-  Option 30 Scheme Outline (at time of survey)
-  500m Scheme Buffer
-  Positive GCN Result 500m Buffer

Likely Presence

-  Unknown
-  likely absence
-  present

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P02	28/10/19	Minor amendments	JW	VH	SM
P01	26/06/19	First Revision	TW	VH	SM

Mott MacDonald Sweco

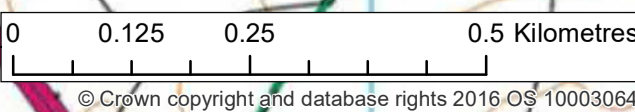


Drawing Status	For Information	Suitability	S02
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Project Title
A417 Missing Link

Drawing Title
Great Crested Newt Population Survey Results

Scale	Designed	Drawn	Checked	Approved
1:8,000	TW	JW	VH	SM
Original Size	Date	Date	Date	Date
A1	12/06/19	28/10/19	28/10/19	28/10/19
Drawing Number	Originator	Volume	Project Ref. No.	
551505 - MMSJV	- VOL	- EBD	551505	
Location	Type	Role	Number	
000	- DR	- LB	- 00045	
			Revision P02	



Appendix F - Presence/Absence Survey Results

AA1 AMPHIBIAN POND SURVEY												
Ecology ID	A417		Land Parcel Reference	GR95689		Date	09/05/2019		Visit Number	1		
Pond Ecology ID	Pond 2		Easting (X)	392409		Northing (Y)		215940				
Surveyor(s)	DL RW											
Weather Conditions (Description)	still, dry, overcast, rain during the day		Cloud Cover	3		Wind		2				
			Rain	0								
Air Temperature at Time of Torching (°C)	10		Minimum Overnight Temperature (°C)	6		Torch Power		1,000,000				
Turbidity	3		Vegetation Cover	2		Pond Margin Inaccessible (%)		0				
Survey Methods Used	Torching			Bottle-trapping			Netting			Egg Search	Refuge Search	
	Yes			Yes			No					
3	Start time (24 hours)	22:00		Number of traps used	2					Yes	No	
	Finish time (24 hours)	22:05										
Species	Sex/life stage			Sex/life stage			Sex/life stage			(using any method) Larvae		
	Male	Female	Unknown sex	Male	Female	Immature	Male	Female	Immature			
Great Crested Newt												
Smooth Newt												
Palmate Newt												
Smooth or Palmate Newt			3									
Species	Adults		Juveniles		Tadpoles		Spawn		Comments (incl. justification for deviation from torch, bottle-trap, egg search)			
Common Frog	1								Very small lined-pond, reduced in size by vegetation and silt over recent years. Only a small area of two square metres suitable for bottle trapping.			
Common Toad												
Other Amphibian (state)									Photo References			
										Are further surveys needed?		Yes

AA1 AMPHIBIAN POND SURVEY												
Ecology ID	A417		Land Parcel Reference	GR95689		Date	15/05/2019		Visit Number	2		
Pond Ecology ID	Pond 2		Easting (X)	392409		Northing (Y)		215940				
Surveyor(s)	DL NB											
Weather Conditions (Description)	still, dry, sunny, recent days very warm		Cloud Cover	1		Wind		2				
			Rain	0								
Air Temperature at Time of Torching (°C)	13		Minimum Overnight Temperature (°C)	8		Torch Power		1,000,000				
Turbidity	3		Vegetation Cover	2		Pond Margin Inaccessible (%)		0				
Survey Methods Used	Torching			Bottle-trapping			Netting			Egg Search	Refuge Search	
	Yes			Yes			No					
3	Start time (24 hours)	22:00		Number of traps used	2					Yes	No	
	Finish time (24 hours)	22:05										
Species	Sex/life stage			Sex/life stage			Sex/life stage			(using any method) Larvae		
	Male	Female	Unknown sex	Male	Female	Immature	Male	Female	Immature			
Great Crested Newt												
Smooth Newt												
Palmate Newt												
Smooth or Palmate Newt			1									
Species	Adults		Juveniles		Tadpoles		Spawn		Comments (incl. justification for deviation from torch, bottle-trap, egg search)			
Common Frog	1								Very small lined-pond, reduced in size by vegetation and silt over recent years. Only a small area of two square metres suitable for bottle trapping. Netting difficult in shallow water			
Common Toad												
Other Amphibian (state)									Photo References			
										Are further surveys needed?		Yes

AA1 AMPHIBIAN POND SURVEY												
Ecology ID	pond 2		Land Parcel Reference	GR95689		Date	20/05/2019		Visit Number	3		
Pond Ecology ID	pond 2		Easting (X)	392398		Northing (Y)		215944				
Surveyor(s)	JD MC											
Weather Conditions (Description)	humid, wet overcast conditions		Cloud Cover	7		Wind		2				
			Rain	2								
Air Temperature at Time of Torching (°C)	11		Minimum Overnight Temperature (°C)	7		Torch Power		1,000,000				
Turbidity	5		Vegetation Cover	5		Pond Margin Inaccessible (%)		0				
Survey Methods Used	Torching			Bottle-trapping			Netting			Egg Search	Refuge Search	
	No			Yes			Yes					
4	Start time (24 hours)		21:25		Number of traps used	2		Yes			Yes	Yes
	Finish time (24 hours)		21:35									
Species	Sex/life stage			Sex/life stage			Sex/life stage			(using any method) Larvae		
	Male	Female	Immature	Male	Female	Immature	Male	Female	Immature			
Great Crested Newt												
Smooth Newt												
Palmate Newt				1	2		1					
Smooth or Palmate Newt											2	
Species	Adults		Juveniles		Tadpoles		Spawn		Comments (incl. justification for deviation from torch, bottle-trap, egg search)			
Common Frog					No		No		No torching undertaken as turbidity high.			
Common Toad					No		No					
Other Amphibian (state)					No		No		Photo References			
										Are further surveys needed?		Yes

AA1 AMPHIBIAN POND SURVEY												
Ecology ID	pond 2			Land Parcel Reference	GR95689		Date	23/05/2019		Visit Number	4	
Pond Ecology ID	pond 2			Easting (X)	392344		Northing (Y)		215944			
Surveyor(s)	BG MC											
Weather Conditions (Description)	dry			Cloud Cover		4		Wind		2		
				Rain		0						
Air Temperature at Time of Torching (°C)	15			Minimum Overnight Temperature (°C)		11		Torch Power		1,000,000		
Turbidity	3			Vegetation Cover		5		Pond Margin Inaccessible (%)		0		
Survey Methods Used	Torching			Bottle-trapping			Netting			Egg Search	Refuge Search	
	Yes			Yes			No					
	3	Start time (24 hours)	21:45	Number of traps used		2						
	Finish time (24 hours)	21:50								Yes	No	
Species	Sex/life stage			Sex/life stage			Sex/life stage			(using any method) Larvae		
	Male	Female	Immature	Male	Female	Immature	Male	Female	Immature			
Great Crested Newt												
Smooth Newt												
Palmate Newt												
Smooth or Palmate Newt												
Species	Adults		Juveniles		Tadpoles		Spawn		Comments (incl. justification for deviation from torch, bottle-trap, egg search)			
Common Frog	0		0		No		No		Shallow water makes netting difficult			
Common Toad	0		0		No		No					
Other Amphibian (state)	0		0		No		No					
Photo References												
Are further surveys needed?										No		

AA1 AMPHIBIAN POND SURVEY												
Ecology ID	A417		Land Parcel Reference	GR95689		Date	09/05/2019		Visit Number	1		
Pond Ecology ID	2a		Easting (X)	392349		Northing (Y)		215979				
Surveyor(s)	DL RW											
Weather Conditions (Description)	dry still evening, cool		Cloud Cover	3		Wind		4				
			Rain	0								
Air Temperature at Time of Torching (°C)	10		Minimum Overnight Temperature (°C)	6		Torch Power		1,000,000				
Turbidity	2		Vegetation Cover	3		Pond Margin Inaccessible (%)		0				
Survey Methods Used	Torching			Bottle-trapping			Netting			Egg Search	Refuge Search	
	No			Yes			No					
3	Start time (24 hours)	21:50		Number of traps used	5					Yes	Yes	
	Finish time (24 hours)	22:00										
Species	Sex/life stage			Sex/life stage			Sex/life stage			(using any method) Larvae		
	Male	Female	unknown sex	Male	Female	Immature	Male	Female	Immature			
Great Crested Newt												
Smooth Newt												
Palmate Newt	2	3		1	5							
Smooth or Palmate Newt			1							1		
Species	Adults		Juveniles		Tadpoles		Spawn		Comments (incl. justification for deviation from torch, bottle-trap, egg search)			
Common Frog									covered 95% by duckweed, water only deep enough around 25% of margin, allowing 5 bottles			
Common Toad												
Other Amphibian (state)									Photo References			
										Are further surveys needed?		Yes

AA1 AMPHIBIAN POND SURVEY												
Ecology ID	A417		Land Parcel Reference	GR95689		Date	15/05/2019		Visit Number	2		
Pond Ecology ID	2a		Easting (X)	392349		Northing (Y)		215979				
Surveyor(s)	DL NB											
Weather Conditions (Description)	dry still evening, warm recent days		Cloud Cover	1		Wind		2				
			Rain	0								
Air Temperature at Time of Torching (°C)	13		Minimum Overnight Temperature (°C)	8		Torch Power		1,000,000				
Turbidity	2		Vegetation Cover	3		Pond Margin Inaccessible (%)		0				
Survey Methods Used	Torching			Bottle-trapping			Netting			Egg Search	Refuge Search	
	No			Yes			No					
3	Start time (24 hours)	21:45		Number of traps used	4					Yes	Yes	
	Finish time (24 hours)	21:55										
Species	Sex/life stage			Sex/life stage			Sex/life stage			(using any method) Larvae		
	Male	Female	unknown sex	Male	Female	Immature	Male	Female	Immature			
Great Crested Newt					2							
Smooth Newt				1								
Palmate Newt				4	4							
Smooth or Palmate Newt			5									
Species	Adults		Juveniles		Tadpoles		Spawn		Comments (incl. justification for deviation from torch, bottle-trap, egg search)			
Common Frog									covered 95% by duckweed, water only deep enough around 25% of margin. Water level dropped several inches from last week, limiting open water even more.			
Common Toad												
Other Amphibian (state)									Photo References			
										Are further surveys needed?		Yes

AA1 AMPHIBIAN POND SURVEY												
Ecology ID	pond 2a			Land Parcel Reference	GR95689		Date	20/05/2019		Visit Number	3	
Pond Ecology ID	pond 2a			Easting (X)	392344		Northing (Y)		215990			
Surveyor(s)	JD MC											
Weather Conditions (Description)	light rain, humid with almost completely cloud cover. intervals of drizzle to light rain didn't prevent survey			Cloud Cover	7		Wind		2			
				Rain	2							
Air Temperature at Time of Torching (°C)	12			Minimum Overnight Temperature (°C)	7		Torch Power		1,000,000			
Turbidity	4			Vegetation Cover	4		Pond Margin Inaccessible (%)		0			
Survey Methods Used	Torching			Bottle-trapping			Netting			Egg Search	Refuge Search	
	No			Yes			No					
3	Start time (24 hours)	21:25		Number of traps used	5					Yes	Yes	
	Finish time (24 hours)	21:35										
Species	Sex/life stage			Sex/life stage			Sex/life stage			(using any method) Larvae		
	Male	Female	Immature	Male	Female	Immature	Male	Female	Immature			
Great Crested Newt				1	1							
Smooth Newt												
Palmate Newt	2	1		6	2							
Smooth or Palmate Newt												
Species	Adults		Juveniles		Tadpoles		Spawn		Comments (incl. justification for deviation from torch, bottle-trap, egg search)			
Common Frog	1		0		No		No		Common frog observed 15 m from pond 2a. Two roman snails were recorded. Water turbid and duckweed cover prevents torching. Shallow water difficult for netting			
Common Toad	3		0		No		No					
Other Amphibian (state)	0		0		No		No		Photo References			
										pond 2a general photo		
										Are further surveys needed?		Yes

AA1 AMPHIBIAN POND SURVEY												
Ecology ID	pond 2a			Land Parcel Reference	GR95689		Date	23/05/2019		Visit Number	4	
Pond Ecology ID	pond 2a			Easting (X)	392344		Northing (Y)		215944			
Surveyor(s)	BG MC											
Weather Conditions (Description)	dry			Cloud Cover		4		Wind		2		
				Rain		0						
Air Temperature at Time of Torching (°C)	15			Minimum Overnight Temperature (°C)		11		Torch Power		1,000,000		
Turbidity	3			Vegetation Cover		5		Pond Margin Inaccessible (%)		0		
Survey Methods Used	Torching			Bottle-trapping			Netting			Egg Search	Refuge Search	
	No			Yes			No					
	3	Start time (24 hours)	21:45	Number of traps used		2						
	Finish time (24 hours)	21:50								Yes	Yes	
Species	Sex/life stage			Sex/life stage			Sex/life stage			(using any method)	Larvae	
	Male	Female	Immature	Male	Female	Immature	Male	Female	Immature			
Great Crested Newt												
Smooth Newt												
Palmate Newt	5			1								
Smooth or Palmate Newt												
Species	Adults		Juveniles		Tadpoles		Spawn		Comments (incl. justification for deviation from torch, bottle-trap, egg search)			
Common Frog					No		No		Duckweed cover prevents torching; shallow water difficult for netting			
Common Toad					No		No					
Other Amphibian (state)					No		No		Photo References			
										Are further surveys needed?		Yes

AA1 AMPHIBIAN POND SURVEY												
Ecology ID	Palmer A417			Land Parcel Reference	GR95689		Date	28/05/2019		Visit Number	5	
Pond Ecology ID	2a			Easting (X)	392349		Northing (Y)		215979			
Surveyor(s)	DL &JDD & BC											
Weather Conditions (Description)	dry still evening, warmer nights			Cloud Cover	8		Wind		2			
				Rain	0							
Air Temperature at Time of Torching (°C)	15			Minimum Overnight Temperature (°C)	10		Torch Power		1,000,000			
Turbidity	2			Vegetation Cover	3		Pond Margin Inaccessible (%)		0			
Survey Methods Used	Torching			Bottle-trapping			Netting			Egg Search	Refuge Search	
	No			Yes			No					
3	Start time (24 hours)		22:00	Number of traps used		5					Yes	Yes
	Finish time (24 hours)		22:10									
Species	Sex/life stage			Sex/life stage			Sex/life stage			(using any method) Larvae		
	Male	Female	Unknown sex	Male	Female	Immature	Male	Female	Immature			
Great Crested Newt												
Smooth Newt												
Palmate Newt	1	1		5	4							
Smooth or Palmate Newt			2									
Species	Adults		Juveniles		Tadpoles		Spawn		Comments (incl. justification for deviation from torch, bottle-trap, egg search)			
Common Frog									Still largely covered by duckweed, torching not effective method.			
Common Toad												
Other Amphibian (state)									Photo References			
										Are further surveys needed?		Yes

AA1 AMPHIBIAN POND SURVEY												
Ecology ID	A417		Land Parcel Reference	GR95689		Date	30/05/2019		Visit Number	6		
Pond Ecology ID	2a		Easting (X)	392349		Northing (Y)		215979				
Surveyor(s)	NB CD											
Weather Conditions (Description)	dry still evening, warm recent dates			Cloud Cover	4		Wind		2			
				Rain	0							
Air Temperature at Time of Torching (°C)	13		Minimum Overnight Temperature (°C)	8		Torch Power		1,000,000				
Turbidity	4		Vegetation Cover	3		Pond Margin Inaccessible (%)		0				
Survey Methods Used	Torching			Bottle-trapping			Netting			Egg Search	Refuge Search	
	No			Yes			No					
3	Start time (24 hours)		21:45		Number of traps used		4		Yes	Yes		
	Finish time (24 hours)		21:55									
Species	Sex/life stage			Sex/life stage			Sex/life stage			(using any method) Larvae		
	Male	Female	unknown sex	Male	Female	Immature	Male	Female	Immature			
Great Crested Newt												
Smooth Newt					2							
Palmate Newt				5	9							
Smooth or Palmate Newt												
Species	Adults		Juveniles		Tadpoles		Spawn		Comments (incl. justification for deviation from torch, bottle-trap, egg search)			
BIAN POND									covered 95% by duckweed, water only deep enough around 25% of margin. Water level dropped several inches from last week, limiting open water even more.			
Common Toad												
Other Amphibian (state)								Photo References				
									Are further surveys needed?		No	

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.16
Reptile Survey Technical Report

28 September 2020

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Executive Summary

The proposed A417 Missing Link scheme aims to provide a dual carriageway to a current stretch of single carriageway between the Cowley roundabout and Crickley Hill. The scheme would increase capacity by creating a free-flowing link between the Brockworth Bypass and Cowley roundabout, resulting in a continuous flow between the M4 Junction 15 (Swindon) and the M5 Junction 11a (Gloucester/Cheltenham).

A habitat suitability assessment was completed identifying all suitable reptile habitat within 100m of the scheme, which is the likely distance the scheme impacts are to extend for reptiles. From this desk assessment 50 sites were identified which required further investigation. Eighteen sites were subsequently identified as offering suitable habitat with potential to support common reptile species; these areas required further presence/absence surveys, which were undertaken between June and October 2018. At sites where presence of reptiles was confirmed, population estimate surveys were undertaken between March 2019 and September 2019.

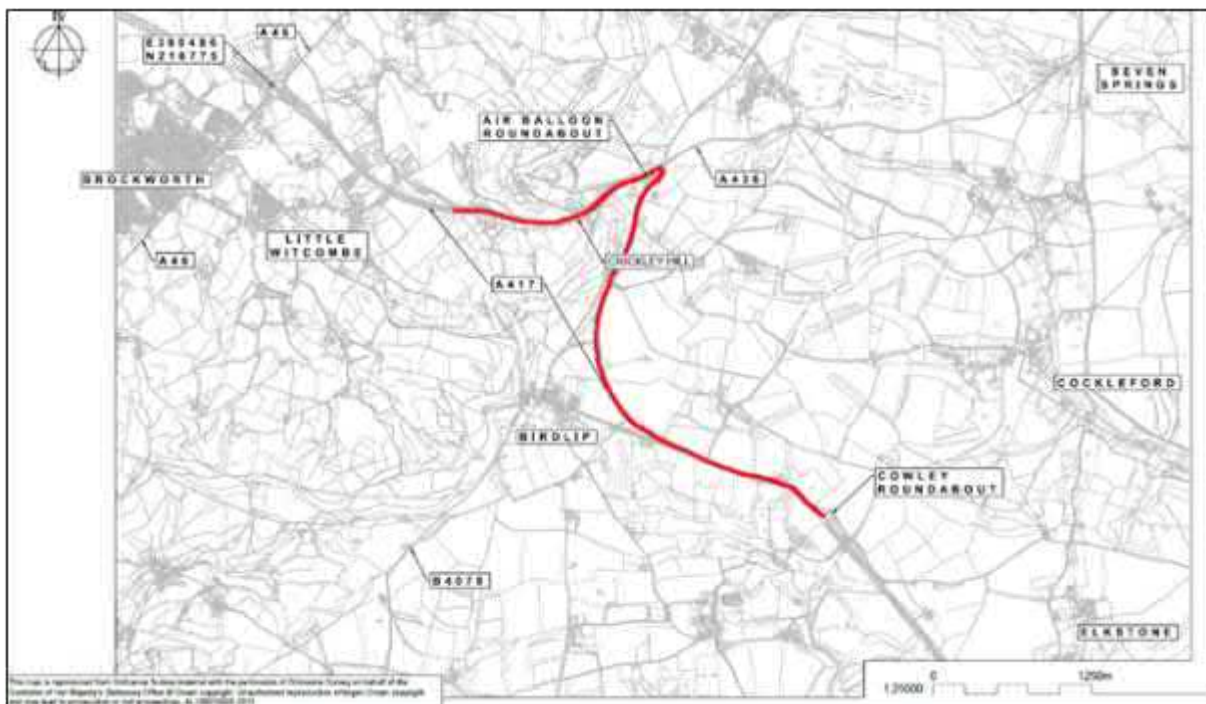
Surveys identified the presence of reptiles within 100m of the scheme at 17 of the 18 surveyed sites. Eleven of the 18 survey sites were identified as having good or exceptional reptile populations. All four species of common reptile were found on the scheme.

1. Introduction

1.1. Background

- 1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and as an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'missing link', forms the only section of single carriageway along the route, with an at-grade junction located at the 'Air Balloon' public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5km stretch shown on Figure 1.1 below.

Figure 1.1 Current A417 route and scheme extent



1.2. Purpose of the Report

- 1.2.1. This Stage 2 reptile Technical Report has been prepared during Stage 2 of Highways England's Project Control Framework (PCF). This document presents the reptile Technical Report that has been prepared to date for the proposed A417 Missing Link scheme (hereafter referred to as 'the scheme'). The Technical Report provides an overview of the reptile survey results for the 2018 and 2019 survey period.

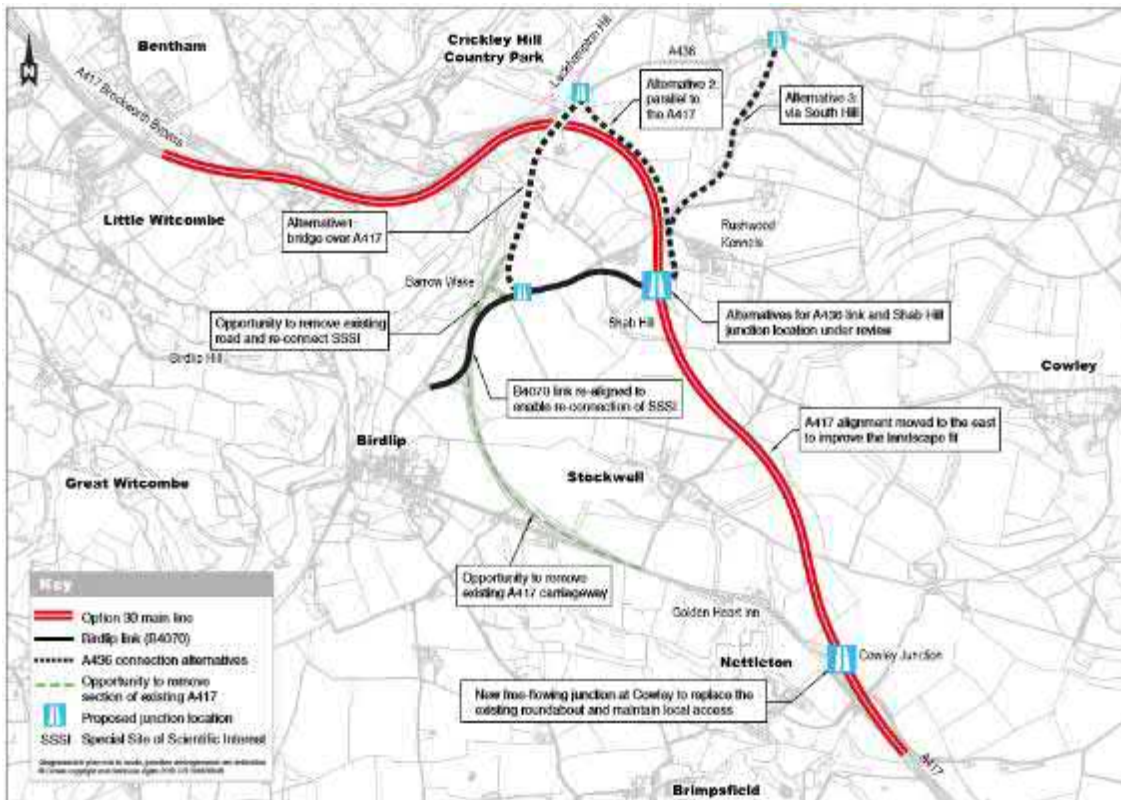
1.3. Overview of the Scheme

- 1.3.1. The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill.
- 1.3.2. The proposed scheme would aim to increase capacity by creating a free-flowing link between the Brockworth Bypass and the Cowley roundabout and remove the at-grade junction with the A436 (Air Balloon roundabout). This Missing Link will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester / Cheltenham (M5 Junction 11a). The current road and the extent of any proposed scheme is illustrated in Figure 1.1.

Option 30

- 1.3.3. Option 30 is the chosen preferred route option as of May 2019. Option 30 is a 5.6km long surface route following the route of existing A417 at Crickley Hill, but with less of a slope. A new section of road would be built through Shab Hill to the east of the existing A417, re-joining the existing road near Cowley roundabout, shown in figure 1.2 below. There would be 3 lanes of carriageway going up Crickley Hill and 2 lanes coming down, with 2 lanes in both directions after the hill. Option 30 would include 2 new slip road junctions:
- A slip road junction at Shab Hill for local and A436 traffic to join or leave the A417 by way of a new link road.
 - A slip road junction to replace the existing Cowley roundabout for traffic to Nettleton Bottom, Cowley, Elkstone and other local destinations.
- 1.3.4. A new link road would be built between the slip road junction at Shab Hill and the existing A417 to connect traffic to and from Birdlip and the A436 with the new A417. This new link road would end in a new roundabout near Barrow Wake.

Figure 1.2: A417 Missing link proposed option 30



1.4. Scope of the Report

1.4.1. The objectives of this report are:

- to present the methodology, constraints and results of the presence/absence and population estimate surveys
- to present the relative abundance of the common reptile populations, if any

1.4.2. Guidance on ecological assessments recommends that all ecological features that occur within a zone of influence (ZoI) for a proposed scheme are investigated (CIEEM, 2016)¹. All areas within 100m of the proposed scheme footprint were assessed for reptile habitat suitability.

1.5. Legislation

Legal Protection

1.5.1. Due to the geographical location of the scheme, only 4 widespread species of reptile could potentially be encountered. Rare species such as the smooth snake *Coronella austriaca* and sand lizard *Lacerta agilis* have restricted ranges, so

¹ Chartered Institute of Ecology and Environmental Management (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal

their distribution and habitat preferences are not represented within the study area. Therefore, rare species are not considered any further as part of this assessment.

- 1.5.2. The 4 widespread species of reptile that could be present comprise the common lizard *Zootoca vivipara*, slow worm *Anguis fragilis*, grass snake *Natrix natrix* and adder *Vipera berus*. They are protected under Schedule 5 (Sections 9.1, 9.5a, 9.5b) of the Wildlife and Countryside Act 1981 (as amended), it is illegal to:
- Intentionally or deliberately kill, injure or take any reptiles
 - possess or advertise / sell / exchange a reptile (dead or alive) or any part of a reptile

1.6. Status of Reptiles at a National Level

- 1.6.1. Four common reptiles and two rare reptiles species are native to the UK. Slow worms and common lizards are widespread and likely to occur nationally, but adders and grass snakes are less widespread, largely due to habitat loss. Adders have decreased in range and numbers considerably over the past 50 years and are noted as a priority Species under the UK Post-2010 Biodiversity Framework.

1.7. Status of reptiles at county Level

- 1.7.1. Gloucestershire Council places a large emphasis on reptile conservation. There are large areas within the county of suitable habitat which may house extensive populations of all 4 common reptile species.
- 1.7.2. Gloucestershire Centre for Environmental Records (GCER) lists all reptile species as being recorded in the county, refer to Appendix A. In addition, the slow worm is listed in the local Biodiversity Action Plan (BAP) for South Gloucestershire as a local priority species.

1.8. Reptile ecology

Grass Snake

- 1.8.1. Due to a diet consisting largely of frogs, toads and newts, the grass snake generally utilises fresh water habitats near to areas of open grassland.
- 1.8.2. Grass snake hibernacula generally comprise of disused rabbit holes within well drained slopes.
- 1.8.3. They can be observed basking near to hibernacula during the springtime in the evening and early morning.

- 1.8.4. Grass snakes lay shelled eggs, usually within compost heaps or similar areas providing warmth to aid incubation.

Common Lizard

- 1.8.5. The common lizard favours habitat which has a complex structure, for example mature grassland with scattered scrub, stone walls and heathland.
- 1.8.6. Mating takes place in spring and females give birth to live young in August.
- 1.8.7. The common lizard prefers open sunny locations for basking and is usually found in dry, exposed locations where dense cover exists close by.
- 1.8.8. Common lizards feed predominantly on spiders and insects.

Slow Worm

- 1.8.9. Slow worms are often found in low intensity managed grassland, sheltering and foraging within grass that has developed into a thatch like structure.
- 1.8.10. Slow worms are often found in disused hay meadows, landfill sites, gardens, allotments, highway verges and brownfield sites and are widespread throughout the UK.
- 1.8.11. Slow worms feed on slow-moving soft bodied prey items, particularly small slugs.

Adder

- 1.8.12. The adder is found throughout Britain, occurring most commonly in open habitats such as heathland, moorland, open woodland and sea cliffs, and rarely stray into gardens.
- 1.8.13. Mating takes place in April to May and female adders incubate their eggs internally and give birth to live young in August or September.
- 1.8.14. Adders feed largely on small rodents and lizards. They are creatures of habit, returning to the same hibernacula annually.
- 1.8.15. They are a Priority Species under the UK Post-2010 Biodiversity Framework.

2. Methodology

2.1. Desk Study

- 2.1.1. Biological records within a 2km radius of the proposed scheme were acquired from the Gloucestershire Centre for Environmental Records (GCER) in February 2017. The results of this data search are summarised in Appendix A. This included protected species, notable habitats and statutory and non-statutory designated sites.
- 2.1.2. In addition to the GECR data search, data was also obtained in 2018 from the National Trust and Gloucestershire Wildlife Trust, which indicated the presence of priority species adder at Crickley Hill Country Park. James Weston from South Gloucestershire amphibian and reptile group (SGARG) is undertaking monitoring of the Crickley Hill site for adders and has kindly provided his survey results. These study areas were not monitored by Mott MacDonald to avoid disturbance and population overestimates. The SGARG data is included in Chapter 3.
- 2.1.3. All potentially suitable habitats directly impacted by the scheme were identified using the MAGIC online viewer tool (Defra, 2017) and the use of 1:10,000 Ordnance Survey Mapping and aerial photography. These were recorded and given a unique identifier. At the time of the desk study and subsequent surveys in 2018, there were two options under consideration. The desk study therefore identified all potentially suitable habitat directly affected these two options. Since the announcement of the preferred route in March 2019 only sites affected by route option 30 were surveyed further during the 2019 survey season.

2.2. Habitat Assessment

- 2.2.1. An extended Phase 1 Habitat Survey was undertaken in May and June 2017 by two experienced Mott MacDonald Ecologists. Suitable habitat within a 100m radius of the scheme was identified and assessed further to determine whether these areas had the appropriate habitat structure to support reptile populations. This was based on the following characteristics:

- Location in relation to species range
- Vegetation structure
- Insolation (exposure to sun)
- Aspect
- Connectivity to other good quality habitat
- Prey abundance
- Refuge opportunities
- Hibernation habitat potential

- Disturbance
- Egg-laying site potential (for Grass Snake only)

2.2.2. The habitat assessment graded each habitat as having either “low”, “medium” or “high” potential to support reptiles, based on the criteria above.

2.3. Field Survey

- 2.3.1. At sites identified as providing potential reptile habitat, survey sites were set up. A mix of corrugated tin, onduline and roofing felt tiles measuring 0.5 metres by 0.5 metres were deployed at each site with the potential to support reptiles, in areas of suitable habitat. The tiles act as artificial refugia; attractive to reptiles as basking locations as they heat up quicker than the surrounding environment, as well as providing cover.
- 2.3.2. In linear habitats, such as road verges and field margins, refugia were placed approximately every 10 metres. Conversely, in non-linear habitats (entire fields and woodland), a density of around 10 tiles per hectare was deployed. Each tile was numbered with spray paint and a GPS location recorded.
- 2.3.3. After a settling-in period of at least 7 days, surveys on each habitat area were undertaken to check for reptiles. As well as checking the artificial refugia, surveyors checked any suitable natural refugia (e.g. logs, stones) and conducted a visual search between refugia. Details including refugia number, species, life stage (adult, sub-adult, juvenile) and sex (when possible) were recorded on a survey proforma, along with weather, time and date. Each visit was conducted during the following conditions:
- Time: conducted between 07:00 and 19:00
 - Air temperature: 10°C - 20°C
 - Wind: still to moderate (equivalent to Beaufort 4; 13 - 17mph)
 - Rain: no or light rain only at time of survey. Surveys between periods of heavy rain (when all other conditions are suitable) are also acceptable.
- 2.3.4. Sites were initially subjected to seven visits to determine presence or likely absence. Following these initial surveys, the number of surveys was extended to twenty visits to provide a more accurate estimate of population sizes on the sites where presence had been confirmed. Surveys were undertaken in suitable weather conditions, between June and October 2018 and March to September 2019, to determine presence or likely absence of reptiles. No reptiles were identified at site 48 during the initial 7 survey visits. However, surveys were continued at this site for a total to 16 survey visits due to its proximity to site 45 and its connectivity to Crickley Hill. However, following 16 visits with no reptiles recorded, surveys were stopped at this site. All other sites that were surveyed for

Option 30 recorded positive results and were subject to population estimate surveys.

- 2.3.5. Due to the presence of the priority species; adder, during the 2019 survey season, specific adder sites were set up in suitable locations alongside existing reptile sites. Adder survey sites were targeted in areas which provided high quality habitat such as areas of rough grassland and scrub with suitable hibernacula features such as bunds or hedge banks. Surveys at adder sites were commenced in March 2019 to capture the early part of the season when adders emerge from hibernacula.
- 2.3.6. Population size and importance of reptile population is assessed according to categories described under Froglife Advice Sheet 10: Reptile Survey. These identify site importance for reptiles according to the maximum number of adult animals recorded by a single surveyor on a single day during observation and refuge checks, where artificial refugia are at a density of 10 per hectare².
- 2.3.7. The site monitored by SGARG was an exception to this. The survey results are derived from a pre-existing reptile monitoring site with a density of refugia lower than 10 per hectare. The tile density is unknown; therefore a calculation has been made based on an estimate of 10 tiles per hectare.
- 2.3.8. Each population category present is awarded a score, these are totalled to estimate site importance. Categories summarised in Table 1.

Table 1: Reptile Population Score Categories

Species	Low population (Score 1)	Good population (Score 2)	Exceptional population (Score 3)
Slow worm	< 5	5-20	>20
Common lizard	< 5	5-20	>20
Adder	< 5	5-10	>10
Grass snake	< 5	5-10	>10

Source: Froglife Advice Sheet 103

- 2.3.9. Each population present is also awarded a population density score. This is calculated using the 'maximum number recorded over single visit' (also known as the peak count) divided by the area of the habitat available. The population density scores are given in Table 2 below. Values related to the number of individuals per hectare.

² Froglife 2015, Surveying for Reptiles: Tips, techniques and skills to help you survey for reptiles. <https://www.froglife.org/wp-content/uploads/2013/06/Reptile-survey-booklet-3mm-bleed.pdf>

³ Froglife 1999, Reptile Survey: An introduction to planning, conducting and interpreting surveys for snake and lizards conservation https://www.wildcare.co.uk/media/wysiwyg/pdfs/froglife_advice_sheet_10_-_reptile_surveys.pdf

Table 2: Reptile Population Density Categories

Species	Low	Medium	High
Slow Worm	<50 / hectare	50 – 100 / hectare	>100 / hectare
Common Lizard	<20 / hectare	20 – 80 / hectare	>80 / hectare
Adder	<2 / hectare	2 – 4 / hectare	>4 / hectare
Grass Snake	<2 / hectare	2 – 4 / hectare	>4 / hectare

Source: Adapted from Herpetofauna Groups of Great Britain and Ireland⁴.

2.3.10. As a general rule, sites are automatically classed as of importance to reptile species if they:

- support 3 or more reptile species
- support 2 snake species
- support an exceptional population of 1 species
- support an assemblage of species scoring at least 4 (according to a total of score obtained from Table 1 above)
- are of significant regional importance due to local rarity

2.4. Site Status Assessment

2.4.1. Following the completion of the surveys an assessment of the status of the site was then made. The importance of the site takes into account the population estimate but also several other factors:

- The quality and rarity of the habitat and population,
- How connected the population is to the wider area,
- The local significance of the population and
- The estimated size of the population.

2.5. Survey Constraints

2.5.1. Where reptiles have not been identified as occupying an area, this does not guarantee their absence. There is always the risk of reptiles being over-looked due to use of the artificial refugia and abundance of natural habitat. Along with potentially low populations, some may go undetected.

⁴ Herpetofauna Groups of Great Britain and Ireland (1998) Evaluating local mitigation/translocation programmes: Maintaining best practice and lawful standards. <https://www.arguk.org/downloads-in-pages/resources/scientific-and-technical-reports/4-evaluating-local-mitigation-translocation-best-practice-and-lawful-standards/file>

- 2.5.2. Access was granted for nearly all sites with suitable reptile habitat. Table 3 below shows the 18 sites that had 20 surveys completed across two survey seasons.
- 2.5.3. Access to site 39 was restricted at certain times throughout the season and was also only permitted on Tuesdays. These access restrictions meant that in order to achieve the full 20 survey visits, two surveys were undertaken on the same day on a number of occasions. Where 2 surveys were undertaken, these were done in the morning and late afternoon, depending on suitable weather conditions.
- 2.5.4. Access for some reptile sites was not granted until later in the 2018 survey window and some sites were not set up until the beginning of the 2019 survey period. Specific adder sites were set up due to the regional importance of the species.
- 2.5.5. The suitability of areas of areas changed throughout the years with various sites being cut, grazed and vulnerable to public interference.

Table 3 Reptile site summary and set up date

Reptile Site	Adder Site	Reptile set up 2018	Reptile set up 2019	Adder site up date 2019
2	A5	August 2018	April 2019	March 2019
3	-	-	May 2019	-
6	A1	-	April 2019	March 2019
8	-	June 2018	May 2019	-
10	-	May 2018	-	-
18	A18	-	April 2019	April 2019
21	-	May 2018	April 2019	-
25	A10	-	April 2019	April 2019
39	-	-	April 2019	-
41	-	June 2018	April 2019	-
43	A43	August 2018	April 2019	April 2019
44	A8	August 2018	April 2019	March 2019
45	-	August 2018	April 2019	-
46	A6	August 2018	April 2019	March 2019
47	A9	August 2018	March 2019	March 2019
48	A4	August 2018	March 2019	March 2019
49	A7		March 2019	March 2019
ARG		South Gloucestershire Amphibian and Reptile Group monitoring site. No monitoring from Mott MacDonald to avoid disturbance and remove duplicate results.		

-
- 2.5.6. A small number of felts we destroyed by livestock or by habitat management e.g. grass cutting. However, these were replaced as soon as where necessary (Site 2). A small number were also disturbed and moved by members of the public who believed they were litter (Site 41, 45 and 48).
- 2.5.7. Where sites were made unsuitable during the course of the seasons due to various reasons these surveys were stopped, and felts collected.
- 2.5.8. A number of surveys were undertaken in July 2019, outside of the optimal survey season. Surveys in July are not normally undertaken as the typical higher temperatures mean that reptiles do not need to visit survey tiles to warm up. Surveys were undertaken in July due to a period of poor weather in June delaying surveys, as well as certain site access restrictions meaning that to undertake 20 survey visits, surveys had to continue in July. However, this is not considered to be a significant constraint as surveys on all sites extended over a wide part of the survey season, and were not restricted to sub-optimal months. Surveys were only undertaken during suitable temperatures and the July surveys provided some valuable results, including recordings of adder on sites where none had been recorded during the spring surveys. Overall, the surveys are considered to provide a robust assessment of the distribution and abundance of reptiles along the corridor of the proposed scheme.
- 2.5.9. Reptile site 3 was only subject to 17 surveys (out of 20 surveys to establish population size). However, it is considered that sufficient survey data has been collected at this site to enable a robust conclusion on the likely impact on reptiles to be assessed and for an appropriate mitigation strategy to be developed.
- 2.5.10. Access was not possible during the 2018 or 2019 surveys to a number of land parcels, including GR298558, GR258761 and GR306305. Observations from neighbouring land parcels indicates that suitable reptile habitat is likely to be present within these land parcels and further investigation should be undertaken once access is granted.

3. Results

3.1. Desk Study Results

- 3.1.1. The data search results from GCER revealed records of all four-reptile species up to a 2km radius of the scheme. Refer to Appendix A. Adder, slow worm and common lizard were all found at Crickley Hill Country Park and Barrow Wake SSSI (Site Special Scientific Interest). Both of these sites are within 200m of the scheme. The closest grass snake record was in Bentham 160m away from the scheme in 2008.

3.2. Habitat Assessment

- 3.2.1. All habitat within 100m of the scheme was assessed for its suitability to support reptiles. Fifty sites were originally identified during the desk study as requiring further assessment. During the initial site visits in May 2018 18 of the 50 sites were identified as offering suitable habitat to support common reptile populations. Of the 18 sites 17 were subject to further presence/absence surveys carried out between June and October 2018 and March to June 2019 by Mott MacDonald. 1 site monitoring was undertaken by SGARG.
- 3.2.2. Sixteen surveys were undertaken at Site 48 with no record of reptiles and therefore reptiles are likely absent from this site.
- 3.2.3. The remaining 17 sites are described in more detail in the sections below. A site map which shows the locations of the 17 surveyed sites and the discontinued site 48 is presented in Appendix B. Appendix C displays sites specifically set up for adders, this often overlap with reptile monitoring sites.

3.3. Description of Habitats

Site 2 (Adder 5)

- 3.3.1. Site 2 lies at the southern end of the scheme, south of the Cowley roundabout on the east side of the A417, partly using the underpass. The habitat consists of a long grass and wildflower verge, approximately 3-4 metres wide, which includes cock's foot *Dactylis glomerata*, Yorkshire fog *Holcus lanatus*, creeping buttercup *Ranunculus repens* and vetch *Vicia* species. Patches of thicker vegetation and scrub surrounds the underpass and extends north, with a drystone wall separating the verge from arable fields. High prey availability and plentiful refuge opportunities provide good cover and foraging opportunities for reptiles. Overall this constitutes a medium quality reptile habitat.
- 3.3.2. Figure 3.1 shows the habitat at site 2.

Figure 3.1 Site 2 habitat example



Site 3

3.3.3. Site 3 is a road verge leading from the Cowley roundabout south towards the A417 underpass. The habitat consists of a long grass, bramble, shrubs and wildflowers, approximately 6-7 metres wide, which includes cock's foot, Yorkshire fog, creeping buttercup and vetch species. Patches of thicker vegetation and scrub appear as you get closer to the underpass and extends along to reptile site 2. High prey availability and plentiful refuge opportunities provide good cover and foraging opportunities for reptiles. This area is regularly mown, at time of survey some long dense grass and partly mown sections are present. A small wooded area borders this site and is connected to grazed farmland. Overall this constitutes a medium quality reptile habitat.

3.3.4. Figure 3.2 below provides an example of the habitat present at site 3.

Figure 3.2 Site 3 habitat example



Site 6 (Adder 1)

3.3.5. Site 6 is located on the east side of the current A417, in the disused Birdlip quarry site, recently used as bike track. This site is a mixture of bare ground, long semi-improved grassland and shrub, connected to site 8, 150m north. A

large number of bare earth tracks through areas of diverse plant species. A large number of natural refugia and basking areas. The site is connected to surrounding farmland with a diverse sward structure. Various scrub patches and a beech *Fagus sylvatica* woodland to south. Species present include selfheal *Prunella*, wild thyme *Thymus serpyllum*, pyramidal orchid *Anacamptis pyramidalis*, common spotted orchid *Dactylorhiza fuchsii*, bee orchid *Ophrys apifera*, willowherb *Epilobium* sp rosebay willowherb *Chamaenerion angustifolium*, white clover *Trifolium repens*, false oat grass *Arrhenatherum elatius*, oxeye daisy *Leucanthemum vulgare* and fox and cubs *Pilosella aurantiaca*. Overall this constitutes a high-quality reptile habitat.

3.3.6. Figure 3.3 below demonstrates an example of the habitat present.

Figure 3.3 Site 6 habitat example



Site 8

3.3.7. Site 8 is located in Stockwell Farm and is situated between grazing fields and is a wide margin approximately 24metres wide, with a larger woodland area to the south. This woodland is continuous with the nettle and bramble-dominated ruderal habitat. A mixture of tall sward and short, dead grass creates a complex vegetation structure. Providing good basking habitat, but mowing regimes may mean reptiles move in and out periodically. Overall this constitutes a medium quality reptile habitat.

3.3.8. Figure 3.4 below demonstrates an example of the habitat present.

Figure 3.4 Site 8 habitat example



Site 10

3.3.9. Site 10 is a wide field margin at Stockwell Farm; close to livestock fields and hard standing areas. The site possesses a complex mosaic structure of different grassland, including good foraging, basking and hibernating potential; log piles, large rocks and other debris litter the hardstanding edges. Combined with a south facing slope and compost heaps 50m to the west across a small farm track also offer good egg-laying habitat for Grass Snakes. High prey availability and excellent connectivity, however overall size and relative isolation makes this area a medium- quality habitat for reptiles.

3.3.10. Figure 3.5 below demonstrates an example of the habitat present.

Figure 3.5 Site 10 habitat example



Site 18 (Adder 18)

3.3.11. Site 18 is a long south facing strip of field margin between two arable fields, comprising improved and rough grassland approximately 5-6metres wide, with variable sward structure including small amounts of scrub creating refuge opportunities. There are various patches of tussock and denser grassland with a more complex species diversity, including; vetch sp *Vicia*, cocks foot *Dactylis*

glomerata, red clover *Trifolium pratense*, birds foot trefoil *Lotus corniculatus*, yorkshire fog *Holcus lanatus*, meadow buttercup *Ranunculus acris* and oxeye daisy *Leucanthemum vulgare*. Egg-laying habitat for grass snakes is limited, but the longer denser patches of grassland connectivity to the wider habitat means that there is high potential for reptiles. Overall this constitutes a high-quality reptile habitat.

3.3.12. Figure 3.6 below demonstrates an example of the habitat present.

Figure 3.6 Site 18 habitat example



Site 21

3.3.13. Site 21 is located within the habitat to the immediate east of the Barrow Wake underpass. The quiet road is bordered by two moderately steep banks covered in a mosaic of short perennial and tall ruderal species which receive plenty of sun. The small shrubs and trees at the top of the bank provide good cover and foraging opportunities; they border the surrounding grazing and pasture fields. Connectivity is limited to a small corridor to the north, along the A417 verge. Overall this constitutes a medium quality reptile habitat.

3.3.14. Figure 3.7 below demonstrates an example of the habitat present.

Figure 3.7 Site 21 habitat example



Site 25 (Adder 10)

3.3.15. Site 25 is split into two sections across a small access track. The north sits in a 2.21ha semi improved grassland field with an arable field margin, with long tufted grass, unmanaged, ungrazed and variable sward structure with longer and shorter sections of grass. The southern section is located in a 5.5ha area of rough grassland. The small shrubs and trees along the access track road provide good cover and foraging opportunities, with a dry-stone wall running along the track. Species include: cock's foot *Dactylis glomerata*, woolly thistle *Cirsium eriophorum*, bird's foot trefoil *Lotus corniculatus*, mouseear *Cerastium*, Yorkshire fog *Holcus lanatus* and white clover *Trifolium repens*. The dense grassland and thatch give this area high-quality reptile habitat.

3.3.16. Figure 3.8 below demonstrates an example of the habitat present.

Figure 3.8 Site 35 habitat example



Site 39

3.3.17. Site 39 is a slightly smaller site, 0.26 hectares of improved abandoned grassland with areas of dense nettle *Urtica dioica* and bramble and is located between two patches of dense scrub, notably hawthorn *Crataegus monogyna* and blackthorn *Prunus spinosa*, interspersed with elder *Sambucus nigra*, hazel *Corylus avellane* and field maple *Acer campestre*. Surrounding this is an area of mature broadleaved woodland comprising beech, oak and sycamore. The A417 is directly north of the scrub and southern border comprised of a small stream. Overall this constitutes a medium quality reptile habitat.

3.3.18. Figure 3.9 below demonstrates an example of the habitat present.

Figure 3.9 Site 39 example habitat



Site 41

3.3.19. Site 41 is primarily a road verge, dominated by grass habitats with varying sward heights. Thin lines of scrub shield the verge from the A417 on the opposite side. A hay meadow exists at the northern end of the site, which is exposed to sun throughout the day. The verge itself is only subject to infrequent cutting, decreasing disturbance. The denser grassy areas provide suitable egg-laying habitat for grass snake, and dead wood in the adjacent woodland provides potential hibernacula. Connectivity is good to the south; the site is continuous with the A417 verge and a woodland corridor. There is woodland to the north, beyond the hay meadow, which also provides high quality foraging and hibernating opportunities. Overall this constitutes a medium quality reptile habitat.

3.3.20. Figure 3.10 below demonstrates an example of the habitat present.

Figure 3.10 Site 41 habitat example



Site 43 (Adder 43)

3.3.21. The area is a small valley, with improved grassland comprising much of the centre; species include cock's foot *Dactylis glomerata*, false oat grass *Arrhenatherum elatius* and nettles. The western portion of the site contains a tussock border and denser vegetation with a more complex structure and species diversity. Hawthorn and bramble pockets to the north, and beech woodland to the west both offer cover and hibernation opportunities. Egg-laying habitat is limited, but a ditch line and potential for amphibians means that there is potential for grass snake presence. Wider habitat connectivity is good; rough grassland to the west, pasture to the southeast and ash woodland to the north. The north-west corner of the field has the greatest reptile potential due to the carrying sward height, ant hills and higher plant species richness, therefore offering plenty of basking opportunities. Overall this constitutes a high-quality reptile habitat.

3.3.22. Figure 3.11 below demonstrates an example of the habitat present.

Figure 3.11 Site 43 habitat example



Site 44 and Adder 8

3.3.23. Site 44 is located on the west side of the A417, approximately 400m south of the 'Air Balloon' roundabout. The mixed woodland adjacent to the carriageway offers good foraging and hibernation potential. The site then opens out into a meadow with varying sward height. Patches of dense vegetation and ruderal habitat alongside more open areas create the complex structure preferable for basking and foraging. The woodland and scrub at the edges of the field provide good cover. Figure 3.12 shows the different habitats within the site. Overall this constitutes a high-quality reptile habitat.

3.3.24. Figure 3.12 below demonstrates an example of the habitat present.

Figure 3.12 Site 44 habitat example



Site 45

3.3.25. Located within the south - eastern most section of Crickley Hill Country Park situated on a moderate incline, connected to the rest of the habitats within the park; woodland, scrub and open meadows. The variety in sward height and denser ruderal areas provides a complex grass structure and facilitates high insect prey diversity. The presence of deadwood and drystone walls offers additional cover and hibernating opportunities along with the woodland itself. Overall this constitutes a high-quality reptile habitat.

3.3.26. Figure 3.13 below demonstrates an example of the habitat present.

Figure 3.13 Site 45 habitat example



Site 46 (Adder 6)

3.3.27. Site 46 is an area of semi-improved grassland at the back of the Air Balloon public house which has been left unmanaged for a number of years. The field is separated from the car park by a line of scattered shrubs. The majority of the area is comprised of long grass and ruderal species, creating a variety of sward heights and grass structure. There are drystone walls partially bordering the east

and west sides of the field, and a line of conifers to the south. This habitat provides good foraging, basking and cover opportunities for reptiles and is connected to site 47 below via adjacent grassland. Overall this constitutes a medium quality reptile habitat.

3.3.28. Figure 3.14 below demonstrates an example of the habitat present.

Figure 3.14 Site 46 habitat example



Site 47 (Adder 9)

3.3.29. Site 47 is on the west side of the A417, approximately 250m south of the 'Air Balloon' roundabout. The site is a field comprising a variety of different grasses of mixed height; this supports a high prey availability. The field is adjacent to deciduous woodland and well connected to neighbouring grassland habitats and site 46. The south-facing slope receives sun exposure for most of the day, offering good basking opportunities. Refuge and hibernation opportunities are also rife, with drystone walls, tussocks, disused mammal burrows and ant hills all present. Overall, this constitutes a high-quality reptile habitat.

3.3.30. Figure 3.15 below demonstrates an example of the habitat present.

Figure 3.15 Site 47 habitat example



Site 48

3.3.31. Site 48 is located along the eastern edge of Crickley Hill Country Park on either side of the access road to the Crickley Hill car park. The site is a field comprising grazed semi-improved grassland. The site is connected to good quality reptile habitat within the Crickley Hill Country Park to the west, which includes locally frequent large ant hills, indicating a lack of intensive management. Areas of dense scrub and deadwood habitat provide good hibernation opportunities within the adjacent habitat, and a drystone wall to the east provides further refuge and potential hibernation habitat. The grassland is subject to cattle grazing and also regular disturbance by dogwalkers. Overall, this constitutes poor-quality reptile habitat, but is adjacent to areas of higher quality habitat.

3.3.32. Figure 3.16 below demonstrates an example of the habitat present.

Figure 3.16 Site 48 habitat example



Site 49 (Adder 7)

3.3.33. Site 49 is to the east of the proposed new A417 and is a 450m vegetated north facing bund. The site is a field comprising a variety of different grasses of mixed height, scrub and immature woodland species such as hawthorn and buckthorn; this supports a high prey availability. This is adjacent to agricultural fields and low use improved grassland fields. The north-facing slope receives sun exposure as it is not overly steep, offering good basking opportunities. Refuge and hibernation opportunities are also abundant, with a crumbling drystone wall, tussocks, disused mammal burrows and anthills all present. Overall, this constitutes a medium-quality reptile habitat.

3.3.34. Figure 3.17 below demonstrates an example of the habitat present.

Figure 3.17 Site 49 habitat example



Site ARG

3.3.35. Site ARG is located within the Crickley Hill Country Park SSSI. The site is a SSSI comprising a variety of different grasses of mixed height, scrub and immature trees, supporting a high prey availability. There are areas of unimproved calcareous grassland and a south-facing slope, which is very steep, offering good basking opportunities. Refuge and hibernation opportunities are also abundant, with a crumbling drystone wall, tussocks, disused mammal burrows and anthills all present. Overall, this constitutes a high-quality reptile habitat.

3.3.36. Figure 3.18 below demonstrates an example of the habitat present.

Figure 3.18 Site ARG habitat example



3.4. Reptile Population Survey Results

- 3.4.1. Surveys identified the presence of all four common reptiles within 100m of the scheme, with at least one species recorded at 17 of the 18 surveyed sites. All four common species were recorded at 4 of the 18 sites. Eleven of the 18 survey sites were identified as having good or exceptional reptile populations (site 2, 3, 6, 8, 10, 41, 43, 44, 46, 47, and 49), along with the site monitored by SGARG, as shown in table 4.
- 3.4.2. Slow worms were present at all sites except site 44. Slow worm populations were low (>5) at 7 of the 16 positive sites and good (5-20) at 8 sites. The highest slowworm population recorded in one visit was at site 47, with 36 individuals and an exceptional population score.
- 3.4.3. Common lizards were present at 13 sites with low populations at 6 sites and good populations at 7 sites.
- 3.4.4. Grass snakes were present at 4 sites with low populations at each. All 4 (6, 8, 41, 45) sites had a peak count of 1.
- 3.4.5. Adders were present at 8 of the sites. All sites had low scores except the site monitored by SGARG which had a peak count of 5 giving it a good population score.
- 3.4.6. No reptiles were identified at site 48, which is likely due to the poorer quality habitat and levels of disturbance from the public and from grazing livestock.
- 3.4.7. The results from each survey are discussed in detail below. Sites are grouped into areas that have similar species abundance. Appendix D displays peak count results for all reptiles.

Site 2 (Adder 5) and site 6 (Adder 1)

3.4.8. Both sites had good populations of both slow worms and common lizards. In general, the peak counts for reptiles were much higher in the late spring/early summer (June). Site 2 was monitored across 2018 and 2019 and peak counts were much higher in the 2019 period. Site 6 was started in March 2019 and peak counts were much higher towards the end of the June survey period. Site 6 also had the presence of grass snakes and adders, both with low populations counts. Site 6 had a peak count of 3 adders. At both sites, more adults of both slow worms and lizards were present than sub-adult or juveniles.

Site 3, 39, 45

3.4.9. Slow worms accounted for the majority of reptiles present at site 3, 39 and 45, with the exception of 45 where there was one grass snake recorded on 2 occasions and site 39 where 1 common lizard was recorded on one occasion. In general, peak counts per day were highest at the start and end of the survey season (April-September). Site 45 and 39 had a low population of slow worm and site 3 had a peak count of 6 slow worm giving it a good population score.

3.4.10. Site 45 had rotated grazing throughout the monitoring period, potentially impacting results.

Site 18 (Adder 18), 41 and 49 (Adder 7)

3.4.11. Site 18, 41 and 49 all had populations of slow worms and adders with no common lizards. Site 41 also 1 adult grass snake individual spotted twice in September of the 2018 survey season, and one juvenile grass snake was spotted in the summer 2019 surveys. Slow worm populations at site 41 and 49 had peak counts of 9 and 6 respectively and site 18 had a low population score with a peak count of 1.

3.4.12. All 3 sites had low populations scores for adders with the peak counts being less than 5 individuals per survey. Total reptile counts were a lot higher in the 2019 May-June survey period compared to other survey times.

Site 8, 10 and 44 (Adder 8)

3.4.13. Site 8, 10 and 44 all had good population scored for common lizards. Site 8 also 1 adult grass snake individual spotted during the spring 2019 survey season. Slow worm populations were present at site 8 and 10 with low populations scores but none were recorded at site 44.

3.4.14. Common lizards in generally were more abundant in September 2018 particularly at site 44 with a peak count of 19.

Site 21, 43 (Adder 43) and 46 (Adder 6)

3.4.15. Slow worms and common lizards accounted for all reptiles present at site 21, 43 and 46. In general, peak counts per day were highest during the 2019 survey season. More juvenile slow worms and common lizards were found during the late 2018 survey period than in the 2019 survey period, but this reflects the later time of year that these sites were surveyed in 2018. Peak counts went up significantly from May – July.

Site 47 (Adder 9)

3.4.16. Slow worms and common lizards accounted for all reptiles present at site 47. This site is the only site with an exceptional population score for slow worms with a peak count of 36 in one survey day. Common lizard peak count was 19 giving a good population score.

3.4.17. In general, peak counts per day were highest during the 2019 survey season and were low during the 2018 September surveys.

Site 25 and ARG site

3.4.18. Site 25 had low populations scores for slow worms and common lizard with a peak count of 2 and 1 respectively. Adders were present at this site but only recorded during the June and July surveys of 2019, with only 3 individuals being recorded. In generally at this site more individuals were found during the June and July surveys than in the months prior. This site was no monitored in 2018.

3.4.19. The site currently monitored by SGARG will continue to be monitored. To date (July 2019) 84 reptiles have been found at the site, with good populations scores for slow worms and common lizards and the only site to have a good population score for adders. Following the trend of all the other sites more reptiles have been found in the later part of the 2019 survey period than previous months. Courtship male adder dancing and mating were observed at this site on more than one occasion.

Overall Survey Results

3.4.20. A summary of the number of reptiles recorded in each survey site during the surveys is presented in Table 4 below, together with calculated reptile densities and population categories. Only results for the reptiles species found are displayed in Table 4. Full results including tile densities, full weather conditions and survey results are presented in Appendix E.

Table 4 Reptile survey results by species and survey site

Species	Total number recorded over 20 visits	Max number recorded over single visit	Area of reptile habitat (Ha)	Population Score (Refer to Table 1)	Population Density (/Ha)* (Table 2)
Site 2					
Slow worm	54	8	0.14	Good	Medium
Common Lizard	34	6	0.14	Good	Medium
Adder	7	1	0.14	Low	High
Site 3					
Slow worm	36	6	0.18	Good	Low
Site 6					
Slow worm	41	7	1.57	Good	Low
Common Lizard	58	12	1.57	Good	Low
Adder	15	3	1.57	Low	Low
Grass Snake	1	1	1.57	Low	Low
Site 8					
Slow worm	15	5	0.66	Good	Low
Common Lizard	19	5	0.66	Good	Low
Grass Snake	5	1	0.66	Low	Low
Adder	2	1	0.66	Low	Low
Site 10					
Slow worm	13	4	1.03	Low	Low
Common Lizard	23	5	1.03	Good	Low
Site 18					
Slow worm	3	1	0.29	Low	Low
Common Lizard	1	1	0.29	Low	Low
Adder	14	2	0.29	Low	High
Site 21					
Slow worm	14	3	0.26	Low	Low
Common Lizard	14	4	0.26	Low	Low
Site 25					
Slow worm	10	2	2	Low	Low
Common Lizard	6	2	2	Low	Low
Adder	3	1	2	Low	Low
Site 39					
Slow worm	7	2	0.25	Low	Low
Common Lizard	1	1	0.25	Low	Low
Site 41					
Slow worm	48	9	0.39	Good	Low
Common Lizard	1	1	0.39	Low	Low
Adder	1	1	0.39	Low	Medium
Grass Snake	3	1	0.39	Low	Medium
Site 43					
Slow worm	20	7	2.91	Good	Low
Common Lizard	9	2	2.91	Low	Low
Site 44					
Common Lizard	59	19	1.33	Good	Low
Site 45					
Slow worm	11	1	0.69	Low	Low
Grass Snake	2	1	0.69	Low	Low
Site 46					
Slow worm	48	9	0.56	Good	Low
Common Lizard	1	1	0.56	Low	Low

Site 47					
Slow worm	101	36	0.61	Exceptional	Medium
Common Lizard	77	19	0.61	Good	Medium
Site 49					
Slow worm	21	6	0.19	Good	Low
Adder	3	1	0.19	Low	High
ARG Site					
Slow worm	90	28	1.88	Exceptional	Low
Common Lizard	25	5	1.88	Good	Low
Adder	15	5	1.88	Good	Medium
Grass Snake	3	1	1.88	Low	Low

3.5. Assessment of importance

3.5.1. As per the criteria described in section 2.3.10, each site was assessed to evaluate its importance for reptiles. Sites 2, 6, 8, 18, 25, 41, 47 and ARG were assessed as being important reptile sites. Table 5 below provides full results for the assessment of each site against every criterion.

Table 5 Assessment of importance

Survey site	Three or more reptile species?	Two snake species?	Exceptional population of one species?	Assemblage of species scoring at least 4?	Significant regional importance?	Important site?
2	Yes			Yes		Yes
3						
6	Yes	Yes		Yes		Yes
8	Yes	Yes		Yes		Yes
10						
18	Yes					Yes
21						
25	Yes					Yes
39						
41	Yes	Yes		Yes		Yes
43						
44						
45						
46						
47			Yes	Yes		Yes
48						
49						
ARG	Yes	Yes	Yes	Yes		Yes

3.6. Summary

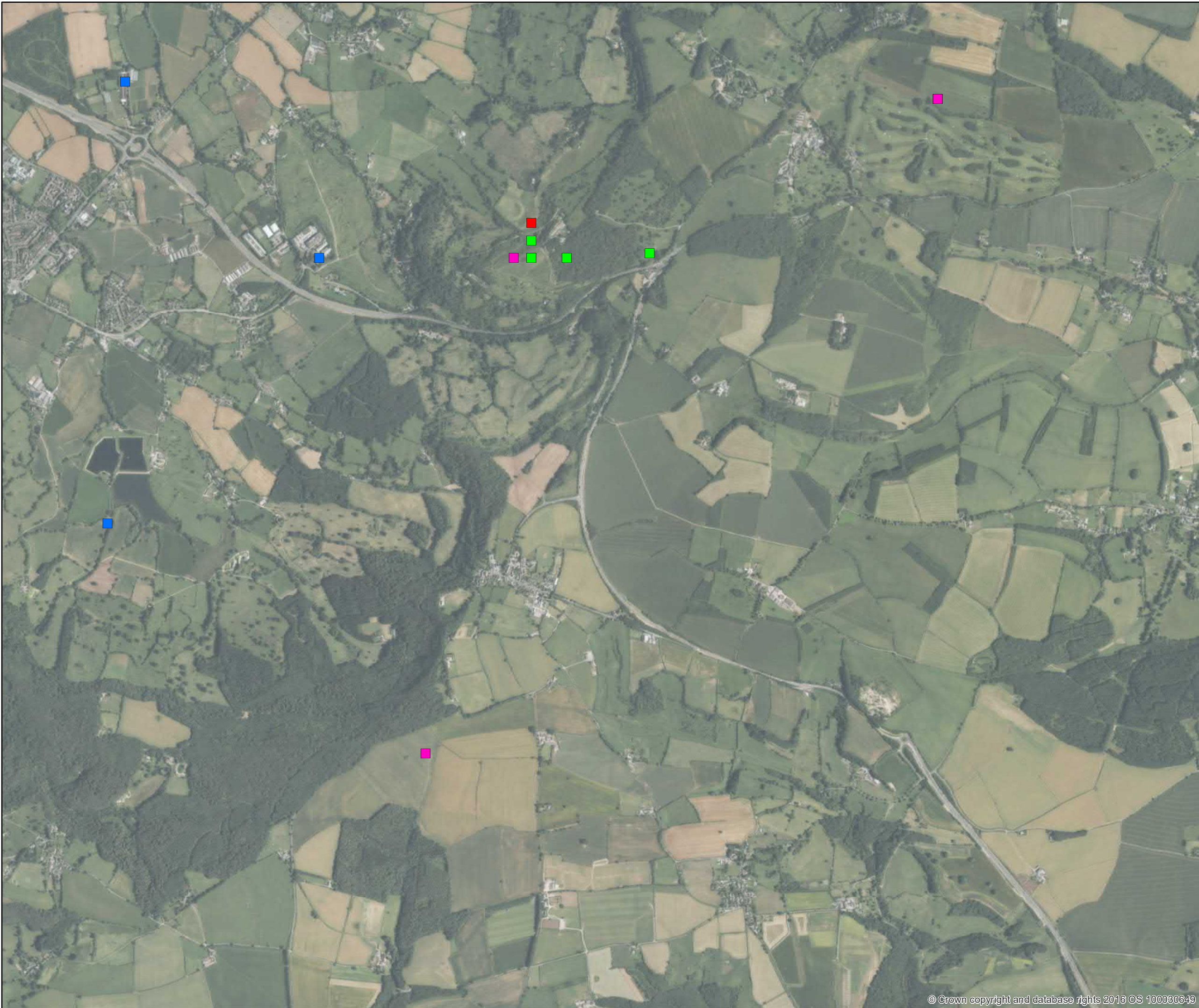
- 3.6.1. The scheme area surveyed for reptiles (100m from Option 30) supports at all 4 reptile species, with some areas supporting good and exceptional population of slow worms, common lizards and adders. Grass snake were only recorded at a low population. Widespread reptiles are locally common in Gloucestershire, however slow worms are part of a South Gloucestershire BAP, as well as adders which are a UK Post-2010 Biodiversity Framework priority species.
- 3.6.2. Considering the presence of adders at 8 sites, particularly the ARG site with a good population score and the observation of adder breeding behaviour, habitats within 100m of the scheme should be considered of high conservation value for adders and connectivity between these identified populations should be given consideration.

4. Conclusion

- 4.1.1. Reptiles have been found in 17 of the 18 areas that were surveyed within 100m of the scheme. All 4 species of widespread reptile were recorded at sites 6, 8, 41 and ARG.
- 4.1.2. Slow worm populations were found at all sites except sites 44 and 48. Slow worm populations were good or exceptional at 10 of the 17 sites. Sites 47 and ARG have exceptional populations of slow worms. Common lizards were found at 14 sites; 8 with good populations and 6 with low populations.
- 4.1.3. Grass snakes and adders were also found at a number of sites within 100m of the scheme. Site 6, 8, 41, 45 and ARG all had low population scores for grass snakes with a peak count of 1 at each. Adders proved slightly more abundant with populations present at 8 of the surveyed sites. Of the 8 sites with adders present, 7 had low population scores and 1 (ARG site) had a good population with breeding behaviours observed.
- 4.1.4. Sites 2, 6, 8, 18, 25, 41, 47 and the ARG site were assessed as being important reptile sites. Eleven of the 18 survey sites were identified as having good or exceptional reptile populations of one or more species (site 2, 3, 6, 8, 10, 41, 43, 44, 46, 47, and 49).

Appendix A – Results from GCER

Scientific Name	Common Name	Location	Grid Reference	Distance from Scheme (m)	Direction	Year
<i>Vipera berus</i>	Adder	CRICKLEY HILL and BARROW WAKE SSSI	SO927162	452	N	2011
<i>Vipera berus</i>	Adder	Leckhampton Hill SO9417	SO945177	1860	NE	2009
<i>Vipera berus</i>	Adder	Cotswold Hills Golf Club	SO950170	1710	NE	2006
<i>Vipera berus</i>	Adder	Crickley Hill Country Park	SO927161	378	N	2016
<i>Vipera berus</i>	Adder	Crickley Hill Country Park	SO927161	378	N	2016
<i>Vipera berus</i>	Adder	CRICKLEY HILL and BARROW WAKE SSSI	SO929161	234	N	2016
<i>Zootoca vivipara</i>	Common Lizard	Near Birdlip	SO921133	1470	SW	2011
<i>Zootoca vivipara</i>	Common Lizard	CRICKLEY HILL and BARROW WAKE SSSI	SO926161	386	NE	2007
<i>Zootoca vivipara</i>	Common Lizard	Leckhampton Hill SO9417	SO946177	1940	NE	2009
<i>Zootoca vivipara</i>	Common Lizard	Cotswold Hills Golf Course	SO950170	1740	NE	2007
<i>Zootoca vivipara</i>	Common Lizard	Leckhampton Hill	SO946177	1940	NE	2009
<i>Zootoca vivipara</i>	Common Lizard	Cotswold Hills Golf Course	SO950170	1740	NE	2007
<i>Natrix natrix</i>	Grass Snake	Witcombe Reservoir	SO903146	1638	S	2014
<i>Natrix natrix</i>	Grass Snake	Badgeworth, Primrose Vale Farm	SO904171	1504	NW	2011
<i>Natrix natrix</i>	Grass Snake	Bentham	SO915161	507	NW	2008
<i>Anguis fragilis</i>	Slow-worm	CRICKLEY HILL and BARROW WAKE SSSI	SO927163	516	N	2010



Notes

Legend

Records

- reptile, Adder
- reptile, Common Lizard
- reptile, Grass Snake
- reptile, Slow-worm

P01	03/10/18	First Revision	DB	AE	SM
Rev	Date	Amendment Details	D	C	A

**Mott MacDonald
Sweco**



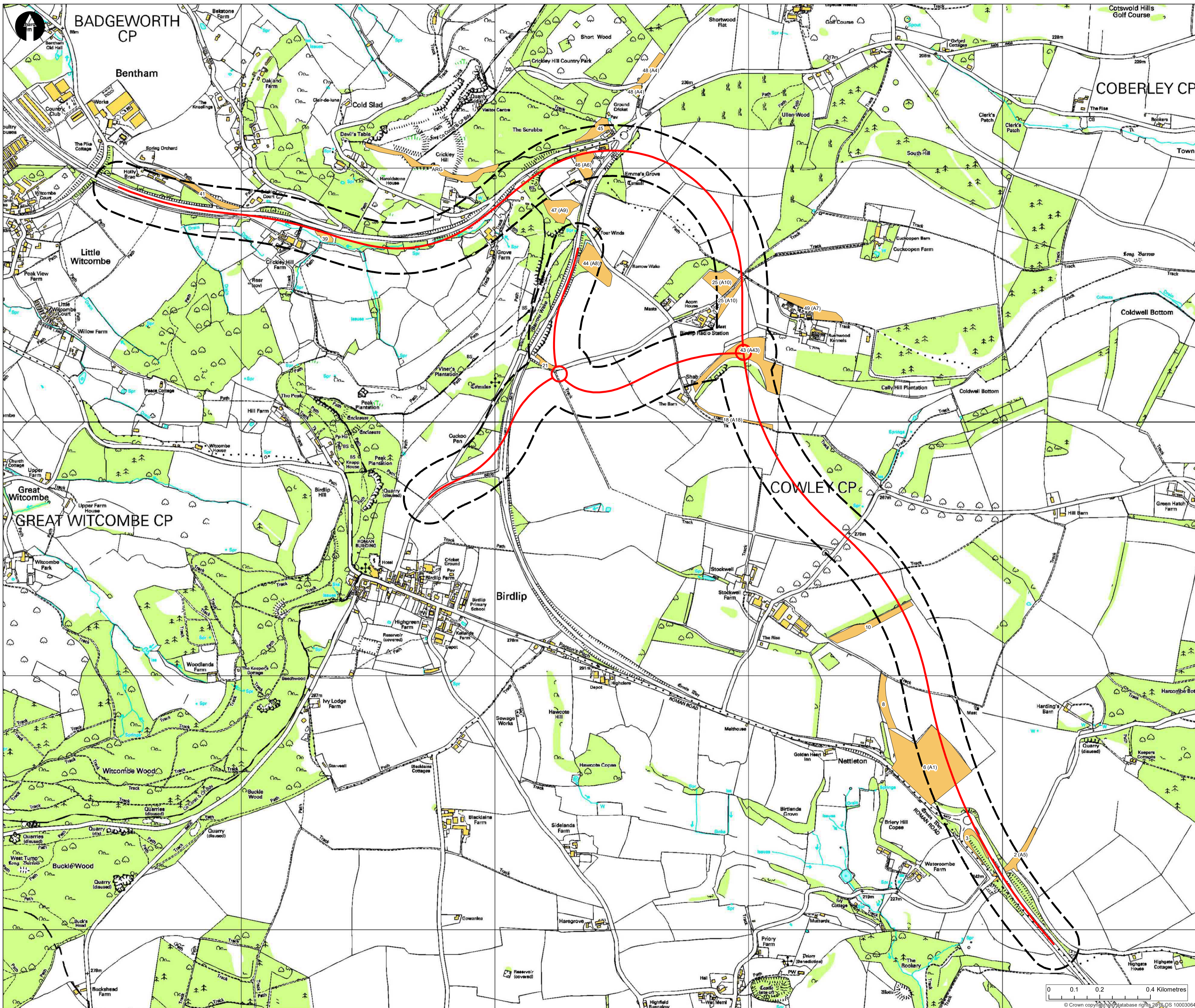
Client
For Information Suitability
S02

Project Title
A417 'Missing Link' at Air Balloon

Drawing Title
Biological Records - Reptiles

Scale 1:20,000	Designed DBy	Drawn DBy	Checked AE	Approved SM
Original Size A3	Date 30/10/2018	Date 30/10/2018	Date 29/10/2018	Date 30/10/2018
Drawing Number HE PIN 551505	Originator MMSJV	Volume EBD	00054	Project Ref. No. 551505
000	DR	LB	00054	Revision P01
Location	Type	Role	Number	

Appendix B – Location of reptile survey sites 2018 and 2019



Notes

Legend

- Scheme Centreline (at time of survey)
- 100m Scheme Buffer Reptile
- Sites

P02	13/11/19	Second Revision	TW	GG	SM				
P01	05/06/19	First Revision	TW	GG	SM				
Rev	Date	Amendment Details	Drawn	Chk'd	App'd				

Mott MacDonald Sweco

highways england

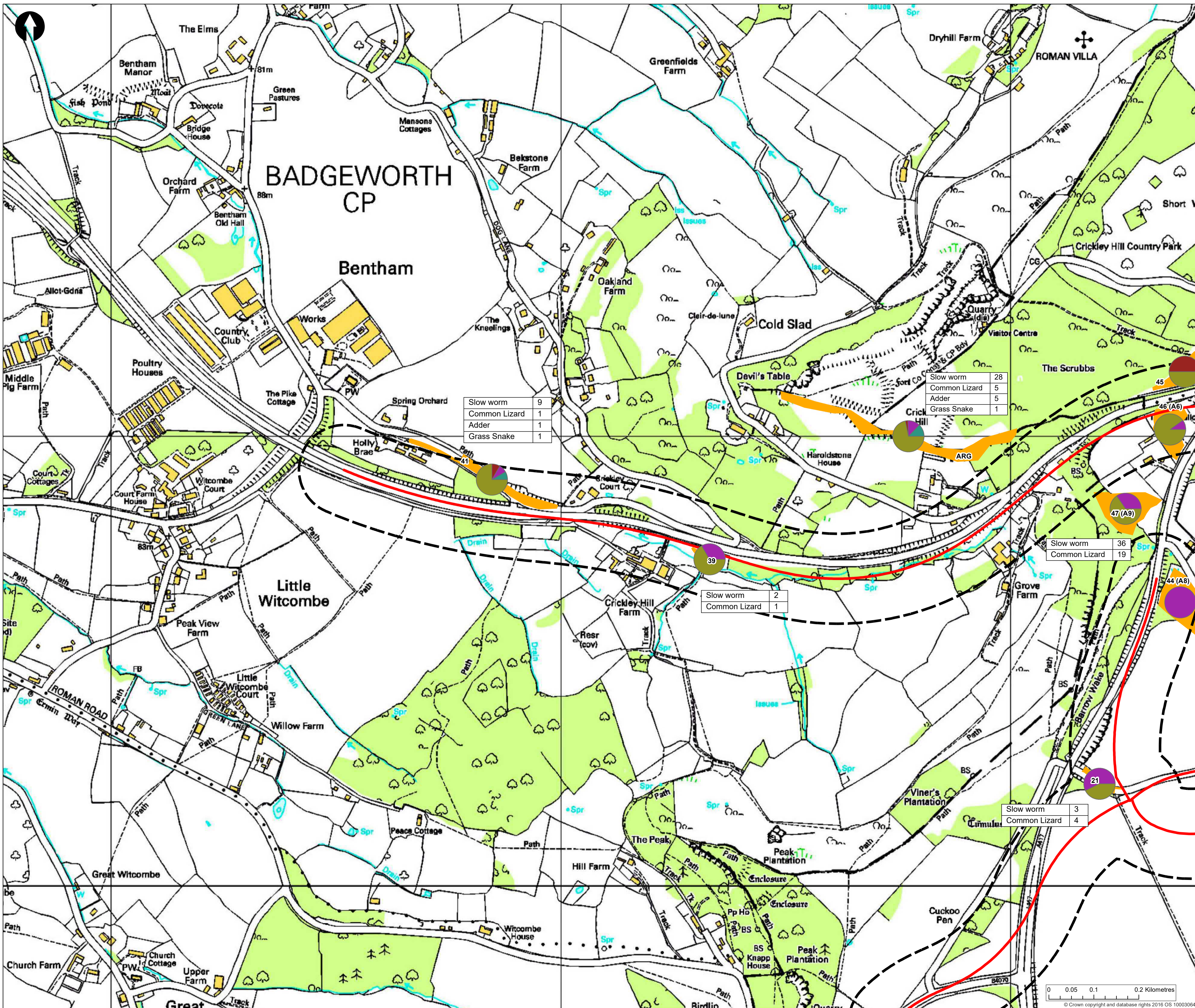
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Drawing Title				
Reptile Site Locations				
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Original Size	Date	Date	Date	Date
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Drawing Number	Originator	Volume	Project Ref. No.	
551505 - MMSJV - EBD -			551505	
000 - DR - LB -			Revision	
			00055	P02

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Appendix C – Location of adder survey sites 2018 and 2019

Appendix D – Results map for reptiles 2018 and 2019



Legend

- Scheme centreline (at time of survey)
- 100 Metre Buffer
- Reptile Sites

PEAK SPECIES COUNT

- Adder
- Common lizard
- Grass snake
- Slow worm

Slow worm	9
Common Lizard	1
Adder	1
Grass Snake	1

Slow worm	28
Common Lizard	5
Adder	5
Grass Snake	1

Slow worm	2
Common Lizard	1

Slow worm	36
Common Lizard	19

Slow worm	3
Common Lizard	4

Notes

P03	13/11/19	THIRD REVISION	JW	VH	SM
P02	25/09/19	SECOND REVISION	JW	VH	SM
P01	23/07/19	FIRST REVISION	TW	VH	SM
Rev	Date	Amendment Details	Drawn	Chk'd	App'd

Mott MacDonald Sweco

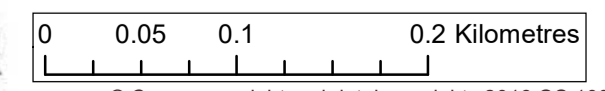
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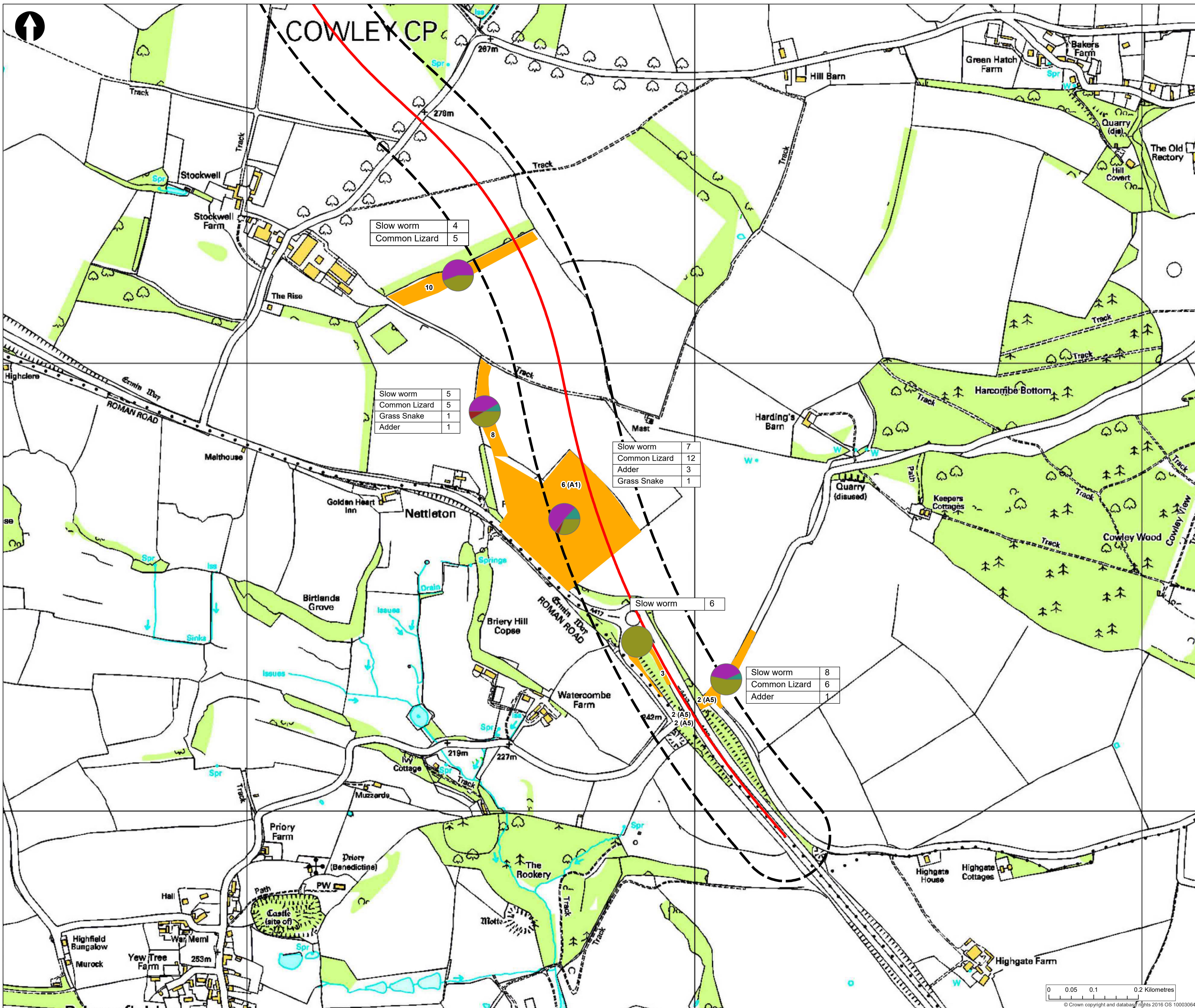
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Project Title: A417 MISSING LINK

Drawing Title: REPTILE SURVEY SITES PEAK COUNT

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Original Size: A1	Date: 23/07/19	Date: 25/09/19	Date: 25/09/19	Date: 25/09/19
Drawing Number: 551505 - MMSJV - EBD -	Originator: 000 - DR - LB -	Volume: 00057	Project Ref. No: 551505	Revision: P03





Notes

- Legend**
- Scheme centreline (at time of survey)
 - 100 Metre Buffer
 - Reptile Sites
- PEAK SPECIES COUNT**
- Adder
 - Common lizard
 - Grass snake
 - Slow worm

Rev	Date	Amendment Details	Drawn	Chk'd	App'd
P03	13/11/19	THIRD REVISION	JW	VH	SM
P02	25/09/19	SECOND REVISION	JW	VH	SM
P01	23/07/19	FIRST REVISION	TW	VH	SM

Mott MacDonald Sweco



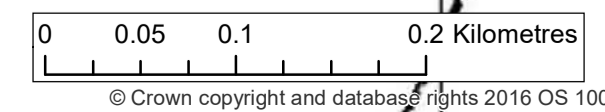
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Suitability	FOR INFORMATION

Project Title
A417 MISSING LINK

Drawing Title
REPTILE SURVEY SITES PEAK COUNT

PAGE 3 OF 3

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Drawing Number	HE 019	Originator	551505 - MMSJV	Volume	EBD	Project Ref. No.		551505	
	000	DR	LB	00057		Revision		P03	



Appendix E – Full survey results 2018 and 2019

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.17
Otter Technical Report

28 September 2020

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Executive summary

Highways England are proposing an upgrade to dual carriageway of the Missing link section of the A417 between Cowley roundabout and Crickley Hill (Birdlip, Gloucestershire, Grid reference SO919158). This connection aims to improve journey times and reduce the safety risks associated with this section of the road network.

This report investigates the presence of otter *Lutra lutra* within the zone of influence of the scheme. The report is informed by a desk study undertaken within 2 kilometres of the redline boundary and subsequent otter surveys undertaken along watercourses within 250 metres of the proposed scheme redline boundary. A total of 4 watercourses were subject to surveys including, Norman's Brook, Horsbere Brook, Upper Frome and Coldwell Bottom. A 2-kilometre section of each watercourse was subject to surveys which were undertaken in 2018 and 2019.

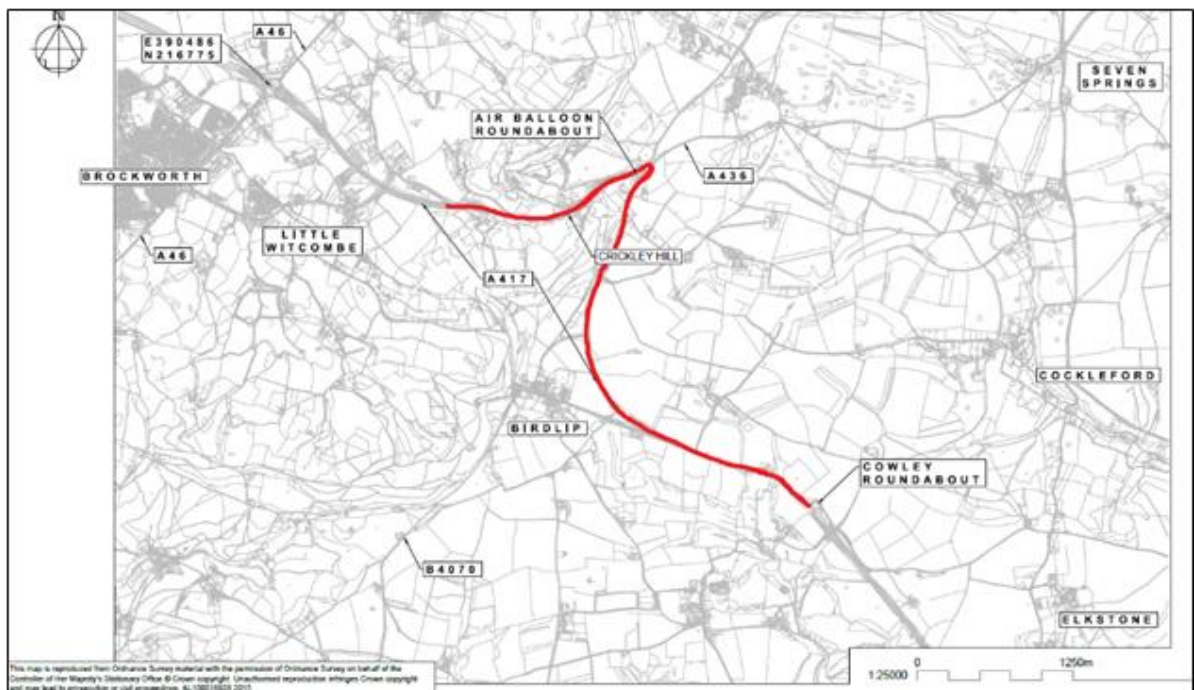
Desk study results confirmed the presence of otter along Norman's Brook, the Frome, Horsbere Brook and the Churn, although only one record was returned within the 2-kilometre data search. Survey results confirmed the presence of otters along the Upper Frome. No evidence of otter was recorded along any of the other watercourses.

1. Introduction

1.1. Background

- 1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and as an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the ‘missing link’, forms the only section of single carriageway along the route, with an at-grade junction located at the ‘Air Balloon’ public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5 kilometre stretch shown on Figure 1.1 below (central grid reference SO934161).

Figure 1.1 A417 Missing Link Scheme Location

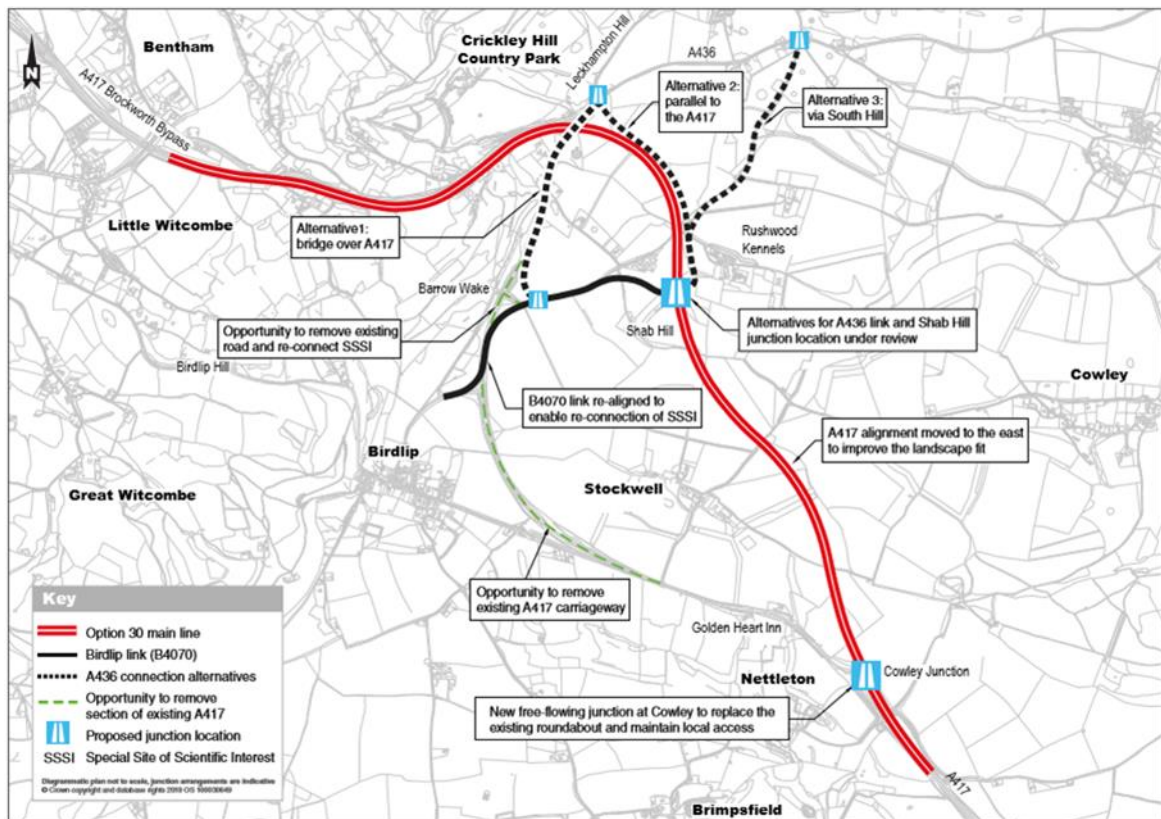


1.2. Scheme proposal

- 1.2.1. The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill. The scheme will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester (M5 Junction 11a). This connection aims to improve journey times and reduce the safety risks associated with this section of the road network.
- 1.2.2. The preferred route was announced by Highways England as option 30 in March 2019 (Figure 1.2 below). A third ascending lane would be added to the A417 at Crickley Hill and the gradient would be reduced to 7%. A new section of road

would be built through Shab Hill to the east of the current A417 and the roundabouts at Cowley and Air Balloon would be removed. A new junction would be added at Shab Hill with links to Birdlip and the A436. Three options for a connection to the A436 were considered with Alternative 2 selected for assessment in the Environmental Statement.

Figure 1.2 A417 Preferred Route Announcement, Option 30



1.3. Scope of the report

1.3.1. The objectives of this report are:

- to collate and review existing records for otters
- to present the methods, constraints and results of otter habitat assessment and field signs surveys
- to inform the Biodiversity chapter of the Environment Statement

1.4. Legislation and national policy

1.4.1. Otters *Lutra lutra* are a European protected species (EPS) protected under the *Conservation of Habitats and Species Regulations 2017*. In summary, it is an offence to:

- deliberately kill or injure this species

- deliberately disturb this species so as to impair its ability to survive, to breed or reproduce, or to rear or nurture its young
- damage or destroy a breeding site or resting place used by this species

1.4.2. Otters are partially protected under the *Wildlife and Countryside Act 1981* (as amended). In summary, it is an offence to:

- intentionally kill or injure these species
- intentionally or recklessly:
 - disturb these species whilst occupying any structure or place used for shelter or protection
 - obstruct access to any structure or place used by these species for shelter or protection

1.4.3. Otters are listed as priority species under Section 41 of the *Natural Environment and Rural Communities (NERC) Act 2006*. Section 40(1) of the Act states that 'every public authority must, in exercising its functions, have regard, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity'. Section 40(3) explains that conserving biodiversity includes, in relation to a living organism or type of habitat, restoring or enhancing a population or habitat.

1.5. Status of otters at the national level

1.5.1. Intensive otter hunting in the eighteenth and nineteenth centuries for sport and fishery protection suppressed the national otter population before a crash because of river pollution from organochlorine insecticides¹ in the mid nineteenth century. By the 1970's they were found only in Scotland, parts of Wales, the West Country and remnant populations in England.

1.5.2. Following a ban on organochlorine insecticide in 1984; along with legal protection and significant improvements in water quality, otters have recovered well and are now widely distributed throughout most of Great Britain. Otters were recorded at 58.8% of surveyed sites in 2009-10; compared with 5.8% in 1977-79, as part of the national otter survey of England.²

1.6. Status of otters at the local level

1.6.1. The fifth national otter survey² recorded otters at 59.15% of sites within the Severn catchment, including presence on the river Frome and within the city of Gloucester.

¹ D.J.Jefferies, The changing otter population of Britain 1700-1989 (1989). British Journal of the Linnean Society vol 38 issue 1

² Environment Agency, Fifth otter survey of England 2009-2010, technical report (2010)

1.7. Otter ecology

- 1.7.1. Otters have been recorded as using almost all types of watercourse. Otters will utilise both flowing and still water bodies such as rivers, ditches, lakes, ponds and reservoirs. In England and Wales, otter activity is confined to fresh water but in Scotland otters will utilise coastal habitats. Otters use aquatic features for foraging and commuting; healthy aquatic habitats are vital to ensure there is sufficient food to support the otter.
- 1.7.2. In addition to aquatic habitats, otters are dependent on terrestrial riparian habitats to provide resting sites. The term resting sites includes a variety of features, for example natal holts, holts, couches, and hovers. Otters will utilise a wide range of features for resting sites, including holes in the ground, tree roots, gaps between rocks, tall ruderal vegetation, and scrub. The use of such habitats is very variable³.
- 1.7.3. Some correlations have identified a preference for otters utilising less disturbed locations, where dense vegetation and woodland provides cover.
- 1.7.4. Otters are largely nocturnal, and occur at very low population densities, with the average home range of a female being approximately 20 kilometres of a water course, and males covering 32 kilometres. Depending on the quality of the habitats this range can vary widely.

³ Chanin, P. (2003). *Monitoring the Otter Lutra lutra*. Conserving Natura 2000 Rivers Monitoring Series No. 10, English Nature, Peterborough.

2. Methodology

2.1. Desk study

- 2.1.1. A detailed desk study was undertaken by Mott Macdonald in 2017 which identified records of protected and notable species within 2 kilometres of the scheme options. These were obtained from Gloucestershire Centre for Environmental Records.
- 2.1.2. The desk study included reviewing other survey and environmental assessment reports undertaken for the study site, including records from previous surveys. WSP undertook a Stage 2 Assessment of a proposed scheme which partly covered the options currently being considered. The results of this Stage 2 Assessment were reported in 'A417 Cowley to Brockworth Bypass Improvement Scheme - Stage 2 Ecology and Nature Conservation Report' (WSP 2006)⁴.
- 2.1.3. Information was also obtained during communications with key stakeholders in 2018 and 2019 including Gloucestershire Wildlife Trust (GWT) and the Environment Agency, regarding the presence of otters within the local area.

2.2. Field surveys

- 2.2.1. Following the extended phase 1 habitat survey undertaken in spring 2017 by Mott MacDonald, 3 water courses within 250 metres of the redline boundary were identified as having potential to support otters. Upper Frome, Norman's brook and Horsbere brook were identified as requiring further detailed survey.
- 2.2.2. A fourth water course; Coldwell Bottom, was assessed for its suitability for otters after a meeting with the Environment Agency on 10th April 2019 where queries were raised over the potential suitability of this watercourse, in particular with regard to otters moving between catchments. This was surveyed once in July 2019. Refer to Appendix A for locations on each watercourse.
- 2.2.3. Each watercourse was surveyed along a 2-kilometre length where access was available, in accordance with Design Manual for Roads and Bridges (DMRB) guidelines.⁵ One of the surveys of the Upper Frome extended 3.5 kilometres downstream. Surveys were undertaken in July, August, September 2018 and May and July 2019. Dates of surveys for each watercourse are provided in Table

⁴ A417 Cowley to Brockworth Bypass Improvement Scheme – Stage 2 Ecology and Nature Conservation Report, WSP, March 2006.

⁵ DESIGN MANUAL FOR ROADS AND BRIDGES, VOLUME 10 SECTION 4, NATURE CONSERVATION ADVICE IN RELATION TO OTTERS, February 2001

2.1. The Upper Frome and Normans Brook were subject to 3 surveys, Horsbere Brook subject to 2 surveys and Coldwell Bottom subject to 1 survey.

2.2.4. Three surveys were undertaken to provide a reasonable confidence in identifying presence or likely absence. This is based on the findings by Parry et al⁶ which identified that the best way of achieving a high probability of detecting otters was to undertake three repeat surveys along two transects between 800 metres and 1000 metres. The surveys undertaken included three repeat visits over one transect (per watercourse), but the transect length was 2000 meters, thus providing a comparable survey effort.

2.2.5. The otter survey involved an assessment of the channels, bank and bordering terrestrial habitat, looking for signs of otters, such as:

- Natal holts, holts and potential holt sites
- Couches
- Spraints
- Anal jelly
- Tracks / footprints
- Silt / sand heaps and slides

2.2.6. All field signs found were photographed, mapped with a GPS (accurate to <5 metres) and with a standardised survey and location reference code.

2.2.7. When recording otter signs, levels of activity were used to categorise the status of any resting site, as per the methodology discussed by Basset and Wynn (2010)⁷. Resting sites were defined as having low, medium or high levels of activity.

2.2.8. Spraints were categorised as fresh, recent, or old as described by Devon Biodiversity Records Centre⁸, as follows:

- fresh spraint- usually black, tarry and sticky. It will have a distinct sweet musky smell
- recent spraint- will be starting to dry out, it may be turning grey and crumble when touched. It may still smell slightly of otter

⁶ Parry, G.S., Bodger, O., McDonald, R.A. and Forman, D.W (2012) *A systematic re-sampling approach to assess the probability of detecting otters *Lutra lutra*, using spraint surveys on small lowland rivers.*

⁷ Basset, S. and Wynn, J. (2010) *Otters in Scotland - How Vulnerable are they to disturbance.* In Practice, No 70, December 2010.

⁸ Devon Biodiversity Records Centre (2017) Otter surveying [online] available at: <http://www.dbrc.org.uk/otter-and-mink-signs/> (last accessed October 2017)

- old spraint- completely dried becoming very pale and crumbly. It may have crumbled completely, leaving a grey ashy deposit, with some fish bones still present

2.2.9. All surveys were undertaken by experienced Mott MacDonald ecologists meeting the CIEEM Competencies for otter survey, and familiar with DMRB guidelines.

2.2.10. Survey dates and weather conditions are provided in Table 2.1 below.

Table 2.1 Otter survey dates and weather conditions

Survey area	Date	Air temperature (°C)	Rain (0-5)	Cloud cover (0-8)	Wind (Beaufort scale)	Significant rain in preceding week
Norman's Brook	16/8/2018	17	0	6	2	No
Norman's Brook	27/09/2018	15	0	0	2	No
Norman's Brook	22/5/2019	18	0	2	2	No
Upper Frome	04/07/2018	23	0	3	1	No
Upper Frome	15/8/2018	19	0	7	2	No
Upper Frome	22/5/2019	16	0	1	1	No
Horsbere Brook	26/09/2018	14	0	0	1	No
Horsbere Brook	23/05/2019	20	0	3	2	No
Coldwell Bottom	16/07/2019	22	0	2	1	No

2.3. Survey constraints and limitations

2.3.1. The surveys were undertaken under optimal conditions at suitable times of the year with no periods of rain in the week preceding the surveys (which may have washed away evidence). However, the surveys provide a snapshot of activity at the site and therefore there is always the risk of protected species being overlooked, either owing to the timing of the survey or the scarcity of the species at the site.

2.3.2. Conditions on site meant that some areas were difficult to access, owing to the density of vegetation. An assessment of these areas was made as far as was practicable, but it is possible that signs of otter were missed and therefore such features would not have been addressed within this report.

2.3.3. Horsbere Brook was subject to 2 surveys rather than the 3 undertaken along Normans Brook and the Upper Frome. The watercourse was originally thought to be hydrologically connected to the section of Norman's Brook which runs parallel

with the existing A417, however, water features surveys (tracer surveys) confirmed that this watercourse was not linked to Horsbere Brook. Horsbere Brook is neither hydrologically connected to the watercourses impacted by the scheme, nor within the 250m buffer of the scheme and so the watercourse will not be impacted. Therefore, given the lack of impact, a reduced survey effort is considered to be proportionate.

- 2.3.4. Coldwell Bottom was subject to a single survey in 2019. As the watercourse is largely dry or with a very shallow low flow that is not suitable to sustain otters, with the exception of the downstream section nearest the Churn, it is only likely to be used very occasionally by otters potentially moving between catchments. Further surveys are not considered proportionate given the habitat present and the distance from the works (220 metres northeast of scheme at closest point).

3. Results

3.1. Desk study

- 3.1.1. One record of otter was returned by the records search, a 2015 road casualty from Brockworth, near Horsbere Brook. A map is included in Appendix B.
- 3.1.2. Personal communications with Gloucestershire Wildlife Trust confirmed the presence of otters in the northern section of Norman's Brook and along downstream sections of the Upper Frome. At the meeting with the Environment Agency in April 2019, the presence of otters on the Churn was also discussed.
- 3.1.3. The desk study confirms that otters are present in the area and known to use Horsebere Brook, Norman's Brook, the Upper Frome and the Churn.

3.2. Habitat assessment

Upper Frome

- 3.2.1. The Upper Frome is fed by springs south of the village of Nettleton, flowing south through Brimpsfield Park before joining the river Frome in Caudle Green, approximately 3 kilometres south of the scheme. It is a small watercourse with a typical depth of 5 to 10 centimetres in its upper reaches and 10 to 30 centimetres in its lower reaches in Brimpsfield Park. There are areas within the upper reaches that the water level drops considerably to below 5 centimetres.
- 3.2.2. The water course is typically less than a metre wide along its 2 kilometre surveyed length but has been damned by weirs in Brimpsfield park to form a succession of lakes and ponds with depths of several metres. The large ponds within Brimpsfield park are stocked with common carp *Cyprinus carpio* and the smaller ponds are likely to contain amphibians, providing suitable prey for otters in spring and early summer. Abundant domesticated and wild duck were recorded and could provide prey for otters. Issues with pollution, high turbidity and low oxygen levels were noted within the small lakes, with several dead common carp recorded during one of the surveys.
- 3.2.3. In its northern and southern extents the surrounding terrestrial habitat is largely semi-improved pastoral grassland, heavily grazed and disturbed by cows with poaching of the banks. There is generally a lack of cover for resting sites and holts directly adjacent to the watercourse, but overhanging rocks and undercut banks do provide some potential for resting sites. There is very limited woodland or dense scrub cover.

3.2.4. Through the central section of Brimpsfield Park there is extensive woodland cover as the watercourse runs through a steep sided valley that is used as a pheasant and partridge shoot. It is likely to be heavily disturbed by gamekeepers, beaters and game birds in the autumn and winter and unlikely to provide undisturbed areas for holts and resting sites in these seasons. A public footpath runs adjacent to the watercourse for large sections through Brimpsfield Park and is used regularly by dog walkers.

Norman's Brook

3.2.5. Norman's Brook flows westwards from Grove Farm, following the westbound lane of the A417 down Crickleley Hill towards Gloucester. At Crickleigh Farm, the brook flows into a culvert that flows under the A417 and surfaces several hundred metres away, north of the A417 in Bentham. This section of watercourse was formerly considered to be linked to Horsbere Brook to the west, however tracer surveys undertaken in 2019 confirmed that the watercourse is linked to Norman's Brook.

3.2.6. The 850-metre length of Norman's Brook that runs adjacent to the A417 was surveyed fully, along with a further 1.6 kilometre section of the brook after it resurfaces north of the A417.

3.2.7. The southern section of Norman's Brook is a small stream with a steep gradient, heavily shaded and in a deeply incised channel. The wetted width is between 0.1 and 1.3 metres with a typical depth of between 10 and 20 centimetres. The water levels appear to fluctuate seasonally depending on rainfall and it is likely to dry at times. Due to its low flow, seasonal drying and lack of pooling, prey availability of fish and amphibians is low. Issues with apparent run-off and pollution were noted and an oily/grey film was noted as accumulating in areas of low flow; this remained present during all of the surveys. This is likely to further reduce the availability of aquatic prey.

3.2.8. Woodland and scrub spread up the bankside for up to 20 metres on either side of the brook. The wider landscape is dominated by rough grassland and semi-improved grazing grassland. Disturbance within the woodland is low and there are likely to be areas suitable for resting within scrub.

3.2.9. The northern section of Norman's Brook has a steadier flow and gentler gradient than the southern section, with good availability of small fish prey. The brook is generally between 1 to 1.5 metres wide, with a depth of up to a metre in places and abundant emergent vegetation. This section runs through a mixture of arable and pastoral land with a narrow, mature woodland strip along its length. The roots of undercut, mature willow *Salix* species and ash *Fraxinus excelsior*

trees along the watercourse provide suitable areas for holts. No evidence of pollution was noted along this section.

- 3.2.10. Disturbance is likely to be moderate as although a public footpath runs parallel to the brook for most of the surveyed length, it is generally set back several metres from the woodland edge.
- 3.2.11. The culvert which links the northern and southern sections of Norman's Brook is very long (several 100 metres) and highly unlikely to be used by otters. Travelling over land, otters would have to cross the busy A417 to reach the southern section of Norman's Brook from the north.

Horsbere Brook

- 3.2.12. Horsbere Brook flows westwards from Witcombe Reservoirs and springs in Little Witcombe, through agricultural land and into the Gloucester suburb of Brockworth. Its gradient is gentle, with a steady flow provided by the reservoir's sluices. The width is typically between 0.5 and 1 metre and the depth is up to 1 metre but generally below 50 centimetres.
- 3.2.13. Small fish, including three-spined stickleback *Gasterosteus aculeatus*, and aquatic invertebrates such as river shrimp *Gammarus pulex* were observed during the survey but the watercourse is unlikely to support populations of larger fish prey due to its relatively small size. It is likely to provide a moderate food supply year-round.
- 3.2.14. The surrounding landscape is a mixture of arable and pastoral farmland, with frequent residential areas; including a school. A narrow mature woodland strip with dense scrub lines the banks of the watercourse along most of its length and provides some potential habitat for resting areas and holts. Disturbance is likely to be moderate as a public footpath runs along the banks of the watercourse in places and is close to the residential area of Brockworth. The A46 and Cirencester road provide significant barriers.
- 3.2.15. Several agricultural ditches join the main watercourse of Horsbere Brook from springs in Little Witcombe. These are seasonally dry and lack the woodland cover of the main body.
- 3.2.16. Whitcombe reservoir, located along the Horsbere Brook is used as a trout fishery and is likely to be targeted by foraging otter. Access around the perimeter of the reservoir was not permitted during the survey and it is unclear what preventative measures the fishery has in place to restrict otters entering the trout fishery.

Coldwell Bottom

- 3.2.17. Coldwell Bottom is an ephemeral stream which runs north and then east from springs in Stockwell, joining the river Churn in Cowley. The upper reaches closest to the scheme were dry in places at the time of survey and disappear underground for approximately 870 metres, before resurfacing to the northeast. The maximum depth is 5 centimetres and the wetted width is up to 50 centimetres.
- 3.2.18. The stream forms a field boundary between sheep grazed semi-improved pastures, with limited suitable habitat for holts or temporary shelter in the immediate vicinity. The spring emerges in a small copse of mature beech trees and the wider area includes broadleaved woodland and coniferous plantation, which could provide temporary resting areas. No evidence of potential fish prey was observed and are unlikely to be present due to the small size and temporary nature of the watercourse.
- 3.2.19. Once the watercourse resurfaces, the lower reaches of Coldwell Bottom has an increased flow but remains shallow, with a typical depth of up to 15 centimetres. It pools in places and at times holds no water, forming muddy areas. This indicates that the water levels are at times higher than during the time of the survey. A pond with an estimated 50 centimetres depth and dense marginal vegetation; including sweet flag iris *Acorus calamus*, forms close to where the watercourse resurfaces and is likely to hold suitable amphibian prey in spring and early summer, along with aquatic invertebrate prey at other times of year. As the stream flows eastwards towards the river Churn, it widens to 1 metre but remains shallow and with a low flow. Prey is likely to be limited to small fish species.
- 3.2.20. The surrounding land is a mixture of semi-improved species poor grassland, semi-improved calcareous grassland and broadleaved woodland. Dense trees and shrubs border the watercourse along much of its length, including mature willow and ash trees that provide potential holts. Immediately before joining the river Churn, Coldwell Bottom flows through an area of mature broadleaved woodland. Disturbance is considered to be low, with a rural setting and public footpaths crossing occasionally. The woodland supports fallen trees and hollows at the base of trees that provide suitable potential holt sites.
- 3.2.21. Photos for the habitat assessments are included in Appendix C.

3.3. Field signs

Upper Frome

3.3.1. Evidence of otter was recorded along the length of the surveyed section of the Upper Frome. Recent spraints were found at 3 locations; 2 were found along the stream near the small lakes to the east of Brimpsfield Park and the third around the village of Caudle Green to the south. Two old spraints were also recorded, one of which was along the upper section of the watercourse, north of Watecombe Farm. The second old spraint was recorded through the wooded section north of Brimpsfield Park. An otter footprint was noted close to the otter spraint in Brimpsfield Park. Several potential holts were recorded, focused around Brimpsfield Park and the areas directly to the north. None of these potential holt sites showed signs of use and are not considered to be active holt sites.

Norman's Brook, Horsbere Brook, Coldwell Bottom

3.3.2. No evidence of otter was recorded during the surveys of Norman's Brook, Horsbere Brook or Coldwell Bottom.

3.3.3. The survey findings are listed in Table 3.1 below. A map of the results is included in Appendix A and photos are included in Appendix D.

Table 3.1 Otter field signs

Watercourse ID	Type of Feature	Date	Easting	Northing	Notes	Photo number
Upper Frome	Spraint	15/8/2018	394761	212400	Recent otter spraint under stone culvert. Fish bones and jasmine smell.	Photos 1 & 2
Upper Frome	Potential holt or couch	15/8/2018	394839	212306	Potential holt or couch underneath overhanging rock and root system	Photo 3
Upper Frome	Potential holt or couch	15/8/2018	395390	212314	Potential holt or couch under rocks, forming cavity within banks of stream.	Photo 4
Upper Frome	Footprint	15/8/2018	394583	212969	Likely otter footprint. Print shows no webbing but appears to have five toes.	Photo 5
Upper Frome	Spraint	15/8/2018	394561	210367	Recent otter spraint under road bridge. Fish bones and jasmine odour.	Photos 6 & 7
Upper Frome	Potential holt or couch	15/8/2018	394545	213028	Potential holt or couch in horizontal platform within tree roots. Above water level	Photo 8

Watercourse ID	Type of Feature	Date	Easting	Northing	Notes	Photo number
					with cavity of unknown depth.	
Upper Frome	Spraint	04/07/2018	394387	213261	Old otter spraint on bolder in channel.	Photo 9
Upper Frome	Spraint	04/07/2018	394567	212891	Very old otter spraint.	Photo 10
Upper Frome	Spraint	04/07/2018	394685	212681	Recent otter spraint	Photo 11
Upper Frome	Footprint	04/07/2018	394574	212966	Otter footprints	Photo 12
Upper Frome	Spraint	04/07/2018	394780	212924	Very old spraint, mostly washed away. Difficult to determine contents	Photo 13
Upper Frome	Spraint	04/07/2018	394681	212737	Two spraints, old and dry	Photo 14

4. Interpretation of results

- 4.1.1. The Upper Frome showed a high potential for otter usage through the availability for food and potential holt sites. Several signs of otter were recorded here during the surveys, including both recent and old evidence. Otters are also known to be present further downstream along the River Frome. The surveys confirmed that otters are using the majority of the areas of watercourse surveyed, although no evidence was recorded in the most northerly sections near the springs at Nettleton and the watercourse is very small and shallow in this upper section and likely to only be very occasionally used by otters. Additionally, no evidence was found in the southern section around Poston Wood and Ostrich Wood. However, as evidence was found both downstream and upstream of this section, it is likely that otters do pass through this section of the watercourse.
- 4.1.2. The southern section of Norman's Brook (adjacent to the existing A417) provided suitable terrestrial habitat however this section of river is often dry, the availability of prey is low, and the watercourse too small to sustain otters. No signs of otter were recorded here during surveys. There is a low potential that this watercourse could be occasionally used as a corridor for movement, particularly when water levels and opportunities for hunting are higher. The watercourse is largely isolated from the northern section of Norman's Brook, with a significant culvert linking the two sections that is highly unlikely to be used by otters due to its length. Overland, otters would need to cross three lanes of the A417 to reach the southern section from the northern section. To the west, the upper sections of Horsbere Brook are around 600m at their closest point and otters may very rarely move overland between these two watercourses. Overall, this section of Norman's Brook shows no signs of use and is likely to be only very occasionally used by otters exploring the far reaches of catchments or potentially moving between catchments.
- 4.1.3. The northern section of Norman's Brook has good terrestrial habitat with opportunities for both shelter and hunting available. Otter presence was confirmed by GWT in the wider Norman's brook, however no signs were recorded during surveys. This suggests that the surveyed area is unlikely to be a regularly used territory but may still be used as a corridor for movement.
- 4.1.4. A moderate food supply and suitable terrestrial habitat was also present at Horsbere Brook; however, no field signs were recorded during surveys. The records check noted an incidence of otter road kill in Brockworth in 2015 which suggests that otters have been using this watercourse fairly recently.
- 4.1.5. Coldwell Bottom is an ephemeral watercourse with very limited food supply, although suitable terrestrial habitat with low disturbance is present. No signs of

otter were recorded in this watercourse and its upper sections are not suitable for sustaining an otter. However, otters are known to be present on the River Churn, of which Coldwell Bottom is a tributary, and therefore this watercourse may be used as a corridor for movement between the Churn and the Frome or Norman's Brook. There is potential that otters may very occasionally move along the Coldwell Bottom stream.

Appendix A - Otter survey areas and field signs map

Appendix B - Data records search map



Key

Legend

● Eurasian Otter

Rev	Date	Amended Details	Drw'n	Chk'd	App'd
P01	30/10/2018	1st REVISION	DBy	AA	AA

Mott MacDonald Sweco

Client 

Drawing Status: For Information Suitability: S2

Project Title: A417 MISSING LINK - PCF STAGE 2

Drawing Title: Biological Records - Eurasian Otter

Scale: 1:20,000	Designed: DBy	Drawn: DBy	Checked: AA	Approved: SM
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Original Size: A3	Date: 31/10/2018	Date: 31/10/2018	Date: 29/10/2018	Date: 30/10/2018
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Drawing Number: 551505 - MMSJV - EBD - 000	Originator: - D	Volume: - LB - 00052	Project Ref. No.: 551505
Location:	Type:	Role:	Revision: P01

Appendix C - Habitat photos



Photo 1 – Upper Frome habitat assessment. Small lake within Brimpsfield Park showing high turbidity and abundant waterfowl.
(E394397, N212610)



Photo 2 – Upper Frome habitat assessment. Dead common carp in areas with low water level.
(E394354, N212605)



Photo 3- Upper Frome habitat assessment. Watercourse through pasture in lower reaches.
(E394799, N211652)



Photo 4 - Upper Frome habitat assessment. Highly disturbed watercourse through pasture in upper reaches.

(E394391, N213242)



Photo 5 – Norman’s Brook habitat assessment. Southern section showing shallow depth, low flow and scrub.

(E392131, N215788)



Photo 6 – Norman’s Brook habitat assessment. Northern section showing increased depth and emergent vegetation.

(E391512, N216926)



Photo 7 – Horsbere Brook habitat assessment. Typical gentle flow, shallow gradient and dense woodland scrub of this watercourse.

(E389563, N216683)



Photo 8 - Horsbere Brook habitat assessment. The public footpath runs close to the watercourse along much of its length.

(E389563, N216683)



Photo 9 – Coldwell Bottom upper section. Completely dry ditch with no signs of recent flow.

(E394551, N214812)



Photo 10 – Coldwell Bottom mid-section. Very low water levels with little flow. Enclosed by mature hedgerows on each bank.

(E395624, N215494)



Photo 11 – Coldwell Bottom lower section. Shallow slow flowing water running through mature broadleaved woodland near connection to the Churn.

(E396464, N215532)

Appendix D - Field signs photos



Photo 1 - Recent otter spraint. Fish bones and jasmine smell.
(394761, 212400)



Photo 2 – location of recent otter spraint under stone culvert.
(394761, 212400)



Photo 3 - Potential holt underneath overhanging rock and root system.
(394839, 212306)




	<p>Photo 4 - Potential holt under rocks, forming cavity within banks of stream. (395390, 212314)</p>
	<p>Photo 5 - Likely otter footprint. (394583, 212969)</p>
	<p>Photo 6 - Recent otter spraint under road bridge. Fish bones and jasmine odour. (394561, 210367)</p>



Photo 7 – location of recent otter spraint under road bridge.
(394561, 210367)



Photo 8 - Potential holt in horizontal platform within tree roots. Above water level with cavity of unknown depth.
(394545, 213028)



Photo 9 – Old otter spraint on boulder in channel.
(394382, 213284)




	<p>Photo 10 – Old otter spraint (394595, 212855)</p>
	<p>Photo 11 – recent otter spraint (394688, 212673)</p>
	<p>Photo 12 – otter footprints (394572, 212957)</p>



Photo 13 – very old
otter spraint
(394780, 212924)



Photo 14 – two old
otter spraints
(394681, 212737)

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.18
Water Vole Technical Report

28 September 2020

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Executive summary

Highways England are proposing an upgrade to dual carriageway of the Missing link section of the A417 between Cowley roundabout and Crickley Hill (Birdlip, Gloucestershire, Grid reference SO919158). This connection aims to improve journey times and reduce the safety risks associated with this section of the road network.

This report investigates the presence of water vole *Arvicola amphibius* within the zone of influence of the scheme. The report is informed by a desk study undertaken within 2 kilometres of the redline boundary and subsequent water vole surveys undertaken within 250 metres of the proposed scheme redline boundary. The results of a desk study undertaken in 2017 are presented, along with habitat assessments and subsequent field signs surveys that were undertaken in August 2018 and May 2019.

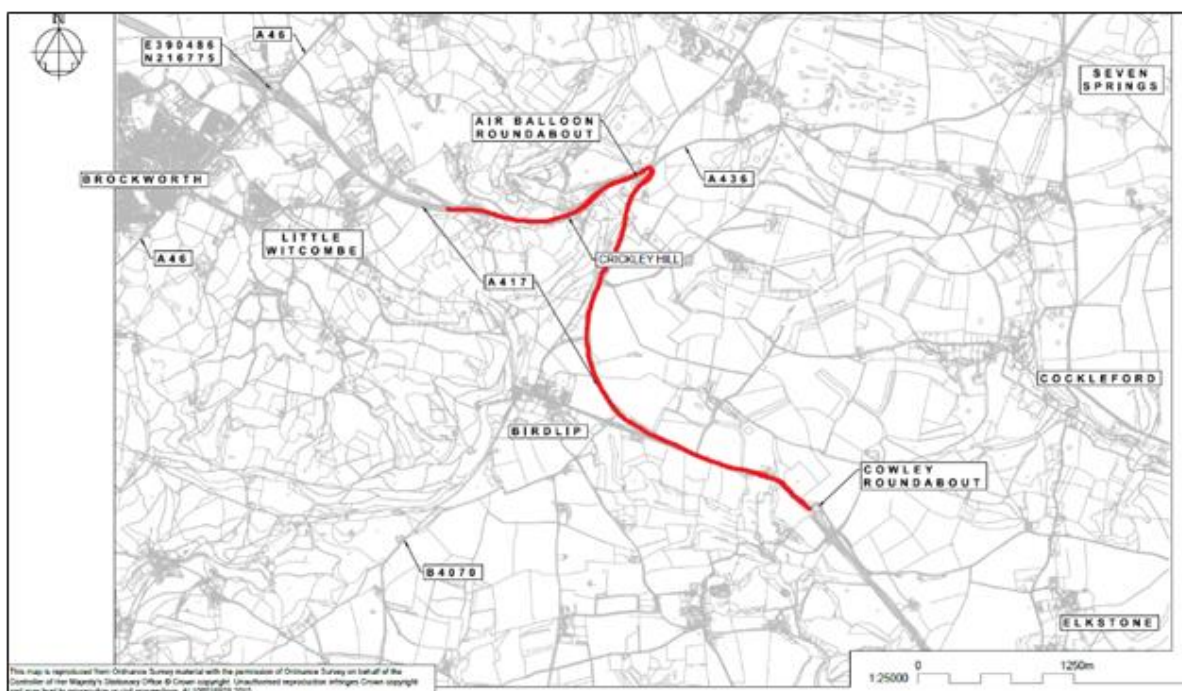
No results of water voles were returned within 2 kilometres of the redline boundary by the biological records search. Two watercourses; Norman's Brook and Upper Frome, were identified as lying partly or wholly within the survey area and were assessed as having low suitability for water voles. The field signs surveys recorded no evidence of water voles on either watercourse.

1. Introduction

1.1. Background

- 1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and as an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'missing link', forms the only section of single carriageway along the route, with an at-grade junction located at the 'Air Balloon' public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5km stretch shown on Figure 1.1 below (central grid reference SO934161).

Figure 1.1 A417 Missing Link Scheme Location Plan

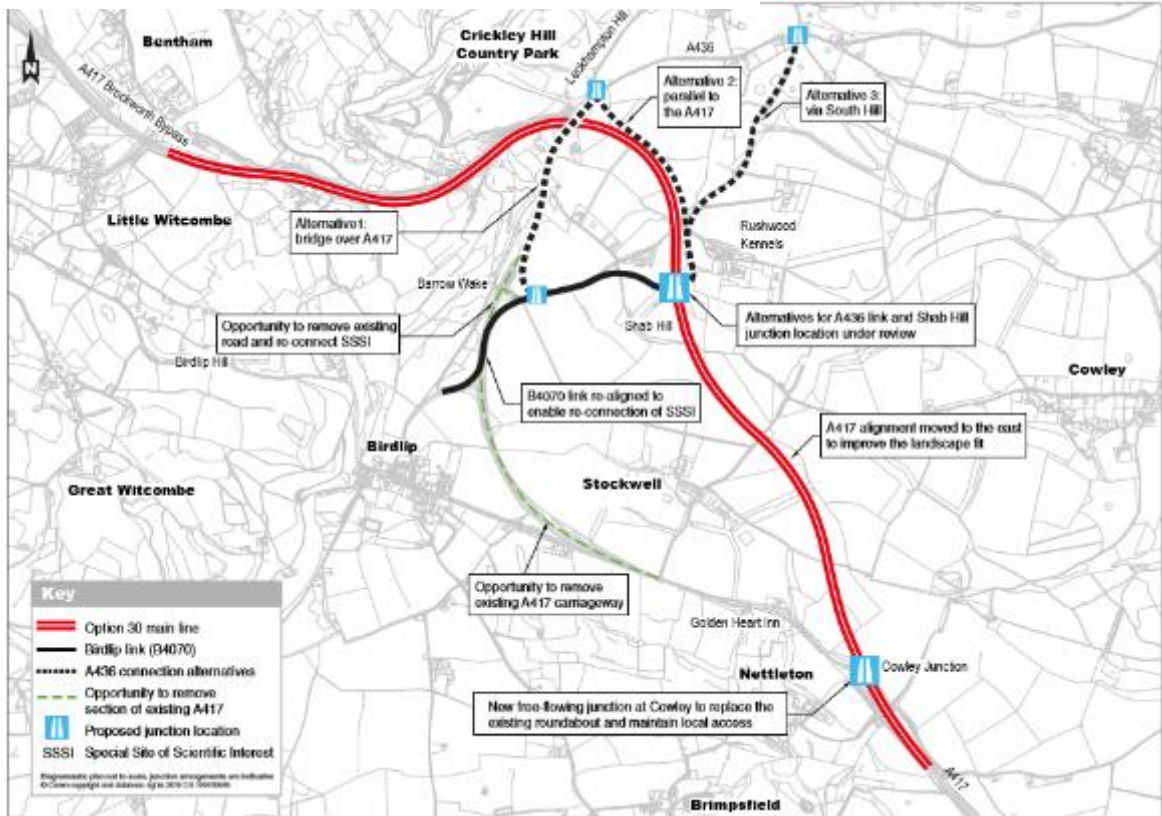


1.2. Scheme proposal

- 1.2.1. The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill. The scheme will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester (M5 Junction 11a). This connection aims to improve journey times and reduce the safety risks associated with this section of the road network.
- 1.2.2. The preferred route was announced by Highways England as option 30 in March 2019 (Figure 1.2 below). A third ascending lane would be added to the A417 at Crickley Hill and the gradient would be reduced to 7%. A new section of road

would be built through Shab Hill to the east of the current A417 and the roundabouts at Cowley and Air Balloon would be removed. A new junction would be added at Shab Hill with links to Birdlip and the A436. Of the three options considered for a connection to the A436, Alternative 2 has been progressed.

Figure 1.2 A417 Preferred route Announcement



1.3. Scope of the report

1.3.1. The objectives of this report are:

- to collate and review existing records for water voles
- to present the methods, constraints and findings of the habitat assessment and field signs surveys
- to inform impact assessment, valuation and recommendations in the Biodiversity Chapter of the Environment Statement

1.4. Legislation and national policy

1.4.1. Water voles are fully protected under the Wildlife and Countryside Act 1981 (as amended). In summary it is an offence to:

- Intentionally kill or injure these species.

- Intentionally or recklessly:
 - Damage or destroy any structure or place used for shelter or protection
 - Disturb these species whilst occupying any structure or place used for shelter or protection.
 - Obstruct access to any structure or place used by these species for shelter or protection.

1.4.2. Water voles are listed as a species of 'principal importance for the conservation of biodiversity in England' under Section 41 of the NERC Act 2006. Following the production of *Biodiversity 2020*, the national strategy for England, actions were identified by experts to help in the recovery of populations of the S41 listed species. Actions identified for the recovery of water voles include the following:

- Continue and extend the National Key Sites for water voles initiative
- Identify Regional Key Areas for water voles following agreed methodologies
- Establish and maintain a national water vole database and GIS
- Continue or establish (as appropriate) and maintain a programme of regular monitoring in National and Regional Key Areas and at a sample of other sites
- Maintain and, where appropriate, extend the area of suitable water vole habitat in National and Regional Key Areas
- Reduce the impact of mink predation, prioritising action in Regional Key Areas.
- Ensure appropriate protection of the water vole and its habitat under the *Wildlife and Countryside Act*

1.5. Status of water voles at the national level

1.5.1. Water voles are widely distributed throughout the lowland areas of Great Britain but are absent from Ireland. Water voles have declined over the last century across the UK, owing predominately to predation by non-native mink and changes in land management. Between 1989 and 1998 a decline of 78% was recorded¹.

1.5.2. Since 1998, it is estimated that the Water vole population has suffered a further 50% decline, although range remains stable. Changes in land management approaches and captive breeding projects are positive drivers of change, but the future population trend is predicted to show an overall decline².

¹ Strachan, C., Strachan, R. & Jefferies, D. J. 2000. Preliminary report on the changes in the water vole population of Britain as shown by the national surveys of the 1989-1990 and 1996- 1998. London: The Vincent Wildlife Trust.

² Mathews, F., Kubasiewicz, L.M., Gurnell, J., Harrower, C.A., McDonald, R.A. and Shore, R.F. (2018). A Review of the Population and Conservation Status of British Mammals: Technical Summary. A report by the Mammal Society under contract to Natural England, Natural Resources Wales and Scottish Natural Heritage. Natural England, Peterborough.

1.6. Water vole ecology

- 1.6.1. Water voles in the UK are strongly correlated with aquatic habitats, although populations on the continent (and rare examples in the UK) also form terrestrial communities⁴. They prefer slow flowing rivers, ditches and lakes.
- 1.6.2. Water voles favour watercourses with steep earthen banks; excavating burrows into these banks with entrances both above and below the water level. Colonies are vulnerable to changes in water levels therefore, steep banks ensure that in times of high flow, water voles can retract to areas of higher ground. Water voles feed predominately on vegetation and require an abundant supply of food throughout the year. 227 plant species have been identified in their diet. Their preference is for well vegetated channels, which provide an abundant food supply whilst providing cover from predators.
- 1.6.3. The males home range is approximately 130 metres, with females typically having smaller ranges of 30 metres. Water voles are quite short-lived animals and will have multiple litters each year. In a good year, this means that populations can expand significantly and thus spread into less suitable habitat.

⁴ Dean, M., Strachan R., Gow, D., Andrews, R. (2016). *The Water Vole Mitigation Handbook* (The Mammal Society Mitigation Guidance Series) [online] available at: <http://www.fensforthefuture.org.uk/admin/resources/downloads/water-vole-mitigation-guidance-final-2016.pdf> (last accessed July 2019)

2. Methodology

2.1. Desk study

- 2.1.1. A detailed desk study was undertaken by Mott Macdonald in 2017 which identified records of protected and notable species within 2 km of the scheme options. These were obtained from Gloucestershire Centre for Environmental Records.
- 2.1.2. Personal communications with Gloucestershire Wildlife Trust (GWT) during 2018 also identified populations of water vole within the local area.
- 2.1.3. The desk study included reviewing other survey and environmental assessment reports undertaken for the study site, including records from previous surveys. WSP undertook a Stage 2 Assessment of a proposed scheme which partly covered the options currently being considered. The results of this Stage 2 Assessment were reported in 'A417 Cowley to Brockworth Bypass Improvement Scheme - Stage 2 Ecology and Nature Conservation Report' (WSP 2006)⁵.

2.2. Field surveys

- 2.2.1. Following the extended phase 1 habitat survey undertaken in spring 2017 by Mott MacDonald, two watercourses with potential to be affected by the scheme were identified as having potential to support water voles. Habitat suitability assessments were completed on Norman's Brook and Upper Frome in August 2018. These were combined with surveys for water vole field signs. A second visit to both watercourses for field signs was completed in May 2019.
- 2.2.2. The Zone of Influence (Zoi) for water vole surveys is in accordance with guidelines provided in the Water Vole Mitigation Handbook and survey experience of the lead surveyor. All watercourses within 250m of the redline boundary were assessed. Watercourses outside of this buffer were included where considered necessary, owing to connectivity to other watercourses. The survey area plus 200 metres upstream and 200 metres downstream was surveyed where access was available.
- 2.2.3. Surveys for water vole field signs followed the guidelines set out in the Water Vole Conservation Handbook⁶. All surveys were undertaken within the water vole's main breeding season (mid-April to September for Southern England) and during good, stable weather.¹ At each watercourse a survey was undertaken

⁵ A417 Cowley to Brockworth Bypass Improvement Scheme – Stage 2 Ecology and Nature Conservation Report, WSP, March 2006 .

⁶ Strachan, R., Moorhouse, T., Gelling, M. (2011). *Water Vole Conservation Handbook 3rd Edition*. Wildlife Conservation Research Unit, Oxford.

during the early season (mid-April to June) and during the late season (July-September). During the survey a habitat assessment was completed, with each watercourse assigned a suitability ranking of either negligible, low, moderate or high. Suitability of habitat for supporting water voles was based on the following:

- bank profile, channel profile and characteristics and water levels
- availability of food sources
- vegetation structure (particularly the extent of suitable marginal vegetation)
- level of shading
- disturbance levels
- bordering land use
- connectivity with other areas of suitable or sub-optimal habitat

2.2.4. During each survey, the banks of each watercourse or water body (up to a distance of 2 metres from the water's edge) were inspected for signs of use by water vole, with a note made of the number of each type of water vole sign recorded so that abundance could be estimated (ranked abundance as frequent, scarce, or none for each section surveyed). Field signs recorded included the following:

- presence of latrines
- presence of burrows (both active and inactive)
- presence of runs
- presence of footprints
- presence of feeding remains
- individual droppings
- sightings and / or sounds (characteristic sound entering the water) of individuals
- An indication of relative population size was estimated based on the number of latrines recorded within the survey area

2.2.5. All surveys were undertaken by experienced Mott MacDonald ecologists, familiar with The Water Vole Mitigation Handbook³ and Water Vole Conservation Handbook⁵ survey guidance, along with having the required knowledge, skills and experience as set in CIEEM's Competencies for Species Survey: Water Vole⁷.

⁷ CIEEM, Technical Guidance Series. Competencies for Species Survey: Water Vole (April 2013)

2.3. Survey constraints and limitations

- 2.3.1. The surveys were undertaken under optimal conditions at suitable times of the year. However, the surveys provide a snapshot of activity at the site and therefore there is always the risk of protected species being overlooked, either owing to the timing of the survey or the scarcity of the species at the site.
- 2.3.2. Due to survey and access agreements, surveys were split over two years, with late season surveys undertaken in 2018 and early season surveys undertaken in 2019. This is not considered to be a constraint to the survey results.
- 2.3.3. Conditions on site meant that some areas were difficult to access, owing to the density of vegetation. An assessment of these areas was made as far as was practicable, but it is possible that signs of water vole were missed and therefore such features would not have been addressed within this report. However, these densely vegetated areas are likely to be heavily shaded by the density of the vegetation and therefore the suitability of these areas for water vole is reduced.

3. Results

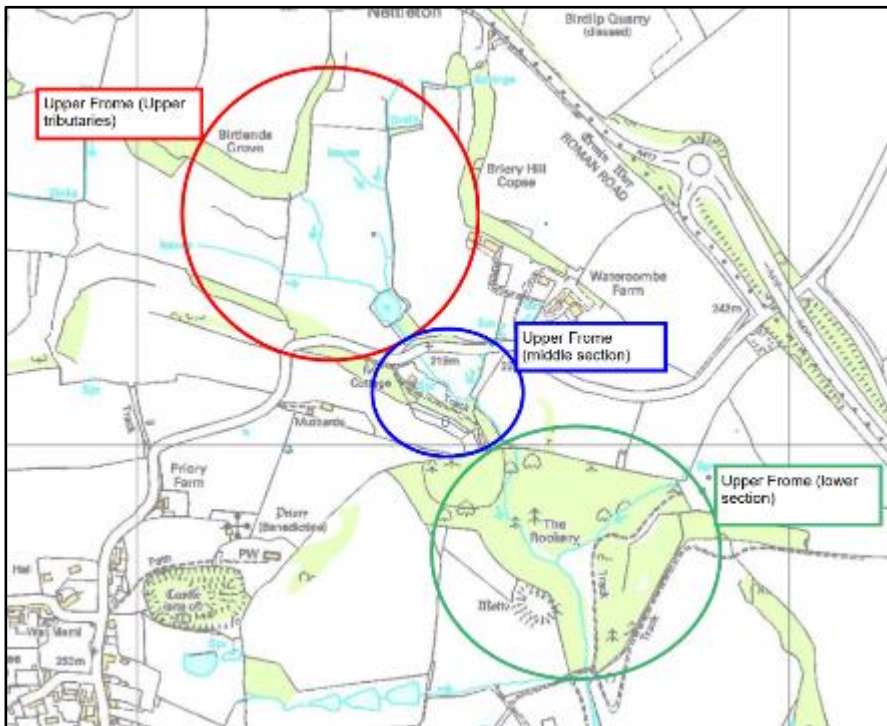
3.1. Desk study

- 3.1.1. No records of water voles within 2km were returned by the biological records search from GCER.
- 3.1.2. The WSP Stage 2 Assessment (2006) surveyed for water voles along Norman's Brook (formerly thought of as Horsbere Brook) in 2003 but found no evidence.
- 3.1.3. GWT confirmed the presence of water voles in Horsbere Brook, approximately 3km west of the survey area.

3.2. Habitat assessment

- 3.2.1. Habitat assessments were undertaken at two watercourses within the survey area; Norman's Brook and Upper Frome, in August 2018.
- 3.2.2. Norman's Brook as watercourse can be split into two sections; The 875m length to the immediate south of the existing A417 all falls within 250m of the redline boundary and was surveyed along its length for its suitability for water voles and field signs. The section to the north of the road is outside of the survey area and therefore not assessed, but runs under a long culvert (approximately 900m) where it connects to the surveyed portion. The southern part of the watercourse (adjacent to the A417) was previously thought to be connected to Horsbere Brook, however, tracer surveys in 2019 confirmed the watercourse to be connected to Norman's Brook.
- 3.2.3. The habitat assessment of upper Frome was split into three distinct sections owing to their differing flows, bank profiles and vegetation structures. The upper tributaries flow slowly from springs south of Nettleton through heavily grazed pasture. After these upper tributaries join in a pond at Watercombe Farm, the middle section flows quickly through woodland with steep-sided rocky banks. The watercourse slows at Brimpsfield Park and joins a tributary from the east to form the lower section. This lower section flows slowly through shallow and low-sided earth-banked woodland. A diagram of the Upper Frome sections is provided below in Figure 3.1.
- 3.2.4. A small 90m section of the Upper Frome (upper tributaries) falls within 250m of the redline boundary and was surveyed for its suitability for water voles and for field signs. As per the water vole mitigation handbook, a further 250m downstream section was subjected to survey. This covered the full length of the Upper Frome (upper tributaries).

Figure 3.1 Upper Frome sections



- 3.2.5. The middle and lower sections of the Upper Frome were also surveyed due changing flows, bank profiles and vegetation structures. A total length of 960m was surveyed along the Upper Frome.
- 3.2.6. The habitat assessments for these surveys are detailed below in table 3.1. Habitat photos are provided in Appendix B and photographs of field signs are provided in Appendix C.

Table 3.1 Water vole habitat assessment

Site name, location & approximate length	Bank profile, bank characteristics and water level	Vegetation structure and shading levels	Bordering land use, disturbance levels	Connectivity	Overall suitability for water voles
Norman's Brook, (SO 92940 15802 to SO 92118 15795), 875m.	Small watercourse in deeply incised channel. Earth banks that have collapsed in places, suitable for water vole burrows. Low flow with frequent man-made structures along length; culverts, pipes, weirs. Water levels appear to	Heavily shaded by woodland along length with limited aquatic vegetation. Areas with increased light penetration where trees have fallen along bankside. Woodland ground flora dominated by dog's mercury, hart's tongue fern, common	Woodland extends 10m from both banks. Wider area is pasture, rough grassland and scrub. Closely borders current A417 to the north and busy bike park to the south	Upstream connectivity poor. Downstream connectivity poor with long culvert (c900 meters) connecting to Norman's Brook.	Low

Site name, location & approximate length	Bank profile, bank characteristics and water level	Vegetation structure and shading levels	Bordering land use, disturbance levels	Connectivity	Overall suitability for water voles
	fluctuate considerably.	nettle and pendulous sedge.			
Upper Frome (Upper tributaries) (SO 94369 12538 to SO 94384 13235), 330m	Minor agricultural ditch with frequent livestock encroachment creating heavily eroded banks. Low suitability for water vole burrows. Shallow along length with frequent muddy pooling and drying out in places. Depth up to 10cm	Water mint and watercress in areas of pooling, with heavily grazed grass and rush species. Occasional shading from hawthorn, blackthorn or elder trees/shrubs.	Surrounding land heavily grazed by cows, leading to muddy pooling in ditch and erosion of banks.	No upstream connection, downstream more suited to water voles.	Negligible
Upper Frome (middle section) (SO 94384 13235 to SO 94584 12999), 260m	Largely steep-sided rocky banks with slow flow and average depth of 15cm. Some areas with earth bank sides and shallower depth.	Limited aquatic vegetation with banks of tall ruderal and willow scrub. Species include bramble, nettle, hogweed, dock, thistle and meadow cranesbill. Watercourse almost completely shaded along length.	Surrounding land is unmanaged scrub and tall ruderal with pasture and woodland in wider landscape. No livestock but possible disturbance from cats or dogs of local home owners.	No upstream connection, downstream more suited to water voles.	Low
Upper Frome (lower section) (SO 94584 12999 to SO 94694 12657), 370m	Shallow, slow running stream in steep-sided valley with average depth of 10cm. Low banks generally not suited to water vole burrows.	Limited aquatic vegetation with heavy shading from open woodland along majority of length. Some open areas with improved grassland and ruderal vegetation.	Stream runs through pheasant shoot with managed woodland, tall ruderal and improved grassland on valley floor. Highly disturbed by game birds and grazing cows.	Downstream connectivity to River Frome	Low

3.2.7. Norman's Brook has low suitability for water voles due to its heavy shading, lack of aquatic herbaceous vegetation, poor bankside vegetation and fluctuating flows.

3.2.8. The Upper Frome (Upper tributaries) has negligible suitability for water voles as its banks are heavily trampled by livestock and has a very low flow with limited herbaceous vegetation. The middle and lower sections of the Upper Frome have low suitability as they are largely undisturbed by livestock but are heavily shaded and lack aquatic or bankside herbaceous vegetation.

3.3. Field signs

3.3.1. No signs of water voles were recorded in either of the two watercourses across the two survey visits. Evidence of mammals along the watercourses was limited to field vole and brown rat. These are detailed in table 3.2 below. Photos are provided in Appendix C.

Table 3.2 Water vole field signs results

Watercourse ID	Type of Feature	Date	Easting	Northing	Notes	
Upper Frome (Upper tributaries)	Mammal dropping (not WV)	15 August 2018	394385	213288	Field vole droppings	Photo 1
Upper Frome (Upper tributaries)	Mammal droppings (not WV)	15 August 2018	394380	213304	Rat droppings	Photo 2
Upper Frome (Upper tributaries)	Mammal dropping (not WV)	15 August 2018	394295	213252	Field vole droppings	
Upper Frome (Upper tributaries)	Feeding remains	15 August 2018	394350	213246	Feeding remains, not indicative of water vole	Photo 3
Upper Frome (Upper tributaries)	Mammal dropping	15 August 2018	394856	212232	Mammal dropping on muddy bank - not water vole	
Upper Frome (lower section)	Burrow	15 August 2018	394871	212226	Mammal hole low to waterline, 20cm wide – not water vole	
Upper Frome (lower section)	Burrow	15 August 2018	394850	212209	Likely kingfisher 0.6m above water-line. Some evidence of whitewashing, 10cm wide.	
Upper Frome (lower section)	Burrow	15 August 2018	394739	212913	Likely rat burrow on earth bank side of shallow stream. 10cm diameter. No visible droppings, under woodland canopy on bankside.	Photo 4
Upper Frome (lower section)	Footprint	15 August 2018	394653	212818	Footprint of small mammal - unlikely to be water vole as digits not splayed in most indicative star configuration	Photo 5

Watercourse ID	Type of Feature	Date	Easting	Northing	Notes	
Upper Frome (lower section)	Burrow	22 May 2019	394665	212787	Rat burrow in bank	
Upper Frome (lower section)	Burrow	22 May 2019	294695	212599	Rat burrow in bank of island in centre of lake	
Norman's Brook	Burrow	16 August 2018	392484	215690	Rat burrow with excavated soil in entrance	Photo 6
Norman's Brook	Feeding remains	16 August 2018	392484	215690	Feeding remains, not indicative of water vole	
Norman's Brook	Burrow	16 August 2018	392838	215726	Rat burrow	

3.3.2. Table 3.3 below provides details on weather conditions and dates of the surveys undertaken.

Table 3.3 Water vole survey dates and weather conditions

Survey area	Date	Air temperature (°C)	Rain (0-5)	Cloud cover (0-8)	Wind (Beaufort scale)
Norman's Brook visit 1	16/8/2018	17	0	6	2
Norman's Brook visit 2	28/5/2019	14	0	2	2
Upper Frome (all sections) visit 1	15/8/2018	19	0	7	2
Upper Frome (all sections) visit 2	22/5/2019	16	0	1	1

3.4. Assessment of water vole population

3.4.1. Water voles are assumed to be absent from the survey area as no records were returned by the desk study and no evidence was recorded during the field signs surveys.

4. Potential Impacts

- 4.1.1. The impact assessment will be covered within the biodiversity chapter of the Environmental Statement for the project. At the time of writing, the Scheme is still being designed and firm conclusions on impacts will be detailed in the aforementioned document.

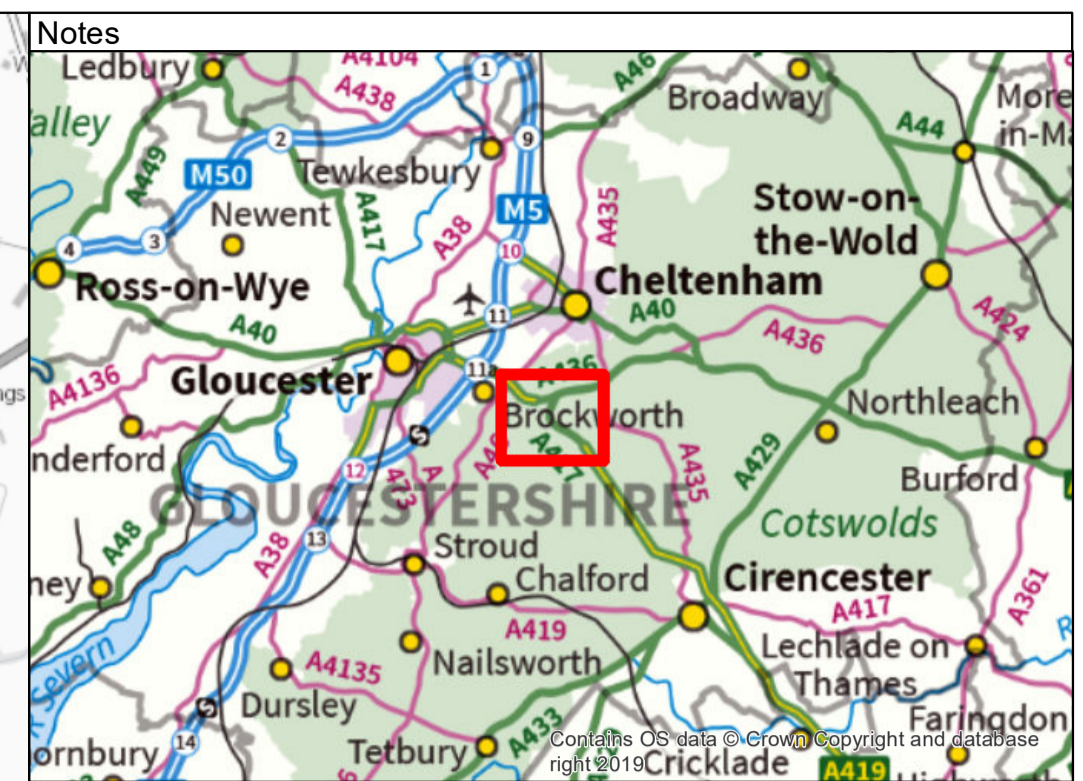
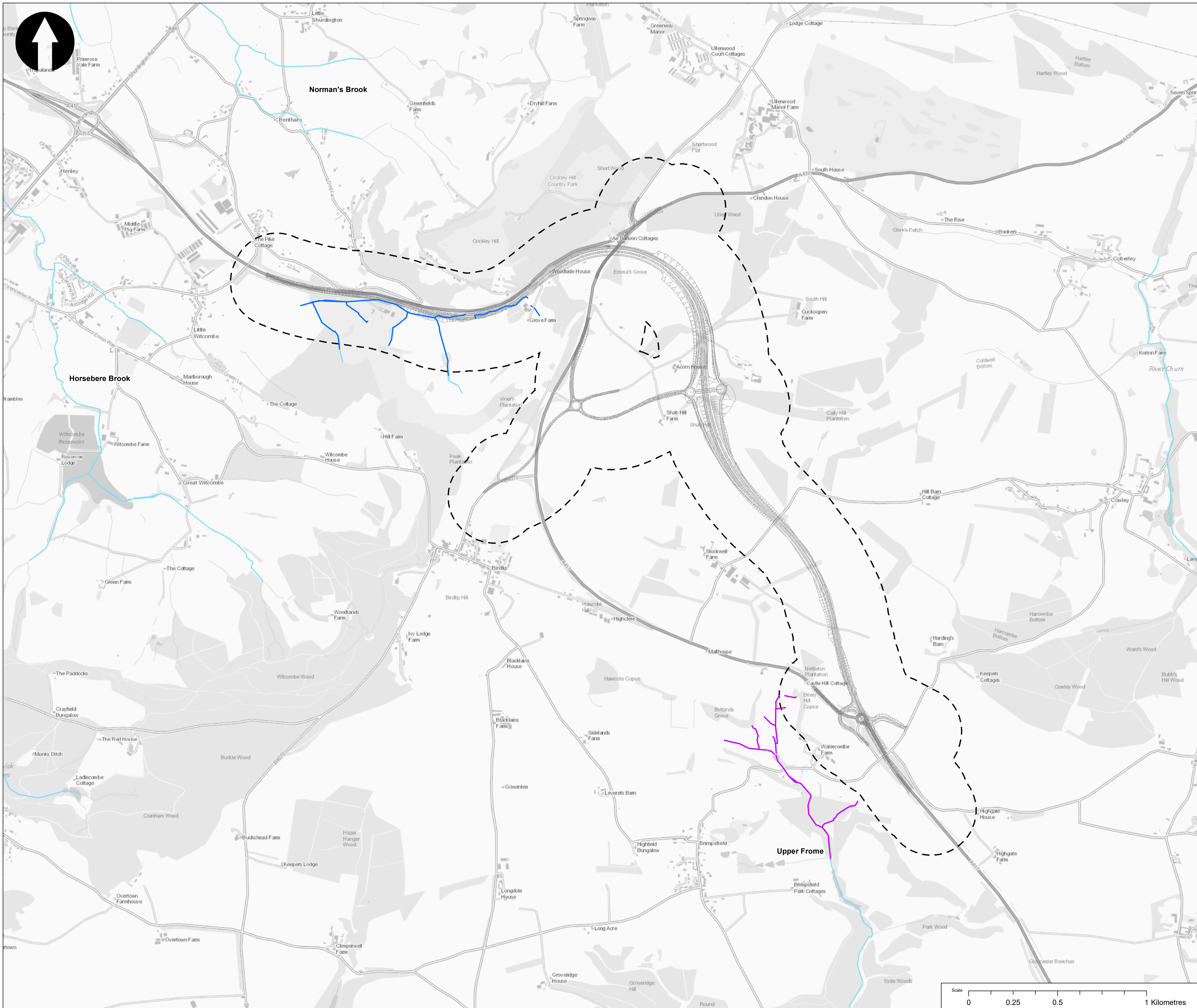
5. Mitigation and Enhancement Recommendations

- 5.1.1. Full details of ecological mitigation measures will be included within the biodiversity chapter of the Environmental Statement for the project.
- 5.1.2. Positive measures should be considered that may offer benefits to Water voles, including habitat reconnection and enhancement.

6. Conclusion

- 6.1.1. A biological records search undertaken in 2017 returned no records of water voles within 2km. Personal communication with Gloucestershire Wildlife Trust confirmed the presence of water voles in Horsbere Brook, approximately 3km from the scheme.
- 6.1.2. Low suitability water vole habitat was identified at two watercourses; Norman's Brook and Upper Frome, within 250m of the redline boundary. Each watercourse was surveyed in both August 2018 and May 2019 for field signs and returned no evidence of water voles.
- 6.1.3. Water voles are assumed to be absent from the survey area as no records were returned by the desk study and no evidence was recorded during the field signs surveys.
- 6.1.4. Full details of potential impacts and mitigation recommendations will be included in the biodiversity chapter of the Environmental Statement for the project.

Appendix A - Water vole survey area



Notes

Legend

- Scheme Extent (at time of survey)
- 250 Metre Scheme Buffer

Water Vole Survey Network

- River Network Outside Survey Area
- Normans Brook Survey Area
- Upper Frome Survey Area

P02	28/10/2019	REVIEW AMENDMENTS	JW	VH	SM
P01	15/07/2019	DRAWING PRODUCED	WG	VH	SM
Rev	Date	Amendment Details	Drawn	Chk'd	App'd

Mott MacDonald Sweco



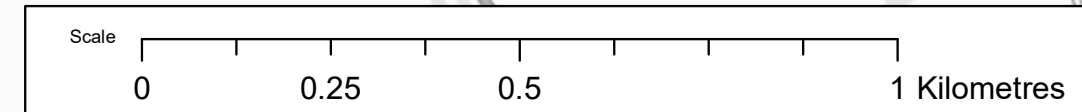
Client	FOR INFORMATION	Subtality	S2
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Project Title
A417 MISSING LINK

Drawing Title
WATER VOLE SURVEY AREA

Scale	1:10,000	Designed	WG	Drawn	JW	Checked	VH	Approved	SM
Original Size	A1	Date	15/07/19	Date	28/10/19	Date	28/10/19	Date	28/10/19

Drawing Number	HE 551505	Originator	MMSJV	Volume	EBD	Project Ref. No.	551505
	000	Type	DR	Role	LB	Revision	00050 P02



Appendix B - Habitat assessment photos



Norman's Brook
habitat assessment



Norman's Brook
habitat assessment



Upper Frome
(Upper tributaries)
habitat assessment



Upper Frome
(Upper tributaries)
habitat assessment



Upper Frome
(Middle section)
habitat assessment



Upper Frome
(Middle section)
habitat assessment



Upper Frome
(Lower section)
habitat assessment

Appendix C - Field signs photos

 A close-up photograph of dark, moist mud. A silver coin is placed on the mud as a scale reference. Several small, dark, cylindrical droppings are visible on the surface of the mud.	<p>Photo 1: Field vole droppings</p>
 A close-up photograph of a muddy bank with some green grass blades. A single, dark, elongated dropping is visible on the mud.	<p>Photo 2: Rat dropping</p>
 A photograph of a pond or stream with dense green aquatic vegetation. The water surface is covered with various plant stems and leaves.	<p>Photo 3: Feedings remains, not indicative of water vole</p>



Photo 4: Likely rat burrow on earth bank side of shallow stream. 10cm diameter. No visible droppings, under woodland canopy on bankside.



Photo 5: Footprint of small mammal - unlikely to be water vole as digits not splayed in most indicative star configuration



Photo 6: Rat burrow
with excavated soil
in entrance

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.19
White-Clawed Crayfish Technical Report

28 September 2020

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Executive Summary

The proposed A417 Missing Link scheme (hereafter referred to as ‘the scheme’) aims to provide a dual carriageway to a stretch of single carriageway between the Cowley roundabout and Crickley Hill in Gloucestershire; the 5.5 kilometre section is the only remaining section of single carriageway. The scheme would increase capacity by creating a free-flowing link between the Brockworth Bypass and Cowley roundabout and remove the at-grade junction with the A436, resulting in a continuous flow between the M4 Junction 15 (Swindon) and the M5 Junction 11a (Gloucester/Cheltenham).

Field surveys to identify white-clawed crayfish *Austropotamobius pallipes* signs were undertaken by Five Rivers Environmental Contracting on behalf of Mott Macdonald in 2018. The scheme has potential to directly impact 1 watercourse with potential to support white-clawed crayfish, Norman’s Brook, and indirectly impact a second watercourse with potential to support white-clawed crayfish, the Upper Frome. White-clawed crayfish surveys were undertaken in October 2018, including manual searching and trapping surveys. Trapping surveys were restricted to the Upper Frome due to a lack of sufficient water depth along Norman’s Brook. No evidence of white-clawed crayfish or any non-native crayfish species was found during the surveys of either watercourse.

No records of white-clawed crayfish were returned within 2 kilometres of the scheme from Gloucestershire Centre for Environmental Records, however, communications with Natural England, Gloucestershire Wildlife Trust and the Environment Agency confirmed the presence of white-clawed crayfish further downstream along the Upper Frome (approximately 3 kilometres south of the scheme), as well as within streams in the Cotswold Beechwoods Special Area of Conservation (approximately 4 kilometres southwest of the scheme).

Norman’s Brook will be directly impacted during the works, including the potential diversion of part of the watercourse. Whist surveys indicate the likely absence of white-clawed crayfish, there is a potential that a very small remnant population may be present. It is recommended that pre-construction surveys are undertaken to update the crayfish surveys. These should be undertaken during the optimum survey period between mid-July and mid-September. Additionally, it is recommended that a precautionary approach is taken during the diversion of the watercourse and that a detailed refugia survey is undertaken during the dewatering of the watercourse to ensure that any remnant populations are identified. A precautionary mitigation plan should be in place to minimise any delays during construction and to ensure the conservation status of white-clawed crayfish is maintained.

Surveys of the Upper Frome indicate the likely absence of white-clawed crayfish from the reaches of the watercourse surveyed. However, there is a known

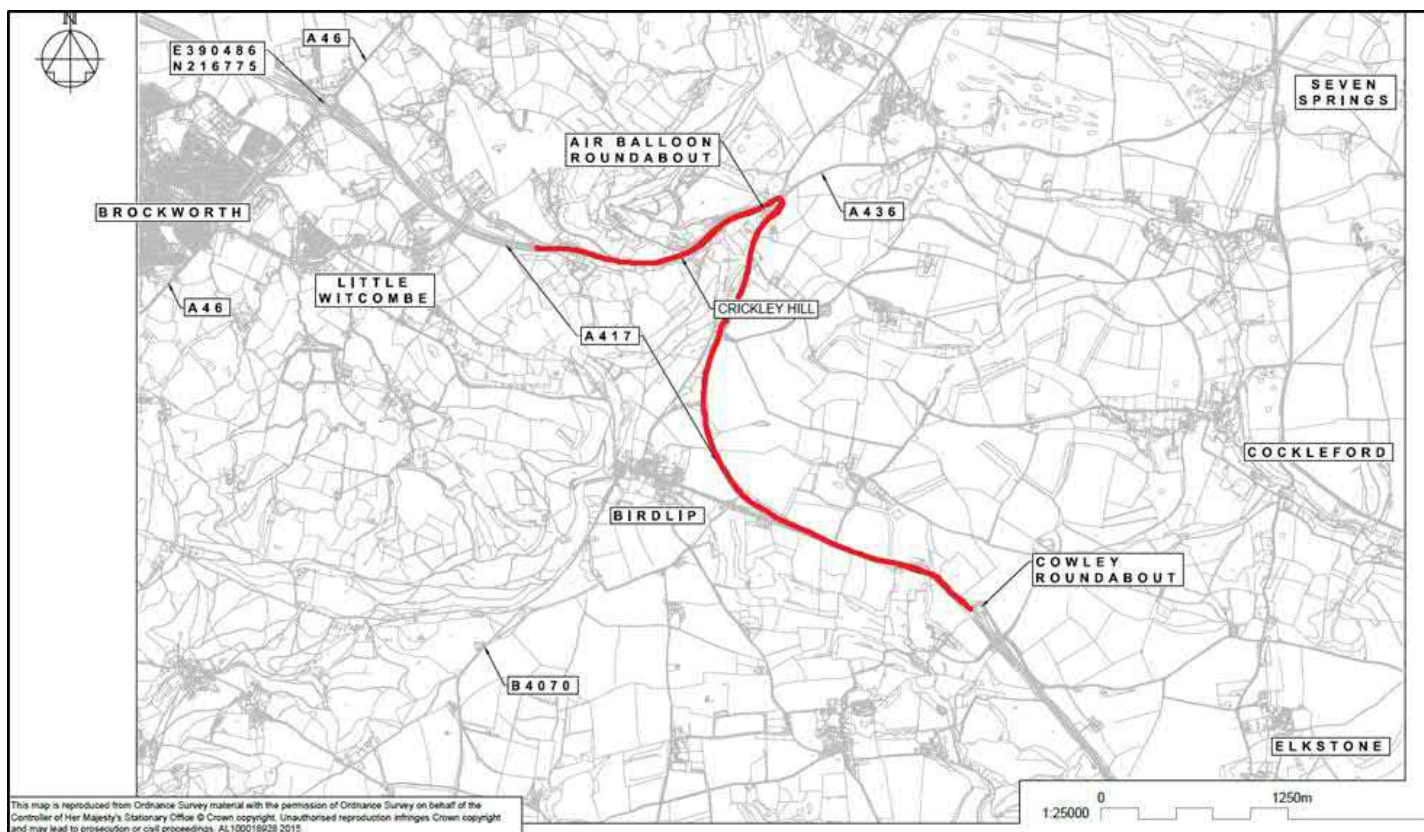
population downstream identified during the desk study. Therefore, mitigation should be implemented to ensure that the scheme does not affect water flows or water quality of water entering the Upper Frome, to ensure no adverse effect on downstream white-clawed crayfish populations. It is recommended that pre-construction surveys are undertaken to update the white-clawed crayfish surveys on the Upper Frome. These should be undertaken during the optimum survey period between mid-July and mid-September.

1. Introduction

1.1. Background

- 1.1.1. The A417/A419 provides an important link between the Midlands/North and South of England, between Gloucester and Swindon, and as an alternative to the M5/M4 route via Bristol. The section of the A417 near Birdlip, known as the 'missing link', forms the only section of single carriageway along the route, with an at-grade junction located at the 'Air Balloon' public house. The single carriageway is located between the Cowley roundabout and the base of Crickley Hill, a 5.5 kilometre stretch shown on Figure 1.1 below.

Figure 1.1 Current A417 route and scheme extent



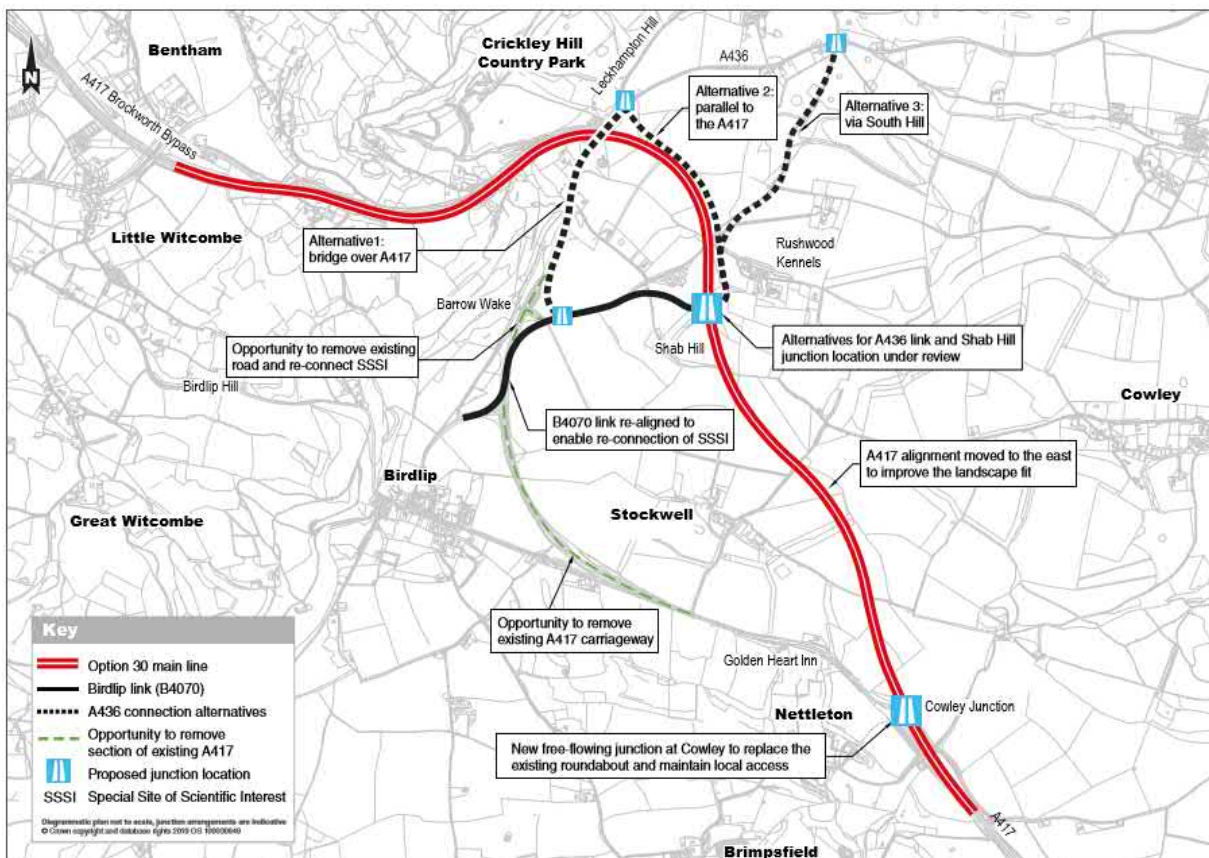
Source: GiGi GIS Portal. Crown Copyright 2016 100030649

1.2. Scheme Proposal

- 1.2.1 The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill.

- 1.2.1. Any proposed scheme would aim to increase capacity by creating a free-flowing link between the Brockworth Bypass and the Cowley roundabout and remove the at-grade junction with the A436 (Air Balloon roundabout). This Missing Link will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester / Cheltenham (M5 Junction 11).
- 1.2.2 The preferred route for the scheme was confirmed as Option 30 by the Secretary of State in March 2019 (see Figure 1.2 below). The Scheme comprises the construction of a new dual carriageway to replace the existing single carriageway section between Brockworth bypass and Cowley Roundabout. It is predominately an “offline” Scheme but approximately a third of the route follows the existing A417 route corridor at Crickley Hill.
- 1.2.3 A new link road would be built between the slip road junction at Shab Hill and the existing A417 to connect traffic to and from Birdlip and the A436 with the new A417. This new link road would end in a new roundabout near Barrow Wake.

Figure 1.2 A417 Missing link proposed option 30



- 1.2.4 Figure 1.2 above shows how there are three A436 link road alternative connections. Alternative 2, parallel to the A417, is the selected route proceeded with for assessment in the Environmental Statement.

1.3. Scope of Report

1.3.1 The objectives of the report are to present the findings of surveys for white-clawed crayfish, which were undertaken on two watercourses which will be potentially impacted by the A417 Missing Link Scheme. This report provides the methodologies used, survey results and any constraints. This report does not provide an assessment of potential impacts or provide recommendations for mitigation.

1.4. Study Area

1.4.1. Guidance on ecological assessments recommends that all ecological features that occur within a zone of influence (Zol) for a proposed scheme are investigated (CIEEM, 2016)¹. The potential Zol for white clawed crayfish includes:

- areas to be directly within the land take for the proposed scheme and access that could cause loss or degradation of suitable aquatic habitat.
- aquatic habitat which could be indirectly affected by the scheme such as through changes in water levels, including any hydrologically connected habitat.

1.4.2. For the A417 Missing Link Scheme, a total of two watercourses were assessed as potentially being impacted and therefore were scoped in for white-clawed crayfish surveys, including:

- Norman's Brook (formerly Horsbere Brook). Stream running parallel with existing A417 to west of Barrow Wake. Watercourse will be directly impacted by Option 30 with potential diversions and culverting.
- River Frome Upper Tributaries. Located 110m southwest of the scheme at its closest point. No direct impacts. Potential for impacts to water levels and flow if Option 30 affects aquifers which feed the tributaries.

1.4.3. The two watercourses selected for survey were the only two watercourses identified at the time of survey with potential to be directly or indirectly impacted by the proposed scheme.

¹ Chartered Institute of Ecology and Environmental Management (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal

1.5. Legislation

1.5.1. White-clawed crayfish are protected under European and National legislation. They are listed under Annexes II and V of the European Council Directive 92/43/EEC the Habitats Directive 1992, transposed into UK Legislation through the Conservation of Habitats and Species Regulations 2017. This legislation requires:

- The identification and designation of important sites for white-clawed crayfish as Special Areas of Conservation (SACs)
- Taking from the wild and exploitation of white-clawed crayfish to be subject to management measures.

1.5.2. White-clawed crayfish are also protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) which makes it an offence to:

- Intentionally take [capture] a wild white-clawed crayfish
- Sell, offer or expose for sale, or have in one's possession or transport for the purpose for sale, any live or dead wild white-clawed crayfish, or any part derived from it.

1.5.3. Also, of relevance for the white-clawed crayfish surveys is legislation relating to North American signal crayfish *Pacifastacus leniusculus*. This highly invasive species has a significant adverse effect on native wildlife and habitats, including white-clawed crayfish, and is therefore included in Schedule 9 of the Wildlife and Countryside Act 1981 (as amended). It is an offence to release into the wild any animal listed under Schedule 9.

1.6. Status of white-clawed crayfish

1.6.1. White-clawed crayfish were once widespread across Europe and Britain but suffered significant decline during the mid to late 1900's and are now internationally and nationally rare. A major threat to native white-clawed crayfish is posed by the introduction of non-native species of crayfish, which have been farmed in Britain since the late 1970s. Soon after the introduction of non-native crayfish farming, crayfish plague (a virulent disease caused by the fungus *Aphanomyces astaci*) broke out and spread rapidly, causing drastic losses of native crayfish in rivers in England. It is believed that this disease was introduced and is spread by the most frequently farmed species, the North American signal crayfish, a carrier of the disease. Crayfish plague can be introduced into a waterbody not only by entry of signal crayfish but also by water, fish or equipment that has been in contact with signal crayfish. This greatly

increases the risk to remaining white-clawed crayfish populations. It is only in areas free of disease that white-clawed crayfish are likely to survive in the future.

- 1.6.2. North American signal crayfish and other non-native crayfish are larger and more aggressive than the native species and produce more young. Consequently, the introduced species pose a threat not only because some are disease-carriers, but also through predation and competition with white-clawed crayfish. In Britain North American signal crayfish are now well-established in the wild.
- 1.6.3. Following the introduction of the North American signal crayfish and associated outbreaks of crayfish plague, most of the remaining populations are concentrated in northern and central England. The remaining populations of white-clawed crayfish are threatened by non-native crayfish introduction and the spread of crayfish plague, as well as habitat loss, degradation, pollution and water abstraction.

1.7. White-clawed crayfish ecology

- 1.7.1. White-clawed crayfish occur in a wide range of waterbodies including both running and still water habitats. They can be found in a wide range of habitats including chalk rivers, clay rivers, upland streams, canals and reservoirs.
- 1.7.2. Typical habitats include fresh water streams less than 1 metre deep, slow flowing glides, still waterbodies and pools. White-clawed crayfish prefer waterbodies that are alkaline rich with a high PH level (preferably between 6.8-8.6) and largely unpolluted. Their distribution is largely determined by geology and water quality, with crayfish occurring in areas with relatively hard, mineral-rich waters.
- 1.7.3. Suitable refuge areas in the watercourse and surrounding habitat are very important as this protects them from predation and from being washed away in high flows. They use a variety of refuges both natural and artificial, depending on habitat availability. They typically favour habitats with an underlying substrate of fine gravel / sand with some pebbles, overlaid with aggregations of boulders and large cobbles. Areas of undercut bank and overhanging trees and in-channel vegetation are also important habitat features. However, white-clawed crayfish are also known to inhabit watercourses with deep muddy substrates and little aquatic vegetation.
- 1.7.4. White-clawed crayfish activity varies by season, in response to temperature, river flow and annual cycle of growth, breeding and periods of inactivity. Breeding typically takes place between September and November when water temperatures drop below 10°C for an extended period. During the breeding season different areas within the watercourse may be used for shelter and

feeding. During the winter period, between December to March, they spend most of their time in torpor in refuges, until the water temperatures increases. Females carry their eggs over the winter period, they hatch on her and then remain for a period before they disperse. Young disperse in the water from June onwards.

- 1.7.5. Their diet includes a wide range of food including fallen leaves, aquatic vegetation, dead fish, aquatic invertebrates such as snails and caddis-fly larvae. Where available, calcified plants are of particular value to their diet as they provide a ready source of calcium.

2. Methodology

2.1. Desk study

- 2.1.1. As part of the preliminary ecological appraisal of the scheme, biological records were acquired from the Gloucestershire Centre for Environmental Records (GCER) in 2017. This included a search for protected and notable species within 2 kilometres from the scheme, where data was available.
- 2.1.2. Information on local white clawed crayfish records was also obtained through discussions with Natural England and Gloucestershire Wildlife Trust during A417 Environmental Working Group meetings in 2018. This information was provided verbally during these Environmental Working Group Meetings. A meeting was held with the Environment Agency on 10.04.2019 during which known locations of crayfish populations were discussed.

2.2. Habitat assessment

- 2.2.1. During the extended phase 1 habitat surveys under taken in May 2017, an initial assessment of habitat suitability was completed identifying all watercourses suitable for white-clawed crayfish within the ZoI of the scheme. More detailed habitat suitability assessments were also undertaken during the surveys in October 2018.

2.3. White-clawed crayfish surveys

- 2.3.1. To determine the presence/likely absence of white-clawed crayfish from the surveyed watercourses, surveys were undertaken by Five Rivers Environmental Contracting. All white-clawed crayfish surveys were led by surveyors holding a Natural England Class Survey Licence (CL11).
- 2.3.2. The survey methodology followed the protocol outlined in the JNCC CSM Guidance for Freshwater Fauna (CSM Protocol 2²) which is based on the method in LIFE in UK Rivers Project (Peay, 2003³).
- 2.3.3. During the surveys, field-based water quality parameters including temperature (°C), pH, dissolved oxygen (DO; mg/l and %) and conductivity ($\mu\text{S cm}^{-1}$) were recorded using a hand held calibrated YSI Pro-plus meter.

² http://jncc.defra.gov.uk/pdf/CMS_Freshwaterfauna_201510.pdf

³ Peay, S. (2003). Monitoring the white-clawed crayfish *Austropotamobius pallipes*. Conserving Natura 2000 Rivers Monitoring Series No.1. English Nature, Peterborough.

- 2.3.4. A strict biosecurity policy was adhered to at all times to prevent the spread of non-native species or pathogens (i.e. crayfish plague). This protocol included:
- Ensuring all equipment was checked, cleaned and dried as per biosecurity policy before leaving the office.
 - All equipment was visually inspected between sites/survey days for any non-native species, cleaned and disinfected with Virkon.
 - At the end of the surveys all equipment was visually checked and cleaned prior to loading the vehicle.
 - On return to office all equipment was disinfected using Virkon and dried thoroughly.

Manual Search

2.3.5. At sites that were suitable, the 'standard method' of manual search of suitable crayfish refuges was undertaken. Manual searching involved facing upstream, gently lifting, sliding/turning and returning potential refuges and looking for crayfish. A refuge may be a single stone (or other item of physical refuge), but if stones were overlapping then multiple stones were lifted until the gravel substrate (or finer substrate) was reached. Where this was undertaken, this counted as 1 refuge.

2.3.6. For manual search, the site must at the time of visit:

- Have areas of suitable crayfish habitat in water depth <400mm
- Water flow <20 cm s⁻¹
- Relatively smooth water surface
- Clarity that enabled a clear view of the bed substrate in areas with potentially searchable physical habitat for white-clawed crayfish
- Water turbidity must be low to ensure crayfish can be seen and caught for species identification

Trapping

2.3.7. Where conditions prevent a complete manual search, the trapping methodology was used. Baited traps were left overnight and crayfish enter the traps and cannot escape.

-
- 2.3.8. Environment Agency consent is required to use crayfish traps and consent was granted for the surveys in October 2018.
 - 2.3.9. Trapping was avoided if rain was forecast or if a watercourse was still under moderate or high flow after rainfall. A trapping session was not valid if there was an increase in flow between trap setting and 4 hours after sunset.
 - 2.3.10. The trapping survey involved setting of mesh-traps, with funnelled entrances at either end which were baited with an attractant and deployed overnight when crayfish most actively forage. Funnel traps were deployed within areas of the survey sections where they could be fully submersed and associated with suitable refuge habitat.

2.4. Constraints

- 2.4.1. The optimal survey window for undertaking white-clawed crayfish surveys is after the breeding season between mid-July and mid-September. Surveys should avoid late-May and June when females may be carrying newly hatched young. The surveys for the A417 missing link scheme in 2018 were undertaken in October which is outside of this optimal survey window. However, the surveys were undertaken at a time of year when crayfish are still active and water temperatures recorded during the surveys were suitable for surveys (9.4°C). It is therefore considered that the surveys were undertaken at an appropriate time of year to detect the presence or likely absence of white clawed crayfish on the surveyed watercourses.
- 2.4.2. The surveys provide a snapshot of activity at the site and therefore there is always the risk of protected species being overlooked, either owing to the timing of the survey or the scarcity of the species at the site.
- 2.4.3. Conditions on site meant that some areas were difficult to access, owing to the density of vegetation, including an 80 metre stretch of the Upper Frome. However, an assessment of these areas was made as far as was practicable, and surveys were undertaken upstream and downstream of these areas where habitat was suitable. Therefore this is not considered a significant constraint. However, there is a risk that any crayfish present and confined to these inaccessible areas would have been overlooked.
- 2.4.4. Access to sections of Norman's Brook between SO 92356 15705 and SO 92137 15783 was not possible at the time of survey due to landowner restrictions. Surveys were undertaken upstream of this, however, there is a risk that any crayfish present and confined to these inaccessible areas would have been overlooked.

3. Results

3.1. Desk study

- 3.1.1. No records for white-clawed crayfish were returned from the GCER Biological Data Search within 2 kilometres of the scheme. From communications with Gloucestershire Wildlife Trust and Natural England, there are known populations of white-clawed crayfish on the wider Upper Frome (approximately 3 kilometres south of the scheme) and within streams within the Cotswolds Beechwoods SAC to the west of Cranham (approximately 4 kilometres southwest of the scheme).
- 3.1.2. At a meeting with the Environment Agency in April 2019, the Environment Agency confirmed that there were populations of white-clawed crayfish within the following watercourses: Climperwell Brook (exact location of records not given but closest point to scheme is at SO91921196, approximately 3.2 kilometres southwest of the A417); Painswick Stream (exact location of records not given but closest point to scheme is at SO91221159, approximately 3.96 kilometres southwest of the A417); and, Slad Brook (exact location of records not given but closest point to scheme is at SO88860899, approximately 7.3 kilometres southwest of the A417).

3.2. Habitat Assessment

Norman's Brook

- 3.2.1. Norman's Brook (currently shown on Ordnance Survey mapping as Horsbere brook but tracer surveys in 2018 confirmed that its Norman's Brook), is a small stream with a steep gradient, and is heavily shaded in a deeply incised channel (Figure 1). The wetted width of the stream at the time of survey was between 0.1 and 1.3 metres wide. The water level was shallow with very low flow and quite heavily silted with frequent woody debris in the stream. During the survey there were obvious issues with run-off, likely from the existing A417, with grey/oily film present in areas of slow flow.
- 3.2.2. A number of culverts were present along the surveyed section of the watercourse (up to 40 metres long) and there was a section of multiple low-head concrete weirs. The watercourse links to the open channel of Norman's Brook via a very long culvert.
- 3.2.3. The water levels within this watercourse appear to fluctuate significantly depending on rainfall and it is likely that the watercourse is dry during times of low rainfall.

- 3.2.4. The watercourse included numerous suitable refuges for crayfish including small and large cobbles, tree roots, undercut banks and woody debris in the water. The water is mineral rich with calcium deposits noted. There was however very limited aquatic or emergent vegetation. The likely ephemeral nature of the watercourse reduces its potential to support a viable population of white-clawed crayfish and the silty water with evidence of pollution reduces the overall suitability of the habitat

Figure 3: Normans Brook



Upper Frome

- 3.2.5. The areas of the watercourse within closest proximity to the scheme comprise a narrow stream between 0.1 and 0.4 metres wide which is very shallow and confined to field boundary ditches. The water levels are likely to frequently dry out depending on weather conditions. Sections are heavily poached by livestock. The stretch of watercourse north of Ordnance Survey grid reference SO 94382 13285 was assessed as being unsuitable for white-clawed crayfish (Figure 2). This is the section of watercourse within closest proximity to the A417 scheme.
- 3.2.6. The lower sections of the surveyed area of the Upper Frome, south of SO 94382 13285, were assessed as being more suitable for white-clawed crayfish with deeper water and a range of suitable refugia including small and large cobbles, boulders, tree roots, undercut banks and woody debris.

- 3.2.7. The watercourse comprises a small stream largely running through a mix of coniferous plantation and semi-natural deciduous woodland. Throughout the length of the surveyed watercourse there were areas of shallow gradient with slow flowing water, pools, and areas with steeper gradient with an abundance of small drops and pools with meanders present. Calcium build-ups were recorded on water drops and areas of shallow, fast flowing water, indicating the mineral rich nature of the water. The downstream section included larger settlement ponds with deep silty substrate and deep leaf litter.

Figure 4: Upper Frome – unsuitable northern section (north of Reach 5):



Figure 5: Upper Frome – Reach 1



3.3. Manual search

Norman's Brook

- 3.3.1. The Norman's Brook survey area was divided up into 3 reaches, the locations of which are shown in Appendix A. Detailed descriptions of each reach are provided in Appendix B. Reach 1 is 155 metres in length (between SO92361570 and SO92491569). Reach 2 is 275 metres long (between SO92491569 and SO92761571). Reach 3 is 130 metres long (between SO92761571 and SO92891574).
- 3.3.2. Each reach was subject to a detailed manual search of suitable refugia along the length of the reach. Suitable refugia included small cobbles (65 - 150mm); large cobbles (150 - 260mm); tree roots; undercut banks; woody debris; and urban debris. A total of 100 refugia were manually searched on each reach. Manual surveys were undertaken on the 24 October 2018.
- 3.3.3. No evidence of white-clawed crayfish, or any non-native crayfish species was recorded during the manual search survey on any of the 3 reaches.

Upper Frome

- 3.3.4. The Upper Frome survey area was divided up into 5 reaches, the locations of which are shown in Appendix A. Detailed descriptions of each reach are

provided in Appendix B. Reach 1 is 200 metres in length (between SO94681265 and SO94621282). Reach 2 is 125 metres long (between SO94621282 and SO94561294). Reach 3 is 130 metres long (between SO94561294 and SO94521306). Reach 4 is 140 metres long (between SO94521306 and SO94421315) and Reach 5 is 165 metres long (between SO94421315 and SO 94382 13285). Within Reach 4, a section approximately 80 metres long could not be surveyed as it was inaccessible due to dense trees and vegetation within the channel.

- 3.3.5. Each reach was subject to a detailed manual search of suitable refugia along the length of the reach. Suitable refugia included boulders; small cobbles (65 - 150mm); large cobbles (150 - 260mm); tree roots; undercut banks; woody debris; and urban debris. A total of 100 refugia were manually searched on each reach. Manual surveys were undertaken on the 25 October 2018.
- 3.3.6. No evidence of white-clawed crayfish or any non-native crayfish species was recorded during the manual search survey on any of the 5 reaches.

3.4. Trapping Survey

Norman's Brook

- 3.4.1. There were no suitable areas to set traps within any of the Norman's Brook reaches, with the water being too shallow. No trapping surveys were undertaken along Norman's Brook.

Upper Frome

- 3.4.2. A total of 15 traps were set up along 4 of the reaches. Reach 5 was not suitable for setting traps due to shallow water. Traps were set on 25 October 2018 and collected on 26 October 2018.
- 3.4.3. No evidence of white-clawed crayfish or any non-native crayfish species was recorded during the trapping survey on any of the 5 reaches.

4. Conclusions and recommendations

4.1. Norman's Brook

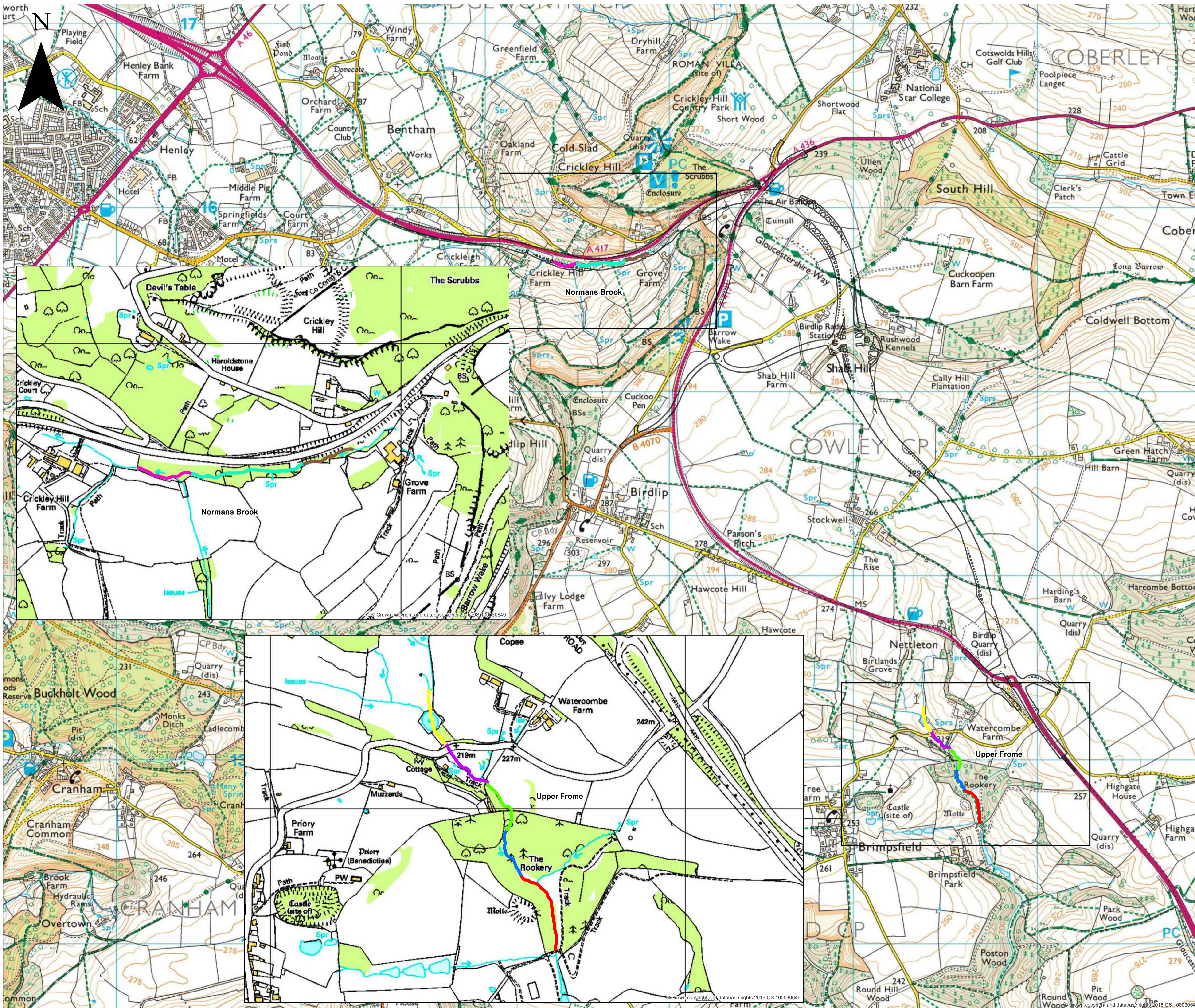
4.1.1. Surveys of Norman's Brook identified no evidence of white-clawed crayfish or any non-native crayfish species. This indicates the likely absence of white-clawed crayfish from the watercourse. However, as the watercourse provides suitable conditions, there is a potential that a very small remnant population may have been missed during the survey, especially as some downstream sections were not accessible during the survey. It is likely that the watercourse will be directly impacted during the works, including the potential diversion of part of the watercourse. It is recommended that pre-construction surveys are undertaken to update the crayfish surveys. These should be undertaken during the optimum survey period between mid-July and mid-September. Additionally, it is recommended that a precautionary approach is taken during the diversion of the watercourse and that a detailed refugia survey is undertaken during the dewatering of the watercourse to ensure that any remnant populations are identified. A precautionary mitigation plan should be in place to minimise any delays during construction and to ensure the conservation status of white-clawed crayfish is maintained.

4.2. Upper Frome

4.2.1. Surveys of the Upper Frome indicate the likely absence of white-clawed crayfish from the reaches of the watercourse surveyed. However, there is a known population downstream of the surveyed reaches identified during the desk study. Therefore, any hydrological impacts on the Upper Frome as a result of the scheme must consider adverse impacts on downstream white-clawed crayfish populations. Mitigation should be implemented to ensure that the scheme does not affect water flows or water quality of water entering the Upper Frome, to ensure no adverse effect on downstream white-clawed crayfish populations. It is recommended that pre-construction surveys are undertaken to update the white-clawed crayfish surveys. These should be undertaken during the optimum survey period between mid-July and mid-September.

Appendices

Appendix A White-clawed crayfish survey areas



Legend

Option 30 Scheme Plan
(at time of survey)

Normans Brook Reaches

- 1
- 2
- 3

Upper Frome Reaches

- 1
- 2
- 3
- 4
- 5

P01	04/07/2019	DRAWING PRODUCED	WG	VH	SM
Rev	Date	Amendment Details	Drawn	Chk'd	App'd

Mott MacDonald Sweco

Client: **highways england**

Drawing Status: FOR INFORMATION Suitability: S2

Project Title: A417 MISSING LINK

Drawing Title: White-Clawed Crayfish Survey Reaches

Scale	1:0	Designed	WG	Drawn	WG	Checked	VH	Approved	SM
Original Size	A1	Date	04/07/2019	Date	04/07/2019	Date	04/07/2019	Date	04/07/2019

Drawing Number: 551505 - MMSJV - EBD - 000 - DR - LE - 00049 Project Ref. No: 551505

Location: P100030649 Role: Number: P01

FILE LOCATION: P:\Southampton\HWA\GIS\Projects\353982 - A417\Ecology\GIS_2019\SURVEY_MAPS\White Clawed Crayfish\HXD\White_Clawed_Crayfish_Reaches.mxd

Appendix B White-clawed crayfish survey results

Watercourse	Date	Reach	U/S NGR	D/S NGR	Reach Length (m)	Water Temp (C)	pH	Wetted Width (m)	Refuges Manually Searched	Refuge Types Present/Searched	Traps Set	Crayfish (Present / Absent)	Total No. Crayfish	Habitat	Bullhead (Present / Absent)	Description
														(None / Present / Frequent / Abundant)		
Norman's Brook	24/10/2018	1	SO 92501 15702	SO 92374 15708	155	9.4	8.14	0.1 - 1.3	100	Small Cobble (65 - 150mm) Large Cobble (150 - 260mm) Tree root Undercut bank Woody Debris Urban Debris	0 - No suitable habitat	Absent	0	Present	Absent	Small stream, heavily shaded in deeply incised channel. Very low flow and quite heavily silted. Lots of woody debris in stream. Obvious issues with run-off - grey/oily film present in areas of slow flow. Nowhere suitable depth for trapping.
Norman's Brook	24/10/2018	2	SO 92770 15722	SO 92501 15702	275	9.4	8.14	0.2 - 1.2	100	Small Cobble (65 - 150mm) Large Cobble (150 - 260mm) Tree root Undercut bank Woody Debris Urban Debris	0 - No suitable habitat	Absent	0	Present	Absent	Small stream, steep gradient, heavily shaded in deeply incised channel. Becomes smaller upstream. Very low flow and quite heavily silted. Lots of woody debris in stream. Obvious issues with run-off - grey/oily film present in areas of slow flow. 40m culvert present halfway through reach and a section of multiple low-head concrete weirs. Nowhere suitable depth for trapping.

Watercourse	Date	Reach	U/S NGR	D/S NGR	Reach Length (m)	Water Temp (C)	pH	Wetted Width (m)	Refuges Manually Searched	Refuge Types Present/Searched	Traps Set	Crayfish (Present / Absent)	Total No. Crayfish	Habitat	Bullhead (Present / Absent)	Description
														(None / Present / Frequent / Abundant)		
Norman's Brook	24/10/2018	3	SO 92881 15758	SO 92770 15722	130	9.4	8.14	0.1 - 1.2	100	Small Cobble (65 - 150mm) Large Cobble (150 - 260mm) Tree root Undercut bank Woody Debris Urban Debris	0 - No suitable habitat	Absent	0	Present	Absent	Very small stream, steep gradient, heavily shaded in deeply incised channel. Becomes smaller upstream. Very low flow and quite heavily silted. Lots of woody debris in stream. Obvious issues with run-off - grey/oily film present in areas of slow flow. 12m culvert present halfway through reach and a section of multiple low-head concrete weirs. Nowhere suitable depth for trapping.
Upper Frome	25/10/2018	1	SO 94645 12845	SO 94688 12659	200	9.4	8.24	0.5 - 3.0	100	Small Cobble (65 - 150mm) Large Cobble (150 - 260mm) Boulder Tree root Undercut bank Woody Debris Urban Debris	4	Absent	0	Present	Absent	Small stream with good flow variation running through coniferous and deciduous woodland creating heavy shading. Poned/settlement pond at d/s of site which was to deep/silty to wade. Large pond located further d/s. Lots of leaf litter and fallen trees in channel. Stream located just off public footpath. Max depth of 40cm - minimum of 2cm.

Watercourse	Date	Reach	U/S NGR	D/S NGR	Reach Length (m)	Water Temp (C)	pH	Wetted Width (m)	Refuges Manually Searched	Refuge Types Present/Searched	Traps Set	Crayfish (Present / Absent)	Total No. Crayfish	Habitat	Bullhead (Present / Absent)	Description
														(None / Present / Frequent / Abundant)		
Upper Frome	25/10/2018	2	SO 94573 12947	SO 94645 12845	125	9.4	8.24	0.7 - 2.0	100	Small Cobble (65 - 150mm) Large Cobble (150 - 260mm) Boulder Tree root Undercut bank Woody Debris Urban Debris	5	Absent	0	Present	Absent	Small stream in deciduous woodland, now outside of the conifer plantation d/s. Greater gradient with an abundance of small drops and pools with meanders present. Pools ideal for setting traps. Public footpath along one back. Wider shallow riffles present. Lots of leaf litter and fallen/overhanging trees.
Upper Frome	25/10/2018	3	SO 94528 13069	SO 94573 12947	130	9.4	8.24	0.2 - 2.7	100	Small Cobble (65 - 150mm) Large Cobble (150 - 260mm) Boulder Tree root Undercut bank Woody Debris Urban Debris	5	Absent	0	Present	Absent	Small stream in deciduous woodland with good gradient, drops and pools present. Sand/calcium build-ups on water drops and areas of shallow, fast flowing water. U/s stream flows through area of improved pasture with heavy cattle poaching present with river creating boggy ground. Fallen/overhanging trees making some areas inaccessible.

Watercourse	Date	Reach	U/S NGR	D/S NGR	Reach Length (m)	Water Temp (C)	pH	Wetted Width (m)	Refuges Manually Searched	Refuge Types Present/Searched	Traps Set	Crayfish (Present / Absent)	Total No. Crayfish	Habitat	Bullhead (Present / Absent)	Description
														(None / Present / Frequent / Abundant)		
Upper Frome	25/10/2018	4	SO 94429 13160	SO 94528 13069	140	9.4	8.24	0.3 - 1.5	100	Small Cobble (65 - 150mm) Large Cobble (150 - 260mm) Boulder	1	Absent	0	Present	Absent	Small stream through deciduous woodland and scrubland. This site was shorter (around 100m) with an area of around 80m inaccessible due to dense trees and vegetation within the channel. Area limited by road bridge. All areas accessible were searched and one area was suitable for trapping.
Upper Frome	25/10/2018	5	SO 94382 13285	SO 94429 13160	165	9.4	8.24	0.2 - 0.8	100	Small Cobble (65 - 150mm) Large Cobble (150 - 260mm) Boulder Woody Debris Submerged Vegetation	0 - No suitable habitat	Absent	0	Present	Absent	Small stream north of road bridge with dense macrophyte cover and silt beds present. Areas were partially inaccessible due to fallen trees and bushes. Concrete weir with ponded/boggy area at midpoint. Ponded area was shallow, heavily shaded with black anoxic silt and fallen trees. U/s of ponded area the stream was very narrow flowing through improved pasture. Heavily poached area with little habitat present. Any cobbles/boulder present were checked. No areas

Watercourse	Date	Reach	U/S NGR	D/S NGR	Reach Length (m)	Water Temp (C)	pH	Wetted Width (m)	Refuges Manually Searched	Refuge Types Present/Searched	Traps Set	Crayfish (Present / Absent)	Total No. Crayfish	Habitat	Bullhead (Present / Absent)	Description
														(None / Present / Frequent / Abundant)		
																suitable for trapping.
Upper Frome	25/10/2018	5	N/A	SO 94382 13285	N/A	9.4	8.24	N/A	N/A	N/A	0 - No suitable habitat	N/A	0	Absent	Absent	Upstream of this NGR the stream is very small (0.1 to 0.4m wide), shallow and ditched and straightened. Conditions are not suitable for white clawed crayfish.

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.20
Terrestrial Invertebrate Survey Report

28 September 2020

A417 MISSING LINK, BIRDLIP, GLOUCESTERSHIRE

INVERTEBRATE SURVEY

Final Document

July 2020

Preliminary Ecological Appraisals • Protected Species Surveys and Licensing • NVC • EclA • HRA • Management Plans
Habitats • Badger • Bats • Hazel Dormouse • Birds • Reptiles • Amphibians • Invertebrates • Riparian and Aquatic Species


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ECOSA Quality Assurance Record

This report has been produced in accordance with the CIEEM Guidelines for Ecological Report Writing 2017 (CIEEM, 2017). The survey work has been undertaken in line with references within CIEEM's Source of Survey Guidance (CIEEM, 2017).

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Author:	 Simon Colenutt BSc (Hons) MCIEEM CEnv Principal Ecologist

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A417 MISSING LINK, BIRDLIP, GLOUCESTERSHIRE

INVERTEBRATE SURVEY

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EXECUTIVE SUMMARY

ECOSA were commissioned by Ove Arup and Partners Ltd 'Arup' to carry out an invertebrate survey to inform the A417 Missing Link Scheme. The invertebrate surveys were undertaken by ECOSA between June and August 2019. Additional surveys were undertaken in May and early June 2020. The main findings of the surveys are:

- A total of three Red Data Book species and twenty-nine Nationally Scarce species of invertebrate were recorded showing that the area has considerable local entomological importance. Additionally, five Species of Principal Importance were recorded;
- Sites 5, 6, 7 and 10 are the most important entomologically and are of regional significance, with Site 1 also being of considerable local significance. Sites 3 and 9 are also considered to be of moderate local importance. Sites 2, 2a and 8 are considered to be of limited entomological value at a local level;
- Provisional outline recommendations have been made for providing habitat enhancements which should be incorporated into the scheme design; and
- As the early part of the invertebrate season was missed in 2019 due to late commissioning of the survey work, a spring survey was carried out in 2020.

1.0 INTRODUCTION

1.1 Background

ECOSA were commissioned by Ove Arup and Partners Ltd 'Arup' to undertake terrestrial invertebrate surveys at a total of 11 sites close to the A417 in the Birdlip area, Gloucestershire during the summer of 2019. One site (Site 2) was divided into two subsections. Each site was visited on at least three occasions; once each in June, July and August 2019. Further survey was undertaken in May and June 2020. Locations of the surveyed sites are shown on **Map 1**.

1.2 Survey Area

The total survey area extends southward and westward in two 'arms' from approximately 500 metres north of the Air Balloon roundabout on the A417, following two branches of the A417. The area covered is approximately 2.5 kilometres from west to east and north to south and encompasses the existing road corridor and the proposed route of the road improvement scheme.

The survey area covers 475 hectares and is characterised by arable farmland with large fields bisected by hedgerows, rural roads, and areas of calcareous grassland and broadleaved woodland. The majority of the site is on the Cotswold plateau, but in the west of the survey area, the land falls away steeply to the west.

The wider landscape consists of further areas of farmland, woodland copses and small villages. The cities of Cheltenham and Gloucester lie approximately four kilometres to the north and west respectively.

Within this area 11 sites were selected by Mott Macdonald for invertebrate survey based on the presence of species rich semi-natural habitat identified during Phase 1 habitat surveys. The majority of these sites are located in the Birdlip area. The most southerly site is Site 1 located to the north of the Cowley roundabout.

1.3 Aims and Scope of Report

Invertebrate surveys were undertaken by ECOSA between June 2019 and August 2019 in order to establish the importance of invertebrate communities present at the site and to identify rare and scarce species present. Additional survey was undertaken in May and June 2020 to cover the spring species.

This report presents the findings of the invertebrate surveys carried out by ECOSA between June and August 2019 and May to June 2020.

1.4 Scheme Proposals

The proposed scheme would provide a dual carriageway to improve the current Missing Link section of single carriageway of the A417 between Cowley roundabout and Crickley Hill. The proposed scheme aims to increase capacity by creating a free-flowing link between the Brockworth Bypass and the Cowley roundabout and remove the at-grade junction with the A436 (Air Balloon roundabout). This Missing Link will provide a free-flowing journey between Swindon (M4 Junction 15) and Gloucester / Cheltenham (M5 Junction 11). The preferred route for the Scheme was confirmed as Option 30 by the Secretary of State in March 2019. The Scheme comprises the construction of a new dual carriageway to replace the existing single carriageway section between Brockworth bypass and Cowley Roundabout. It is predominately an “offline” Scheme but approximately a third of the route follows the existing A417 route corridor at Crickley Hill. A new link road would be built between the slip road junction at Shab Hill and the existing A417 to connect traffic to and from Birdlip and the A436 with the new A417. This new link road would end in a new roundabout near Barrow Wake. A new single carriageway is proposed to connect the existing A436, just east of the existing Air Balloon roundabout, to the proposed Shab Hill Junction.

2.0 PLANNING POLICY CONTEXT

2.1 Introduction

This section summarises the planning policy in relation to ecology and biodiversity within the Tewkesbury and Cotswold Council administrative areas. The west of the survey area lies within Tewkesbury, whilst the east is within Cotswold.

2.2 Planning Policy

2.2.1 National Policy

The National Policy Statement for National Networks (NPSNN) sets out the need for, and government's policies to deliver Nationally Significant Infrastructure Projects on the national road network in England.

Chapter 3 of the NPSNN identifies that in order to be sustainable and to improve people's quality of life, the need for development must be seen in the context of the Government's wider policies on economic performance, environment, safety, technology, sustainable transport and accessibility, as well as journey reliability and the experience of road - rail users. Wider policies relate to:

- Environmental and social impacts – national road networks should be designed to minimise social and environmental impacts and improve quality of life. In delivering new schemes, the Government expects applicants to avoid and mitigate environmental and social impacts in line with the principles set out in the National Planning Policy Framework (NPPF) and the Government's planning guidance.

Chapter 5 of the NPSNN outlines the possible impacts that would be relevant to any type of national networks infrastructure and sets out how these impacts should be considered. The sections include consideration of biodiversity.

The National Planning Policy Framework (NPPF) sets out the government's requirements for the planning system in England. The original document was published in 2012 with the revised NPPF published in July 2018 and updated in February 2019. A number of sections of the NPPF are relevant when taking into account development proposals and the environment. As set out within Paragraph 11 of the NPPF "*Plans and decisions should apply a presumption in favour of sustainable development*". However, Paragraph 177 goes on to state that "*The presumption in favour of sustainable development does not apply where development*

requiring appropriate assessment because of its potential impact on a habitats site¹ is being planned or determined”.

The general impetus of the NPPF in relation to ecology and biodiversity is for development proposals to not only minimise the impacts on biodiversity but also to provide enhancement. Paragraph 170 states that the planning system should contribute to and enhance the natural environment by “...*minimising impacts on biodiversity and providing net gains in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures...*”.

A number of principles are set out in Paragraph 175, including that where harm cannot be adequately avoided then it should be mitigated for, or as a last resort, compensated for. Where impacts occur on nationally designated sites, the benefits must clearly outweigh any adverse impact and incorporating biodiversity in and around developments should be encouraged. Specific reference is also made to the protection of irreplaceable habitats². Where loss to irreplaceable habitats occur planning permission would normally be refused unless there are wholly exceptional reasons and an adequate compensation strategy is in place. Paragraph 175 also states “*development whose primary objective is to conserve or enhance biodiversity should be supported; while opportunities to incorporate biodiversity improvements in and around developments should be encouraged, especially where this can secure measurable net gains for biodiversity*”. Protection of sites proposed as Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Ramsar sites or acting as compensation for SPAs, SACs and Ramsar sites, should receive the same protection as habitat sites.

In addition to the NPPF, Circular 06/05 provides guidance on the application of the law relating to planning and nature conservation as it applies in England. Paragraph 98 states “*the presence of a protected species is a material consideration when a planning authority is considering a development proposal that, if carried out, would be likely to result in harm to the species or its habitat*”. Whilst paragraph 99 states “*it is essential that the presence or otherwise of a protected species, and the extent that they may be affected by the proposed development, is established before planning permission is granted*”.

¹ The NPPF defines a habitats site as “*Any site which would be included within the definition at regulation 8 of the Conservation of Habitats and Species Regulations 2017 for the purpose of those regulations, including candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation, Special Protection Areas and any relevant Marine Sites.*”

² The NPPF defines irreplaceable habitats as “*Habitats which would be technically very difficult (or take a very significant time) to restore, recreate or replace once destroyed, taking into account their age, uniqueness, species diversity or rarity. They include ancient woodland, ancient and veteran trees, blanket bog, limestone pavement, sand dunes, salt marsh and lowland fen.*”

2.2.2 **Local Policy**

A single policy within the Cotswold District Local Plan (2011-2031) refers to ecology and biodiversity:

- **Policy EN8:** Biodiversity and Geodiversity: Features, Habitats and Species. Development will be permitted that conserves and enhances biodiversity and geodiversity, providing net gains where possible. Proposals that would result in significant habitat fragmentation and loss of ecological connectivity will not be permitted. Proposals that reverse habitat fragmentation and promote creation, restoration and beneficial management of ecological networks, habitats and features will be permitted, particularly in areas subject to landscape-scale biodiversity initiatives. Developer contributions may be sought in this regard. Development with a detrimental impact on protected species and species and habitats “of principal importance for the purpose of conserving biodiversity” will not be permitted unless adequate provision can be made to ensure the conservation of the species or habitat.

The Joint Core Strategy for Gloucester, Cheltenham and Tewkesbury (2011-2031) also considers biodiversity through policy:

- **Policy SD9 (Biodiversity and Geodiversity):** The biodiversity and geological resource of the JCS area will be protected and enhanced in order to establish and reinforce ecological networks that are resilient to current and future pressures. This will be achieved by ensuring that European Protected Species and National Protected Species are safeguarded in accordance with the law; encouraging new development to contribute positively to biodiversity and geodiversity whilst linking with wider networks of green infrastructure; encouraging the creation, restoration and beneficial management of priority landscapes, priority habitats and populations of priority species. Where there is a risk of harm as a consequence of development, this should be mitigated by integrating enhancements into the scheme that are appropriate to the location and satisfactory to the local planning authority. If harm cannot be mitigated onsite then, exceptionally, compensatory enhancements off-site may be acceptable.

3.0 METHODS

3.1 Introduction

This section details the methods used during the invertebrate surveys undertaken at the A417 site between June and August 2019, and in May and June 2020.

3.2 Survey Methodology

Invertebrate surveys were undertaken by Simon Colenutt and Adam Wright of ECOSA Ltd. Three surveys were carried between June and August and while this covered the peak in invertebrate activity the spring period was missed due to the date of the commissioning of the survey. Subsequent survey was undertaken in May and June 2020 to compensate for this.

Survey methods involved visual searching of nectaring sites and basking areas, the use of a sweep net and pooter to capture individual species, sweeping vegetation, beating foliage and grubbing. This range of techniques allowed the sampling of a range of species with different habits from the groups selected for survey.

Specimens of some of the more critical/difficult groups were taken in a pooter and identified under the microscope with the aid of specialist keys.

The species groups selected for survey were those considered most likely to be useful in informing site value. These were:

- Diptera (primarily hoverflies, soldier-flies and their allies and picture-winged flies);
 - Aculeate Hymenoptera (bees and wasps);
 - Coleoptera (primarily leaf-beetles, longhorn-beetles and click-beetles);
 - Lepidoptera (primarily butterflies but also any day-flying moths); and
 - Orthoptera (grasshoppers and crickets).
- Incidental species records were made of readily identified species from a range of groups.

In addition, night-time moth trapping surveys were undertaken at Site 1 on two occasions in 2019, using a battery-operated portable moth trap. This site was chosen as one where the equipment could be left unattended overnight. The trap

was operated on a light sensor and inspected at 08:30 in the morning. **Table 1** provides details of each survey visit.

Table 1: Invertebrate Survey Details

Survey Date	Survey Type	Weather Conditions
Site 1		
27 th June 2019	Day	Sunny, wind f.3, 16c.
15 th July 2019	Day	Sunny spells, wind f.1, 18c.
15 th July 2019	Night	Wind f.2, 15c.
16 th July 2019	Day	Sunny, wind f.1, 27c.
5 th August 2019	Day	Sunny spells, wind f.2, 22c.
5 th August 2019	Night	Wind f.3, 16c.
20 th May 2020	Day	Sunny spells, wind f.1. 24c.
4 th June 2020	Day	Cloudy with sunny spells, wind f.2 15c
5 th June 2020	Day	Sunny spells, wind f.3 15c
Site 2a		
26 th June 2019	Day	Sunny spells, wind f.2, 19c.
5 th August 2019	Day	Sunny, wind f.2, 20c.
4 th June 2020	Day	Cloudy with sunny spells, wind f.2 15c
Site 2b		
15 th July 2019	Day	Sunny spells, wind f.1, 18c.
4 th June 2020	Day	Cloudy with sunny spells, wind f.2 15c
Site 3		
26 th June 2019	Day	Mainly overcast, wind f.3, 17c.
27 th June 2019	Day	Sunny, wind f.2, 24c.
15 th July 2019	Day	Sunny spells, wind f.1, 19c.
6 th August 2019	Day	Sunny spells, wind f.4, 18c.
Site 5		
28 th June 2019	Day	Sunny, wind f.1, 22c.
16 th July 2019	Day	Sunny, wind f.1, 27c.
17 th July 2019	Day	Sunny, wind f.1, 22c.
7 th August 2019	Day	Sunny, wind f.2, 21c.
5 th June 2020	Day	Sunny spells, wind f.3 15c
Site 6		
28 th June 2019	Day	Sunny, wind f.2, 20c.
17 th July 2019	Day	Sunny, wind f.1, 19c.
7 th July 2019	Day	Sunny, wind f.2, 21c.
8 th August 2019	Day	Sunny, wind f.1, 20c.
21 st May 2020	Day	Sunny spells, wind f. 2. 18c
Site 7		
28 th June 2019	Day	Sunny spells, wind f.2, 18c.
17 th July 2019	Day	Hazy sunshine, wind f.1, 20c.
6 th August 2019	Day	Sunny spells, wind f.2, 19c.
7 th August 2019	Day	Sunny, wind f.2, 19c.
21 st May 2020	Day	Sunny spells, wind f. 2. 18c
4 th June 2020	Day	Cloudy with sunny spells, wind f.2 15c

Site 8		
26 th June 2019	Day	Sunny spells, wind f.2, 19c.
15 th July 2019	Day	Sunny, wind f.1, 21c.
6 th August 2019	Day	Sunny spells, wind f.3, 19c.
20 th May 2020	Day	Sunny spells, wind f.1. 24c.
Site 9		
27 th June 2019	Day	Sunny, wind f.2, 24c.
16 th June 2019	Day	Sunny, wind f.1, 27c.
26 th June 2019	Day	Sunny spells, wind f.2, 21c.
Site 10		
27 th June 2019	Day	Sunny, wind f.2, 19c.
16 th July 2019	Day	Sunny spells, wind f.1, 25c.
8 th August 2019	Day	Sunny spells, wind f.1, 19c.
20 th May 2020	Day	Sunny spells, wind f.1. 24c.
5 th June 2020	Day	Sunny spells, wind f.3 15c

3.3 Survey Limitations

There were no significant limitations to the invertebrate surveys carried out during the summer period in 2019. However, the date at which surveys were commissioned meant that many spring species would have completed their period of adult activity before survey commenced. Therefore a further suite of surveys was undertaken in May and June 2020.

The weather during the summer of 2019 was generally unsettled with few prolonged periods of warm and sunny weather. As a result, during some of the site visits weather conditions were suboptimal for invertebrate surveys. Where this was the case the sites were revisited in more suitable conditions.

The weather during the 2020 surveys were generally suitable, however, during the early June surveys cloudy spells were encountered, during these periods, the survey was temporarily ceased until the sun returned.

At the scoping stage 10 sites were identified as requiring invertebrate surveys, however, access was denied to Site 4 and therefore the site has not been surveyed. In 2020 no access was granted to Sites 3, 4 and 9 and therefore these were not surveyed.

During the initial surveys carried out Site 2a was assessed as having low potential to support scarce invertebrate species since it was dominated by stinging nettle beds, therefore, on the second survey visit a substitute site was surveyed, 2b. However, during the third visit this had been entirely mown and so site 2a was surveyed once again.

4.0 RESULTS

4.1 Introduction

This section details the results of the invertebrate surveys undertaken at the A417 sites in 2019 and 2020. Paragraph 4.2 discusses the habitats of importance to invertebrates at each site while Paragraph 4.3 discusses the status of the notable and rare species recorded. For the national status definitions refer to **Appendix 2**.

4.2 Summary of Habitat Characteristics Relevant to Invertebrates

4.2.1 Site 1

The site consists of a disused limestone quarry, currently used for low-level recreational motorcycling activities (**Figure 1**, **Figure 2** and **Figure 3**). The area includes a small ash *Fraxinus excelsior* dominated woodland element, although this woodland has a high incidence of ash dieback. There is a considerable matrix of bare ground partly maintained by motorcycle activities, short sward vegetation, rank grassland, dead wood and scrub. There are small pond areas mainly formed in cycle ruts and hollows within the quarry.

The flora is varied, with the following species present considered to be of particular attraction to insects: common bird's-foot trefoil *Lotus corniculatus*, bitter vetch *Lathyrus linifolius*, meadow vetchling *Lathyrus pratensis*, black medick *Medicago lupulina*, tufted vetch *Vicia cracca*, mouse-ear hawkweed *Pilosella officinarum*, cat's-ear *Hypochaeris radicata*, ribbed melilot *Melilotus officinalis*, clovers *Trifolium* species, field scabious *Knautia arvensis*, red bartsia *Odontites vernus*, wild parsnip *Pastinaca sativa*, hogweed *Heracleum sphondylium*, ragworts *Senecio* species, woolly thistle *Cirsium eriophorum* and spear thistle *Cirsium vulgare*. The areas of scrub are dominated by bramble *Rubus fruticosus* aggregate.



Figure 1 – Site 1



Figure 2 – Site 1



Figure 3 – Site 1

4.2.2 Site 2a

A valley dominated by rank grassland and partially shaded by adjacent beech *Fagus sylvatica* woodland (**Figure 4**). A damp ditch extends through the lower section of the site. Large quantities of stinging nettle *Urtica dioica* are present, whilst hogweed is abundant in places. Small amounts of common bird's-foot trefoil, rough hawkbit *Leontodon hispidus*, field scabious and woolly thistle are also present.

Because the habitat was assessed as being poor for invertebrates, during the July 2019 survey an adjacent hay meadow was selected as an alternative site (Site 2b).



Figure 4 – Site 2a

4.2.3 Site 2b

A flower rich hay meadow which unfortunately had been cut at the time of the survey (**Figure 5**), although a four metre border around the field edge had been left uncut and was thus surveyed. Invertebrate forage resources included clovers, hogweed, ox-eye daisy *Leucanthemum vulgare*, meadow vetchling, field scabious, cat's-ear, tufted vetch, bush vetch *Vicia sepium*, and nipplewort *Lapsana communis*. The meadow is rather flat and homogeneous lacking a diversity of invertebrate habitat.



Figure 5 – Site 2b

4.2.4 Site 3

Site 3 is a gently sloping abandoned paddock with a disused horse stable (**Figure 6**), the grassland has evidently not been grazed for a period of several years and is heavily scrubbed over. The paddock is dominated by rank grassland and bramble scrub, with small patches of bare ground and short sward grassland. There are several areas of bare soil utilised by nesting hymenoptera. Plants favoured by insects included common bird's-foot trefoil, medick *Medicago* species, hogweed, black knapweed *Centaurea nigra*, greater knapweed *Centaurea scabiosa*, field scabious,

woolly thistle, common rockrose *Helianthemum nummularia*, nipplewort and St. John's-wort *Hypericum* species. No access to complete the survey was possible to this area in 2020.



Figure 6 – Site 3

4.2.5 Site 5

The main survey area was dominated by tussocky grassland containing clovers, common bird's-foot trefoil, black knapweed, hogweed, rough hawkbit, cat's-ear, yellow rattle *Rhinanthus minor*, woolly thistle and large quantities of red bartsia (**Figure 7**). There are numerous anthills with areas of bare ground. To the north and east of this area are sections of rather poor plantation woodland which were not surveyed in detail.



Figure 7 – Site 5

4.2.6 Site 6

The site is a mix of closed woodland, scattered mature trees and semi-improved grassland (**Figure 8**). A large area of the site consists of mature woodland dominated

by beech *Fagus sylvatica* with a holly *Ilex aquifolium* understory. The woodland is densely shaded with few open areas. A considerable dead wood element is present (**Figure 9**). There is a scrubby margin to this woodland in places, with bramble, hogweed and teasel *Dipsacus fullonum* present.

The south-eastern area of the site is more open, containing rank grassland with mature scattered oak, there are a number of standing dead trees. Insect forage resources within this area include common bird's-foot trefoil, common rockrose, rough hawkbit, hogweed, clovers, black knapweed, greater knapweed, woolly thistle and large quantities of red bartsia

In 2019 the National Trust were undertaking detailed surveys for saproxylic and xylophagous invertebrates within the woodland, thus ECOSA surveyors spent most of their time surveying the more open habitats within the survey area in order to reduce duplication of records.



Figure 8 – Site 6



Figure 9 – Dead wood on Site 6

4.2.7 Site 7

The survey area is divided into two sections, separated by a near-vertical limestone cliff.

The lower section (**Figure 10**) comprises steeply sloping rank grassland with black knapweed, greater knapweed, common bird's-foot trefoil, common rockrose, rough hawkbit and viper's bugloss *Echium vulgare*, harebell *Campanula rotundifolia* present. Scattered sycamore are present up the slope while at the foot of the slope is dense sycamore woodland bordering the survey area. The base of the site is scrubby, with stinging nettle, hogweed and woolly thistle.



Figure 10 – Lower section of Site 7

The upper section (**Figure 11**) of the survey area is a plateau of limestone grassland with a shorter sward, and a matrix of low scrub. Forage resources for insects include field scabious, small scabious *Scabiosa columbaria*, woolly thistle, harebell, cat's-ear, red bartsia, common rockrose, clovers and bramble. The grassland is bordered by woodland and scrub and a raised earthwork runs across the site.



Figure 11 – Upper section of Site 7

4.2.8 Site 8

The northern section of the site consists of densely shaded young mixed woodland with a stream running westwards through the woodland. The ground flora is dominated by stinging nettle. Small amounts of dead wood are present. The southern section of the site is cattle grazed pasture and contains areas of creeping thistle *Cirsium arvense* and marsh thistle *Cirsium palustre* (**Figure 12**). The flora is rather poor, containing small amounts of clovers, cat's-ear, creeping buttercup *Ranunculus repens* and marsh thistle. Two small wet flushes are present adjacent to the woodland edge.



Figure 12 – Site 8

4.2.9 Site 9

Site 9 consists of a pasture which is managed through light and seasonal horse grazing in 2019. The southern section of the site was ungrazed in 2019 (**Figure 13**). It comprises a matrix of short sward and longer grassland, containing an abundance of common bird's-foot trefoil, black knapweed, greater knapweed, ox-eye daisy, small scabious, clovers and a small quantity of mignonette *Reseda lutea*. No access to complete the survey was possible to this area in 2020.



Figure 13 – Northern section of Site 9

The northern section of the site (**Figure 14**) was grazed by horses during all visits, resulting in short sward grassland. Ox-eye daisy was particularly abundant here. Small patches of harebell and mignonette were present. No access to complete the survey was possible to this area in 2020.



Figure 14 – Southern section of Site 9

4.2.10 Site 10

The survey area is a steeply sloping, west-facing limestone escarpment, dominated by moderately tall flower-rich grassland, with some areas of shorter sward (**Figure 15** and **Figure 16**). Invertebrate forage resources were abundant, comprising common bird's-foot trefoil, common rockrose, clovers, cat's-ear, rough hawksbit, mouse-eared hawkweed *Pilosella officinalum*, field scabious, small scabious, woolly thistle, hogweed, harebell and red bartsia. Scattered patches of scrub are present these are dominated by bramble. To the north and south the site is bordered by mixed woodland. The west facing element to this site results in much shaded in the

mornings this has the effect of lowering the sites temperature perhaps reducing diversity of invertebrate species that inhabit the site.



Figure 15 – Southern section of Site 10



Figure 16 – Northern section of Site 10

4.3 Scarce and Rare Species Recorded

4.3.1 *Lepidoptera*

Small heath *Coenonympha pamphilus* **NERC Species of Principal Importance**

Recorded from Site 2b (4th May 2020), Site 5 (28th June and 7th August 2019), Site 7 (28th June and 17th July 2019, 21st May and 4th June 2020), Site 8 (20th May 2020). Site 9 (27th June 2019) and Site 10 (27th June, 16th July 2019 and 8th August 2019, 20th May and 5th June 2020).

Larvae of this butterfly feed on fine grasses such as annual meadow grass *Poa annua*. The small heath is primarily associated with open grassland sites. It is widespread in Britain, but due to a considerable recent national decline has been

added to the NERC list as a Species of Principal Importance listings for monitoring purposes. The small heath remains a relatively common butterfly in Gloucestershire.

Pearl-bordered fritillary *Boloria euphrosyne*. **Nationally Scarce N. NERC Species of Principal Importance.**

Recorded from Site 7 (21st May 2020).

A single fresh individual was recorded nectaring on a range of plants on Site 7. Common dog violet *Viola riviniana* is the most frequently used larval foodplant for this species. Formerly, the pearl-bordered fritillary was a locally common species, but populations have declined significantly in recent decades due to cessation of coppicing and changes in grazing regimes. It now has a widely scattered distribution in the UK. This species flies from late April to June.

Dingy Skipper *Erynnis tages* **NERC Species of Principal Importance**

Recorded from Site 1 (20th May 2020), Site 7 (21st May 2020), Site 10 (20th May 2020).

Larvae of this butterfly feed primarily on common bird's-foot trefoil and horseshoe vetch *Hippocrepis comosa*. It is found in a wide variety of habitats in sheltered situations. It is widely distributed in central and southern England.

Cistus Forester *Adscita geryon* **Nationally Scarce Nb**

Recorded from Site 7 (21st May 2020), Site 10 (27th June 2019, 20th May 2020).

Larvae of the Cistus forester feed on common rock-rose, and also overwinter in this stage. The larval foodplant is abundant on Site 10. Cistus forester is local on chalk and limestone grassland in southern England through the Midlands north to Cumbria and Durham. Welsh populations are very localised and are mainly in the north of that country. There are a number of previous records of the cistus forester within the local area.

Six-belted Clearwing *Bembecia ichneumoniformis* **Nationally Scarce Na**

Recorded from Site 1 (16th July and 5th August 2019).

Several specimens of the six-belted clearwing were recorded on both dates, flying around common bird's-foot trefoil, the larval foodplant for this species. Nationally this species has a scattered distribution through England as far north as Yorkshire. It has also been recorded in Wales. There are existing records for the six-belted clearwing from an adjacent 10 kilometre square.

Cinnabar Moth *Tyria jacobaeae* **NERC Species of Principal Importance**

Recorded from Site 1 (27th June, 16th July and 5th August 2019, 5th June 2020), Site 2a (15th July 2019), Site 3 (26th June and 6th August 2019), Site 5 (16th July and 7th August 2019), Site 6 (28th June, 17th July and 7th August 2019), Site 7 (6th August 2019), Site 8 (26th June and 6th August 2019), Site 9 (16th July 2019), and Site 10 (27th June 2019).

A common species whose larvae develop on ragwort, a plant that is present on most of the survey areas. The cinnabar moth remains widespread and frequent through much of the British Isles, including Gloucestershire. It has, however declined considerably over the last 35 years, and for this reason is listed as a Species of Principal Importance under the NERC Act.

4.3.2 *Diptera*

A cranefly *Ctenophora pectinicornis* **Nationally Scarce N**

Recorded from Site 6 (21st May 2020).

A single specimen was recorded basking on a hazel leaf at the woodland edge in Site 6. This species has a requirement for old broadleaved woodland with dead or diseased trees in which the larvae develop. Although records are widely scattered across Britain, Falk (1991a) notes a strong southern bias. There are a number of records for Gloucestershire.

A robberfly *Machimus rusticus* **Nationally Scarce N**

Recorded from Site 7 (17th July 2019).

Two individuals of this species were recorded from short sward grassland on the upper section of Site 7. Adults of *Machimus rusticus* are active predators, with acute eyesight, launching themselves in rapid “capture darts” at a variety of insects including butterflies, beetles and hoverflies. Larvae are believed to be predatory and live in the soil. Robberflies generally are thermophilous species and may be observed basking on warm bare ground on sunny days. *Machimus rusticus* is confined largely to chalk, limestone and base-rich grasslands in southern England. The map provided by Harvey (2018), shows that there are existing records for the area. This species has recently been downgraded from Vulnerable (RDB 2) to Nationally Scarce N.

Downland Villa *Villa cingulata* Rare RDB 3

Recorded from Sites 5 (28th June and 16th July 2019) and Site 6 (17th July 2019).

Specimens were found during general sweeping on Site 5 on both dates, whilst a single specimen was seen nectaring at hogweed along the woodland margin in Site 6. It is believed that the *Villa cingulata* is associated with calcareous soils, although little is known of the life history of this species. It is suggested that the larvae are parasitoids of lepidopterous larvae, based on continental data. *Villa cingulata* was considered to be a great rarity, and possibly extinct in the United Kingdom, with no records after 1935 until its rediscovery at two sites in the Cotswolds in 2000. There are now a number of recent records, and *Villa cingulata* appears to be increasing in frequency and expanding its range, with modern records for Hampshire and central England (Harvey, 2018). There are existing recent records for Gloucestershire. This species has recently been downgraded from Endangered (RDB 1) to Rare (RDB 3).

A hoverfly *Callicera aurata* Nationally Scarce N

Recorded from Site 6 (17th July 2019).

A single specimen of this elusive hoverfly was found basking on a dead tree trunk at the eastern end of the survey area. Larvae of *Callicera aurata* are believed to develop as filter-feeders in water-filled rot holes, primarily in beech trees, although they have also been found in rot holes in birch *Betula pendula*. *Callicera aurata* is widely but thinly distributed in England, with the majority of records from southern counties. Ball *et al.*, (2011) suggest that the species may be increasing in frequency, particularly in midland counties. There are two previous records for nearby localities.

A picture-winged fly *Acanthiophilus helianthi* Nationally Scarce N

Recorded from Sites 5 (7th August 2019) and Site 6 (8th August 2019).

Specimens were swept from the flowers of black knapweed in low numbers. In the United Kingdom larvae of *Acanthiophilus helianthi* develop in the seed heads of black knapweed, and possibly greater knapweed. Nationally, this species is largely confined to southern English counties. The maps provided by the national recording scheme for Tephritid flies (Clemons, 2018) show previous records for *Acanthiophilus helianthi* near to the current survey areas.

A picture-winged fly *Oxyna nebulosa* Rare RDB 3

Recorded from Site 9 (16th July 2019).

A single adult of *Oxya nebulosa* was swept from ox-eye daisy in the northern section of Site 9. Larvae are believed to induce root galls in the host plant ox-eye daisy. This would appear to be a scarce species nationally with few modern records, and a bias towards western England. Recent records exist for north Somerset and east Gloucestershire.

A picture-winged fly *Rhagoletis alternata* **Provisionally Nationally Scarce N**
Recorded from Site 6 (17th July 2019).

A single specimen was captured whilst basking on a bramble leaf bordering the main woodland. Larvae develop in the fruit of *Rosa* spp. Dog rose *Rosa canina* was present near to the capture site. Although not accorded Nationally Scarce status by Falk (1991a), Clemons (1996) suggests that the status of *Rhagoletis alternata* should be upgraded. *Rhagoletis alternata* is recorded across the United Kingdom, although records are thinly distributed. There are previous records for Gloucestershire.

A picture-winged fly *Terellia longicauda* **Provisionally Nationally Scarce N**
Recorded from Sites 1 (16th July and 5th August 2019), 2 (5th August 2019), 3 (6th August 2019), 5 (16th July, 7th August 2019), 6 (17th July and 7th August 2019), 7 (17th July, 6th August and 7th August 2019), and 10 (16th July and 8th August 2019).

Terellia longicauda was recorded in good numbers from most of the sites where woolly thistle occurred. Larvae of this fly develop in the seed heads of woolly thistle, which was common on many sites. Although not accorded Nationally Scarce status by Falk (1991a), Clemons (1996) suggests that the status of *Terellia longicauda* should be upgraded. Many records are from the midland counties of England. There are also a number of records from Gloucestershire. Records from the south of England are sparser.

A tachinid fly *Lophosia fasciata* **Nationally Scarce N**
Recorded from Site 1 (16th July 2019).

A single specimen of this distinctive fly was found visiting the flowers of wild parsnip in the north-east of the site. *Lophosia fasciata* larvae are parasitic on the hawthorn shield bug *Acanthosoma haemorrhoidale*. It is associated with downland, coastal grassland and dry woodland, and confined to southern England. There is a record for Glamorgan in Wales, and another from the Bristol area, but it would appear to be previously unrecorded in the local area. Falk & Ismay (unpublished) cite 20 post 1960 records nationally for this species.

4.3.3 *Hymenoptera*

Median Wasp *Dolichovespula media* **Nationally Scarce Na**

Recorded from Site 1 (27th June 2019), Site 2 (5th August 2019), Site 3 (6th August 2019), Site 5 (7th August 2019), Site 7 (4th June 2020) and Site 10 (8th August 2019).

Several specimens of *Dolichovespula media* were recorded at some of the survey sites. *Dolichovespula media* is an aerial nester, suspending its nest from the branches of trees and bushes. The median wasp is a relatively recent colonist in Britain, having first been found in East Sussex in 1980. It spread quickly to become established in south-eastern England, and is now been recorded from Kent to Cornwall, in north Wales and as far north as Durham and Cumbria. Because of this rapid establishment, the status of *Dolichovespula media* is no longer accurate and should be downgraded in any future review (Edwards, 1997). There are previous records for Gloucestershire.

A yellow-faced bee *Hylaeus signatus* **Nationally Scarce Nb**

Recorded from Site 9 (16th July 2019).

Several specimens were recorded visiting mignonette *Reseda lutea* on both sections of the site. This plant was not common on site, with relatively few plants present. *Hylaeus signatus* is believed to have an obligate association with *Reseda* species. for pollen collection. It nests in dead woody stems of plants such as bramble and roses. Falk & Lewington (2015) state that *Hylaeus signatus* is widespread but patchily distributed in England as far north as Yorkshire, excluding the south-west. There are also records for south Wales. However, the map given by Else & Edwards (2018) shows no records for some distance around Birdlip, although it is known from West Gloucestershire.

A mining bee *Andrena bucephala* **Nationally Scarce (Na)**.

Recorded from Site 1 (20th May 2020).

A female of this species was found during general sweeping. *Andrena bucephala* is a spring species most often found foraging at trees and shrubs such as hawthorn, maples *Acer* sp. and sycamore *Acer pseudoplatanus*. Although widely distributed in southern England and South Wales, it is generally rare and very local. *Andrena bucephala* is known from various habitats, but many records are from chalk grassland. It is unusual amongst *Andrena* species in that females share entrance

burrows (although it is believed that they have individual nests within the burrow). On occasion this can lead to large numbers of *Andrena bucephala* queuing to gain access to the entrance burrow. There are a small number of other modern records for *Andrena bucephala* in Gloucestershire.

A mining bee *Andrena trimmerana* **Nationally Scarce Nb**

Recorded from Site 7 (6th August 2019).

A single female of *Andrena trimmerana* was collected from the lower section of the site. *Andrena trimmerana* is a predominantly southern species, particularly associated with warm coastal grassland, although other habitats including woodland edge are also utilised. *Andrena trimmerana* is a double-brooded species utilising a variety of plant species for pollen collection. There is a possibility that the two broods actually represent two distinct closely related species, but at present research to establish whether or not this is the case is ongoing. Falk (1991b) notes a considerable decline at inland sites. Data from Else & Edwards (2018) shows the species has previously been recorded from a nearby site.

A mining bee *Lasioglossum malachurum* **Nationally Scarce Nb**

Recorded from Site 6 (17th July 2019).

A single specimen of the mining bee *Lasioglossum malachurum* was recorded during sweeping at the eastern end of the site. *Lasioglossum malachurum* is polylectic, collecting pollen from a wide variety of plants. It has been recorded from a variety of habitats where there is warm disturbed ground. Typical breeding sites are in bare clayey soil on coastal cliffs and landslips, but it also occurs inland in quarries, grassland and heaths. *Lasioglossum malachurum* is primarily restricted to southern England. Previously a very local and scarce species, *Lasioglossum malachurum* has become far more frequent recently and is currently expanding its British range (Edwards & Broad, 2005). The status of *Lasioglossum malachurum* requires review and downgrading, since it is now common over much of southern England. However, there do not appear to be previous records for the Birdlip area (Else & Edwards, 2018).

A mining bee *Lasioglossum pauxillum* **Nationally Scarce Na**

Recorded from Site 7 (28th June and 17th July 2019).

This species was found during general sweeping on the upper section of the site. *Lasioglossum pauxillum* nests in sparsely vegetated light soils in warm, sunny conditions. It may be found in a variety of habitats including calcareous grassland,

soft rock coastal cliffs and heathland. Previously, *Lasioglossum pauxillum* was a scarce species restricted to south east England, but in the last decade it has increased in frequency and expanded its range northwards and westwards (Edwards and Broad, 2005). Its current Nationally Scarce (Na) status now requires downgrading. There appear to be few, if any records from the Birdlip area.

A cuckoo bee *Sphecodes crassus* **Nationally Scarce Nb**

Recorded from Site 3 (15th July 2019).

A single specimen was found during flying around a patch of bare ground containing *Lasioglossum* nest holes. *Sphecodes crassus* is a cleptoparasite of mining bees of the genus *Lasioglossum*. Several species of *Lasioglossum* have been suggested as possible hosts. Because of its cleptoparasitic nature, there is no need for *Sphecodes crassus* to collect pollen. It has been recorded nectaring at a range of flowers including umbellifers and composites. *Sphecodes crassus* is widely distributed in southern and central England as far north as north Yorkshire, and from Wales. It occurs in a range of habitats with warm bare ground or a short sward that are suitable for the host's nests. Such habitats include calcareous grassland, heathland, quarries and soft-rock cliffs. There are previous records of *Sphecodes crassus* from the Birdlip area.

A cuckoo bee *Sphecodes rubicundus* **Nationally Scarce Na**

Recorded from Site 10 (20th May 2020).

A single specimen was recorded during general sweeping. *S. rubicundus* is confined to southern England. One of its host bees *Andrena labialis* has declined significantly recently, particularly at inland sites; inevitably this has led to the cleptoparasitic bee *Sphecodes rubicundus* increasing in scarcity. *S. rubicundus* also uses *Andrena flavipes* as a host; this species was recorded with some frequency during the current survey. There are several modern records for *Sphecodes rubicundus* in Gloucestershire.

A mining bee *Melitta haemorrhoidalis* **Provisionally Nationally Scarce (N)**

Recorded from Site 7 (7th August 2019) and Site 10 (8th August 2019).

Specimens were recorded visiting the flowers of harebell at both sites. *Melitta haemorrhoidalis* is an oligolectic species collecting pollen only from bellflower and harebell (*Campanulacae*). Nationally, *Melitta haemorrhoidalis* is most frequently found on chalk grassland in south east England. Although not listed by Falk (1991b), recent work reveals a significant decline in the distribution of this species and Edwards (1998) states that its status requires review. There are recent records from

Gloucestershire, although none appear to be in the vicinity of the survey areas (Else & Edwards, 2018).

A mining bee *Melitta leporina* **Provisionally Nationally Scarce (N)**

Recorded from Site 5 (17th July 2019) and Site 6 (17th July 2019).

Single specimens were recorded from each site. *Melitta leporina* is believed to be oligolectic on Fabaceae, and is most frequently encountered visiting, or flying around clovers. *Melitta leporina* is associated with open grassland habitats on calcareous, sandy and clay soils. It has a wide distribution in southern England, with most records from the south east. It is scarce in Wales and very rare in northern England. There appear to be no Scottish records. *Melitta leporina* is known to form nesting aggregations in the soil. In view of its restricted distribution Edwards, R. (1998) suggests that the status of *Melitta leporina* requires review and upgrading to Nationally Scarce. There are previous records from the Birdlip area.

A mining bee *Melitta tricincta* **Nationally Scarce Nb**

Recorded from Site 5 (7th August 2019).

A single specimen was recorded collecting pollen from red bartsia at the western end of the site, where this plant was abundant. *Melitta tricincta* has an obligate relationship with red bartsia, apparently the sole plant from which it collects pollen. Nationally, *Melitta tricincta* is mainly recorded from central southern and south-east England, particularly on calcareous grassland, although red bartsia is not restricted to calcareous situations. Falk (1991b) notes a national decline for this species. Data given by Else & Edwards (2018) shows only one previous record for *Melitta tricincta* in Gloucestershire.

A mining bee *Osmia bicolor* **Nationally Scarce Nb**

Recorded from Site 1 (20th May 2020), Site 3 (27th June and 15th July 2019), Site 7 (28th June and 17th July 2019, 21st May 2020), and Site 10 (27th June 2019, 20th May 2020).

Individuals were recorded visiting common bird's-foot trefoil. *Osmia bicolor* constructs its nest in an empty snail shell, where each cell is partitioned with masticated leaves. The space between the last cell and the plug sealing the cell is filled with tiny shells or small pieces of chalk. Once completed, the nest shell is concealed by a covering of dead grass stems or leaf cuttings. *Osmia bicolor* is associated with chalk and limestone grassland and open woodland on calcareous soils. It is regularly seen visiting flowers such as common bird's-foot trefoil, horseshoe vetch and dandelions.

Most records for *Osmia bicolor* are from southern England and south Wales. It is rare or absent in the south-west, and from the midland counties northwards. There are a number of recent records of *Osmia bicolor* from Gloucestershire, although it appears to be previously unrecorded from the Birdlip area.

A nomad bee *Nomada fucata* **Nationally Scarce (Na)**

Recorded from Site 7 (7th August 2019).

This bee proved to be scarce within the survey areas, with only a single specimen noted in the upper section of Site 7. *Nomada fucata* is a cleptoparasite of the mining bee *Andrena flavipes*, which was recorded here on the same date. The host is associated with bare or sparsely vegetated soils in a variety of habitats, where it collects pollen from a wide range of plant species. *Andrena flavipes* is widespread in southern England and south Wales, and appears to have expanded its range in recent decades (Edwards, R. & Telfer, 2002). *Nomada fucata* is now similarly widespread in southern England and south Wales. It is currently a frequently encountered species, although in the 1970s, it endured a period of great scarcity and has in the past been subject to considerable fluctuations in population size and distribution. If *Nomada fucata* continues to prosper at present levels nationally, its status will require review (Edwards, R. & Telfer, 2002). There are a number of recent records of this bee in Gloucestershire.

A nomad bee *Nomada lathburiana* **Rare RDB 3**

Recorded from Site 6 (21st May 2020).

Nomada lathburiana is a cleptoparasite of the mining bee *Andrena cineraria*, which was found to be present at the site on the same date. Formerly essentially a northern species in its UK distribution, *Andrena cineraria* has expanded southwards over the last few decades. It has also increased in frequency. The cleptoparasite *Nomada lathburiana* is most common in northern England, but has also expanded its range southwards with its host. The map in Edwards & Telfer (2002) demonstrates the recent range expansion, and they suggest that the status of *Nomada lathburiana* may require downgrading. There are number of recent records in Gloucestershire.

Brown-banded Carder Bee *Bombus humilis* **Provisionally Nationally Scarce N,
NERC Species of Principal Importance**

Recorded from Site 1 (15th July and 5th August 2019), Site 5 (17th July and 7th August 2019) and Site 7 (7th August 2019).

A queen was recorded at Site 1 visiting flowers of meadow vetchling on 15th July 2019 two workers were recorded from the upper section of Site 7 on 7th August 2019. All other records were of single workers.

This is a medium-sized, pale ginger-brown bumblebee, lacking any trace of black hairs on the abdomen (unlike the common *Bombus pascuorum*) and possessing just a few black hairs above the wing base. *Bombus humilis* is associated with large expanses of tall, open flower-rich grasslands. Pollen is collected from a variety of plants, although species such as clovers, labiates, knapweeds and red bartsia are preferred. Queens emerge from hibernation in May and early-June. Workers are active from June to September, and males appear in August and September. Small nests are constructed on the ground surface in moderately tall, but non-tussocky grassland and are covered with moss and dead grass gathered initially by the queen and later by the workers. Nests seldom contain as many as 100 workers. *Bombus humilis* is a southern species in Britain, with most records from the south and west coasts of England and Wales. The most northerly recent British records are from Anglesey, although old records extend north to Cumberland. *Bombus humilis* has suffered a considerable decline and is now absent from many former sites, particularly away from the coast. Because of its decline, *Bombus humilis* is list as a Species of Principal Importance under the NERC Act and it is considered that its threat status should be upgraded (Edwards, R. & Telfer, 2002). There are a number of recent records of *Bombus humilis* for Gloucestershire.

4.3.4 *Coleoptera*

A weevil *Cleopomiarus graminis* **Nationally Scarce Nb**

Recorded from Site 7 (6th and 7th August 2019).

Specimens of this small, grey-black weevil were swept from harebells in both sections of Site 7. The foodplants of *Cleopomiarus graminis* are bellflowers and harebells, which are restricted to chalk and limestone grasslands in England. *Cleopomiarus graminis* has a similar British distribution, but is much more localised, only being found where large populations of its host plant occur. There are a number of previous records for this weevil from Gloucestershire.

A leaf beetle *Cryptocephalus bipunctatus* **Nationally Scarce Nb**

Recorded from Site & (21st May 2020).

A single specimen of this attractive beetle was recorded from the upper section of the site. This species utilises a wide range of host plants including hazel and rock rose,

both of which are present on the site. it is widespread but local in a variety of habitats, including downland and broad - leaved woodland. there are several recent records for East Gloucestershire.

A flea beetle *Epitrix atropae* **Nationally Scarce Nb**

Recorded from Site 7 (21st May 2020) and Site 8 (20th May 2020).

Specimens of this diminutive beetle were found by sweeping the host plant deadly nightshade *Atropa belladonna*. The beetle was found to be present in some numbers on the host plant at both sites. Nationally there is a widespread but rather disjunct distribution in England. There is a cluster of records for the Birdlip area (Cox, 2007).

A tumbling flower beetle *Variimorda villosa* **Nationally Scarce Nb**

Recorded from Site 7 (28th June 2019).

A single specimen taken whilst sweeping vegetation in the upper section of Site 7. *Variimorda villosa* is associated with semi-natural broad-leaved woodland, where it is thought to develop in either dead wood or plant stems. The latter is believed more likely. Adults are most frequently found at umbel inflorescences. Although widespread in the southern half of England and in south Wales, the distribution of *Variimorda villosa* within this area is localised. It has been previously recorded in Gloucestershire.

Black-headed Cardinal Beetle *Pyrochroa coccinea* **Nationally Scarce Nb**

Recorded from Site 8 (15th July 2019).

A specimen of this beetle was recorded on a deadwood stump along the woodland edge. Larvae of *Pyrochroa coccinea* develop over a period of two or three years in freshly dead deciduous trees, where they develop in dead wood and under bark. *Pyrochroa coccinea* has strong associations with ancient broadleaved woodland and is listed as a Grade 3 ancient woodland indicator *Pyrochroa coccinea* is widely distributed but local in England and Wales. Further recent records for Gloucestershire are recorded.

A chafer *Omaloplia ruricola* **Nationally Scarce Nb**

Recorded from Site 7 (4th June 2020) and Site 10 (27th June 2019)

This chafer is associated with dry calcareous grassland. *Omaloplia ruricola* flies during the late morning and also in the evening. It is believed that the species is myrmecophilous. Although widely distributed in southern England, it has a scattered occurrence. Previous records exist for east Gloucestershire.

4.3.5 *Mollusca*

Roman Snail *Helix pomatia* **Schedule 5 Wildlife & Countryside Act protected.**

Recorded from Site 7 (17th July and 7th August 2019, 4th June 2020).

No live specimens of the roman snail were recorded during the 2019 survey, but small numbers of empty shells were found in both the upper and lower sections of Site 7. However, on 4th June 2020 twenty-one live specimens were recorded on the lower section of the site. These animals were present in a damp bowl at the foot of the slope and were actively feeding a pair were also recorded in copulation. Further records of this species, gathered by Arup surveyors, are shown in **Map 2**, all records are from the Crickley Hill area. *Helix pomatia* is associated with limestone soils, in open woodland, scrub and on downland. Gloucestershire is one of the strongholds for the Roman snail. The species is well known in the Birdlip area, where it can be frequent in spring and early summer.

5.0 EVALUATION, IMPACTS AND RECOMMENDATIONS

5.1 Introduction

This section presents an assessment of the value of the sites surveyed for invertebrates.

5.2 Site Evaluation

The invertebrate surveys carried out at sites close to the A417 around Birdlip during 2019 and 2020 yielded a total of three Red Data Book species and twenty-nine Nationally Scarce species of insect, showing that the area has importance at County Level for its invertebrate fauna. Additionally, five species (small heath butterfly, pearl-bordered fritillary butterfly, dingy skipper, cinnabar moth and *Bombus humilis*) are listed under the NERC Act as being Species of Principal Importance.

Amongst the Nationally Scarce species recorded, the mining bees *Lasioglossum malachurum* and *Lasioglossum pauxillum* have both expanded considerably in range and frequency in recent decades and are now relatively common species. This is also true of the nomad bees *Nomada fucata* and *Nomada lathburiana*. It is likely that the status of these four bees would be downgraded in any future review of status.

The most productive sites for scarce species of invertebrate are considered to be Sites 1, 5, 6, 7 and 10, all of which are of County Level importance for their invertebrate fauna. Whilst Site 9 had fewer species of scarce and threatened insects than the sites mentioned above, it is noteworthy in that it was the only site where either the Rare (RDB3) fly *Oxya nebulosa* or the Nationally Scarce bee *Hylaeus signatus* were recorded during the surveys. Site 9 is considered to be of entomological importance at the Vice-County Level. Site 3 was shown to have four Nationally Scarce insect species present and is considered to be of entomological importance at a Local Level. The least important sites in terms of their insect fauna were Sites 2, 2a and 8, all of which had rather few species of significance. The following provides a summary of each sites value for invertebrates:

Site 1

The survey produced records for six species of Nationally Scarce invertebrate, three of which are specifically associated with chalk or limestone grasslands. These included several specimens of the six-belted clearwing *Bembecia ichneumoniformis* which was not recorded elsewhere during the surveys. Site 1 has a considerable amount of good quality limestone grassland habitat and is considered to be of **County Level importance** for its invertebrate fauna.

Site 2a

The survey produced records of two Nationally Scarce species, one of which, the median wasp *Dolichovespula media*, no longer meets the criteria for its Nationally Scarce assignment. The habitat is dominated by nettles and is generally floristically poor. Site 2 is considered to be of **Low Level importance** for its invertebrate fauna.

Site 2b

No scarce or threatened species of invertebrate were recorded here during the 2019 survey. Survey was restricted to the field margins, as the main body of the field had been cut by the time of the visit. It is possible that the results may have been better had the survey been conducted prior to the main area of the field having been cut but based on the results achieved this site is considered to be of **Low Level importance** for its invertebrate fauna. This was supported by the visit on 4th June 2020, when the field was uncut but still failed to produce any Nationally Scarce species.

Site 3

The survey produced records of four Nationally Scarce species of invertebrate, of which the picture-winged fly *Terellia longicauda* and the mining bee *Osmia bicolor* are specifically associated with chalk or limestone grasslands. Other, more common species associated with this habitat were also present. Although much of the survey area has become rank, it still retains some elements of limestone grassland, and is considered to be of **Local Level importance** for its invertebrate fauna.

Site 5

One Red Data Book species and six Nationally Scarce species of invertebrate were recorded during the survey. Of these, the Red Data Book bee fly *Villa cingulata*, and the Nationally Scarce species *Acanthophilus helianthi*, *Terellia longicauda*, *Melitta tricincta* and *Bombus humilis* are associated with chalk or limestone grasslands. Site 5 is considered to be of **County Level importance** for its invertebrate fauna.

Site 6

The survey produced records of two Red Data Book species and eight Nationally Scarce species of insect. It is likely that the status of the bee *Nomada lathburiana* will be downgraded from Rare (RDB 3) in any future review. The Red Data Book bee fly *Villa cingulata*, and the Nationally Scarce species *Acanthophilus helianthi*, *Terellia longicauda* and *Osmia bicolor* are associated with chalk or limestone grassland. Two Nationally Scarce species of fly, the hoverfly *Callicera aurata* and the picture-winged fly *Rhagoletis alternata* are primarily associated with woodland habitats, with the former having a strong association with rot holes in beech. Site 6 contains some good

limestone grassland as well as excellent beech woodland, and is considered to be of **County Level importance** for its invertebrate fauna.

Site 7

The survey produced records of fifteen species of scarce or threatened invertebrates, eight of which were not recorded elsewhere during the survey. These were the pearl-bordered fritillary butterfly, *Machimus rusticus*, *Andrena trimmerana*, *Lasioglossum pauxillum*, *Nomada fucata*, *Cleopomiarus graminis*, *Cryptocephalus bipunctatus* and *Helix pomatia*. The following eight species are associated wholly or primarily with chalk or limestone grassland; cistus forester moth, *Machimus rusticus*, *Terellia longicauda*, *Melitta haemorrhoidalis*, *Osmia bicolor*, *Bombus humilis*, *Cleopomiarus graminis* and *Helix pomatia*. Site 7 includes areas of good quality limestone grassland and is considered to be of **County Level importance** for its invertebrate fauna. It produced more scarce insect species than any other survey area.

Site 8

The survey produced a record of the Nationally Scarce black-headed cardinal beetle *Pyrochroa coccinea*, a species whose larvae develop in dead wood. The Nationally Scarce flea beetle *Epitrix atropae* was also recorded here. The woodland component of the site is densely shaded with a very poor ground flora, whilst the grassland element of the site also contains a very limited flora. It is considered that Site 8 is of **Low Level importance** for its invertebrate fauna.

Site 9

The Red Data Book picture-winged fly *Oxyna nebulosa* and the Nationally Scarce bee *Hylaeus signatus* were recorded from the site. Neither species were recorded elsewhere during the survey. *Oxyna nebulosa* is associated with ox-eye daisy; there appear to be no other published recent records for this species in the Birdlip area. *Hylaeus signatus* has an obligate association with mignonette or weld; there appear to be no other recent published records for this species in the Birdlip area. Both insects are associated with chalk or limestone grassland. Site 9 has some areas of good quality limestone grassland. Although only two scarce species were recorded during the survey, it is possible further survey could yield more scarce species. It is significant that both scarce species recorded here have apparently not been recently recorded from other sites in the Birdlip area. For this reason, Site 9 is considered to be of **County importance** for its invertebrate fauna.

Site 10

Survey produced records of six Nationally Scarce insect species. Five Nationally Scarce species - the cistus forester moth, the picture-winged fly *Terellia longicauda*,

the mining bees *Melitta haemorrhoidalis* and *Osmia bicolor* and the chafer *Omaloplia ruricola* are associated with chalk or limestone habitats. Much of Site 10 comprises good quality limestone grassland, and the site is considered to be of **County Level importance** for its invertebrate fauna.

In conclusion, it is considered that Sites 5, 6, 7 and 10 are the most important entomologically of those surveyed and are of County Level importance, with Sites 1 and 9 being of importance at the County level importance. Site 3 is considered to be of Local Level importance. Sites 2, 2a and 8 are considered to be of Low Level importance.

5.3 Outline Recommendations

The detailed design of the road improvement scheme should seek to include the following enhancements:

- Ideally, alignment of the road should avoid Site 1 which is of value for invertebrates and a range of other species groups such as reptiles, birds and plant species. Where realignment is not possible then impacts should be avoided or minimised;
- Road verges should be planted with species rich wildflower mixes using . plants and seeds of local provenance. Species mixes should seek to include plants that provide a food source for scarce species identified. This mix should include;
 - Native fine grasses such as red fescue, crested dog's-tail, sweet vernal grass and rough meadow grass;
 - Common bird's-foot trefoil;
 - Black knapweed;
 - Red bartsia;
 - Yellow rattle;
 - Ox-eye daisy;
 - Common rock-rose; and
 - Marjoram.
- A proportion of the re-aligned verges should be managed so that areas of bare rocky ground and sparsely vegetated well drained and calcareous soils are present. The A417 cutting at Baunton (SP 0254 0494) provides a good example of what should be achieved;

- Additional areas of land should be sought for habitat enhancement purposes. Site 2b would be suitable, for example, as it is currently floristically rich in areas. Appropriate management such as the taking of a hay cut in late-summer (around the end of August) followed by light winter grazing could result in enhancements to this site and expansion of the floristically rich areas;
- Any cord wood of trees to be felled should be retained on site as habitat piles. It may also be possible to erect larger sections of trees as ‘monoliths’ providing habitat for species associated with standing deadwood habitats;
- Production of a Construction Environmental Management Plan (CEMP) to be implemented during the construction phase of the scheme in order to minimise potential impacts to invertebrates; and
- Production of an Ecological Management Plan (EMP) to provide recommendations to maintain and enhance compensation areas post development.

The recommendations should be updated once the design of the scheme is finalised.

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Map 1 Site Location Map



**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

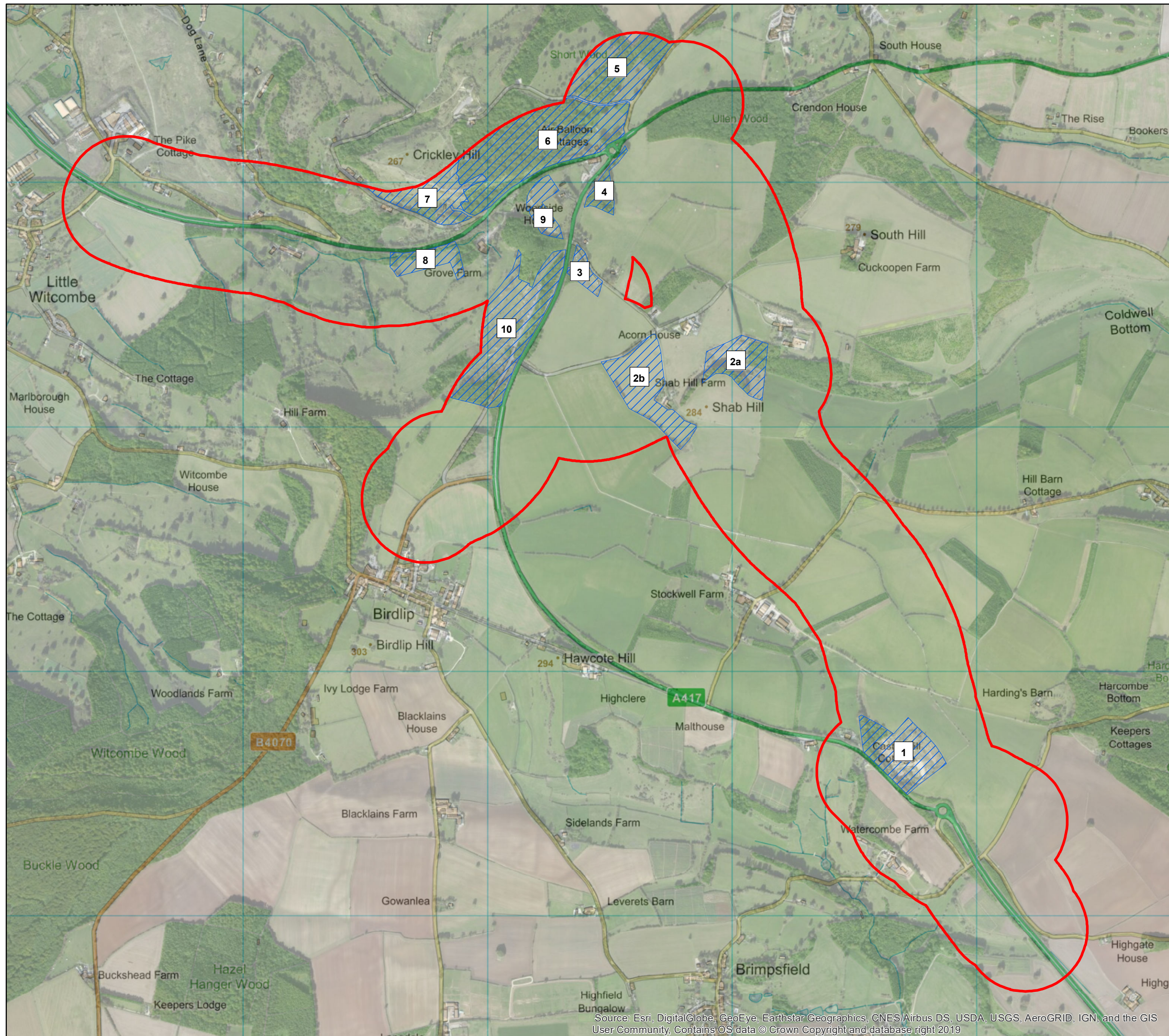
INVERTEBRATE SURVEY

Map 1 - Location of Survey Areas

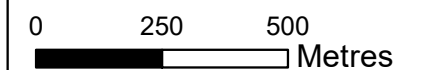
Client:	Ove Arup and Partners Ltd.
Date:	July 2020
Status:	Final

KEY

-  Site Boundary
-  Invertebrate Survey Areas 2019 (as labelled)



Scale at A3: 1:15,000



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Map 2 Location of Roman Snail Records




**A417 ROAD IMPROVEMENT SCHEME,
BIRDLIP, GLOUCESTERSHIRE**

INVERTEBRATE SURVEY

Map 2 - Location of Roman Snail Records

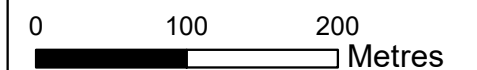
Client:	Ove Arup and Partners Ltd.
Date:	July 2020
Status:	Final

KEY

-  Site Boundary
-  Roman Snail Records 2018 - 2020 (amalgamated ECOSA, Arup and Mott MacDonald records)
-  21 Live Roman Snail Recorded on 4th June 2020 in Damp Bowl at Foot of Slope



Scale at A3: 1:5,000



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Appendix 1 Invertebrate Species Lists

Site 1

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	27/06/2019	15 & 16/07/2019	05/08/2019	20/05/2020 & 4 & 5/06/2020	STATUS
ORTHOPTERA		Grasshoppers & Crickets							
		Chorthippus	brunneus	Field grasshopper			1	1	Common, Widespread
		Chorthippus	parallelus	Meadow grasshopper	1	1	1		Common, Widespread
		Conocephalus	discolor	Long - winged conehead		1	1		Common Widespread
		Metrioptera	roeselii	Roesel's bush cricket			1		Common, Widespread
		Omocestes	viridulus	Common green grasshopper	1	1	1	1	Common, Widespread
DERMAPTERA		Earwigs							
		Forficula	auricularia	Common earwig		1		1	Common, Widespread
HEMIPTERA		True Bugs							
	Coreidae	Squash Bugs							
		Coreus	marginatus		1				Common, Widespread
ODONATA		Dragonflies & Damselflies							
	Aeshnidae	Hawkers							
		Aeshna	cyanea	Southern hawker			1		Common, Widespread
		Aeshna	mixta	Migrant hawker			1		Common, Widespread
LEPIDOPTERA		Butterflies & Moths							
		Aglais	urticae	Small tortoiseshell		1		1	Common, Widespread
		Aphantopus	hyperantus	Ringlet	1	1			Common, Widespread
		Erynnis	tages	Dingy skipper				1	Species of Principal importance NERC
		Inachis	io	Peacock			1		Common, Widespread
		Maniola	jurtina	Meadow brown	1	1		1	Common, Widespread
		Melanargia	galathea	Marbled white		1			Common, Widespread
		Ochlodes	faunus	Large skipper	1	1		1	Common, Widespread
		Pieris	brassicae	Large white			1		Common, Widespread
		Polygonia	c - album	Comma			1		Common, Widespread
		Polyommatus	icarus	Common blue	1		1	1	Common, Widespread
		Pyronia	tithonus	Gatekeeper		1	1		Common, Widespread
		Thymelicus	lineola	Essex skipper			1		Common, Widespread
		Thymelicus	sylvestris	Small skipper			1		Common, Widespread
		Vanessa	atalanta	Red admiral	1		1		Common, Widespread
		Vanessa	cardui	Painted lady	1				Common, Widespread
		Agapeta	hammana				1		Common Widespread
		Agrophylla	straminella				1		Common Widespread
		Agrophylla	tristella				1		Common Widespread
		Agrotis	exclamationis	Heart and dart		1			Common, Widespread
		Agrotis	segetum	The turnip		1			Common, Widespread
		Apamea	monoglypha	Dark arches		1			Common, Widespread
		Autographa	gamma	Silver Y	1				Common, Widespread
		Bembecia	ichneumoniformis	Six - belted clearwing		1	1		Nationally Scarce Na
		Campogramma	bilineata	Yellow shell				1	Common, Widespread
		Catoptria	pinella				1		Common Widespread
		Chloroclysta	truncata	Common marbled carpet			1		Common Widespread
		Chloroclystis	rectangulata	Green pug		1			Common, Widespread
		Cosmia	trapezina	Dun - bar			1		Common Widespread
		Crambus	perlella			1			Common, Widespread
		Crocalis	elinguaria	Scalloped oak			1		Common Widespread
		Cucullia	verbasci	Mullein moth				1	Common, Widespread
		Ecliptoptera	silacea	Small phoenix			1		Common Widespread

ORDER	FAMILY	SCIENTIFIC NAME	ENGLISH NAME	27/06/2019	15 & 16/07/2019	05/08/2019	20/05/2020 & 4 & 5/06/2020	STATUS
		Ectropis	bistortata	Engrailed		1		Common Widespread
		Eilema	complana	Scarce footman	1	1		Common, Widespread
		Eilema	griseola	Dingy footman		1		Common Widespread
		Eilema	lurideola	Common footman	1	1		Common Widespread
		Ennomos	quercinaria	August thorn		1		Common Widespread
		Epirrhoe	alternata	Common carpet		1		Common Widespread
		Eudonia	mercurella		1	1		Common, Widespread
		Hoplodrina	alsines	Uncertain		1		Common, Widespread
		Hoplodrina	blanda	Rustic		1		Common Widespread
		Hypena	proboscidalis	The snout	1			Common, Widespread
		Lacanobia	oleracea	Bright - line brown eye	1			Common, Widespread
		Laothoe	populi	Poplar hawk moth		1		Common Widespread
		Luperina	testacea	Flounced rustic		1		Common Widespread
		Lygephila	pastinum	Blackneck	1			Common, Widespread
		Mesapamea	secalis	Common rustic agg.	1	1		Common, Widespread
		Mniotype	adusta	Dark brocade	1			Common, Widespread
		Mythimna	conigera	Brown - line bright eye	1			Common, Widespread
		Mythimna	ferrago	The clay	1			Common, Widespread
		Mythimna	impura	Smoky wainscot	1	1		Common, Widespread
		Mythimna	pallens	Common wainscot	1			Common, Widespread
		Nemophora	metallica			1		Local Widespread
		Noctua	janthe	Lesser broad-bordered yellow underwing		1		Common Widespread
		Noctua	pronuba	Large yellow underwing	1	1		Common, Widespread
		Nola	confusalis	Least black arches	1			Common, Widespread
		Notocelia	uddmanniana		1			Common, Widespread
		Nudaria	mundana	Muslin footman	1			Local Widespread
		Peribatodes	rhomboidaria	Willow beauty		1		Common Widespread
		Pheosia	tremula	Swallow prominent		1		Common Widespread
		Pleuroptya	ruralis	Mother of pearl		1		Common, Widespread
		Rheumaptera	undulata	Scallop shell	1			Common, Widespread
		Selenia	dentaria	Early thorn		1		Common, Widespread
		Tyria	jacobaeae	Cinnabar moth	1	1	1	Species of Principal Importance (NERC)
		Udea	lutealis			1		Common Widespread
		Udea	olivalis		1			Common, Widespread
		Xanthorhoe	montanata	Silver ground carpet	1			Common, Widespread
		Zygaena	filipendulae	Six - spot burnet	1			Common, Widespread
DIPTERA		True Flies						
	Tipulidae	Craneflies						
		Nephrotoma	flavescens	1				Common Widespread
	Stratiomyidae	Soldier Flies						
		Chloromyia	formosa		1		1	Common, Widespread
		Stratiomys	potamida		1			Local Widespread
	Asilidae	Robber Flies						
		Leptogaster	cylindrica	1	1		1	Common, Widespread
	Dolichopodidae	Long - headed Flies						
		Dolichopus	ungulatus	1				Common, Widespread
		Poecilobothrus	nobilitatus		1			Common, Widespread
	Syrphidae	Hoverflies						
		Cheilosia	bergenstammi		1			Common, Widespread
		Cheilosia	illustrata		1			Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	27/06/2019	15 & 16/07/2019	05/08/2019	20/05/2020 & 4 & 5/06/2020	STATUS
		Cheilosia	pagana				1		Common, Widespread
		Cheilosia	soror				1		Common, Widespread
		Chrysotoxum	bicinctum		1	1		1	Common, Widespread
		Episyrphus	balteatus		1	1	1	1	Common, Widespread
		Eristalis	arbustorum		1		1		Common, Widespread
		Eristalis	pertinax		1		1	1	Common, Widespread
		Eristalis	tenax		1			1	Common, Widespread
		Eupeodes	corollae					1	Common, Widespread
		Eupeodes	luniger		1	1		1	Common, Widespread
		Helophilus	pendulus		1				Common, Widespread
		Melangyna	umbellatarum			1			Common, Widespread
		Melanostoma	mellinum			1	1		Common, Widespread
		Melanostoma	scalare			1	1		Common, Widespread
		Paragus	haemorrhous					1	Common, Widespread
		Pipizella	viduata		1	1		1	Common, Widespread
		Platycheirus	albimanus		1	1	1		Common, Widespread
		Scaeva	pyrastris			1		1	Common, Widespread
		Sphaerophoria	scripta		1	1	1		Common, Widespread
		Syrpita	pipiens		1	1	1	1	Common, Widespread
		Syrphus	ribesii		1	1			Common, Widespread
		Syrphus	vitripennis		1	1	1		Common, Widespread
		Volucella	bombylans		1			1	Common, Widespread
		Volucella	pelluscens		1		1		Common, Widespread
		Volucella	zonaria				1		Common, Widespread
		Xanthogramma	pedisequum			1	1	1	Common, Widespread
	Conopidae	Thick - headed Flies							
		Physocephala	rufipes			1	1		Common, Widespread
		Sicus	ferrugineus		1	1			Common, Widespread
	Tephritidae	Picture - winged Flies							
		Tephritis	formosa				1		Common, Widespread
		Terellia	longicauda			1	1		Provisionally Nationally Scarce N
		Terellia	tussilaginis				1		Common, Widespread
	Ulidiidae	Ulidiid flies							
		Herina	longistylata		1	1		1	Common Widespread
	Scathophagidae	Dung flies							
		Scathophaga	stercoraria		1				Common Widespread
	Sciomyzidae	Snail Killing Flies							
		Pherbellia	cinerella		1				Common, Widespread
	Tachinidae	Tachinid Flies							
		Lophosia	fasciata			1			Nationally Scarce N
		Phasia	hemiptera				1		Common, Widespread
		Phasia	obesa				1		Common, Widespread
		Phasia	pusilla		1			1	Common, Widespread
HYMENOPTERA		Bees, Wasps, Ants & Relatives							
	Eumenidae	Potter & Mason Wasps							
		Ancistrocerus	gazella			1			Common, Widespread
	Vespidae	Social Wasps							
		Dolichovespula	media	Median wasp	1				Nationally Scarce Na
		Vespula	vulgaris	Common wasp			1		Common, Widespread
	Crabronidae	Digger Wasps							

ORDER	FAMILY	SCIENTIFIC NAME	ENGLISH NAME	27/06/2019	15 & 16/07/2019	05/08/2019	20/05/2020 & 4 & 5/06/2020	STATUS
		Ectemnius cephalotes		1				Common, Widespread
		Ectemnius continuus				1	1	Common, Widespread
		Passaloecus singularis					1	Common, Widespread
		Pemphredon lugubris					1	Common, Widespread
	Apoidea	Bees						
	Colletidae	Mining & Yellow - faced Bees						
		Hylaeus dilatatus			1			Common, Widespread
		Hylaeus hyalinatus					1	Common, Widespread
	Andrenidae	Mining Bees						
		Andrena bucephala					1	Nationally Scarce Na
		Andrena nitida					1	Common, Widespread
	Halictidae	Mining & Cuckoo Bees						
		Halictus tumulorum			1	1	1	Common, Widespread
		Lasioglossum albipes			1		1	Common, Widespread
		Lasioglossum cupromicans		1				Common, Widespread
		Lasioglossum pauxillum			1	1		Nationally Scarce Na
		Lasioglossum smeathmanellum				1		Common, Widespread
		Lasioglossum villosulum		1	1		1	Common, Widespread
	Megachilidae	Solitary Bees						
		Megachile centuncularis				1		Common, Widespread
		Osmia bicolor					1	Nationally Scarce Nb
		Osmia caerulescens		1				Common, Widespread
		Osmia spinulosa		1				Common, Widespread
	Anthophoridae	Mining and nomad bees						
		Nomada flavoguttata					1	Common, Widespread
	Apidae	Social & Cuckoo Bees						
		Apis mellifera	Honey bee	1	1	1	1	Common, Widespread
		Bombus humilis	Brown - banded carder bee		1	1		Provisionally Nationally Scarce N and Species of Principal Importance (NERC)
		Bombus hypnorum	Tree bumblebee	1		1		Recent colonist
		Bombus lapidarius	Red - tailed bumblebee	1	1	1	1	Common, Widespread
		Bombus lucorum	White - tailed bumblebee	1		1		Common, Widespread
		Bombus pascuorum	Common carder bee	1	1	1	1	Common, Widespread
		Bombus pratorum	Early bumblebee				1	Common, Widespread
		Bombus terrestris/lucorum worker	A bumblebee	1	1		1	Common, Widespread
		Bombus terrestris	Buff - tailed bumblebee	1		1		Common, Widespread
COLEOPTERA		Beetles						
	Cantharidae	Soldier Beetles						
		Rhagonycha fulva			1			Common, Widespread
	Cerambycidae	Longhorn Beetles						
		Leptura melanura			1			Common, Widespread
	Coccinellidae	Ladybirds						
		Coccinella 7 - punctata	Seven - spot ladybird		1	1		Common, Widespread
		Harmonia axyridis	Harlequin ladybird		1			Common, Widespread
	Elateridae	Click Beetles						
		Agriotes acuminatus			1			Common, Widespread
	Oedemeridae	Oedemerid Beetles						
		Oedemera nobilis		1	1	1	1	Common, Widespread

Site 2a

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	26/06/2019	05/08/2019	04/06/2020	STATUS
ORTHOPTERA		Grasshoppers & Crickets						
		Chorthippus	parallelus	Meadow grasshopper		1		Common, Widespread
		Metrioptera	roeselii	Roesel's bush cricket	1	1	1	Common, Widespread
		Omocestes	viridulus	Common green grasshopper		1		Common, Widespread
LEPIDOPTERA		Butterflies & Moths						
		Inachis	io	Peacock		1	1	Common, Widespread
		Maniola	jurtina	Meadow brown	1	1		Common, Widespread
		Melanargia	galathea	Marbled white		1		Common, Widespread
		Ochlodes	faunus	Large skipper		1		Common, Widespread
		Pararge	aegeria	Speckled wood	1			Common, Widespread
		Pieris	brassicae	Large white		1		Common, Widespread
		Polyommatus	icarus	Common blue		1		Common, Widespread
		Pyronia	tithonus	Gatekeeper		1		Common, Widespread
		Thymelicus	sylvestris	Small skipper				Common, Widespread
		Vanessa	cardui	Painted lady	1			Common, Widespread
		Agrophylla	straminella				1	Common, Widespread
		Campptogramma	bilineata	Yellow shell		1		Common, Widespread
		Odezia	atrata	Chimney sweeper			1	Local, Widespread
		Petrophora	chlorosata	Brown silver - line	1			Common, Widespread
		Rheumaptera	undulata	Scallop shell	1			Common, Widespread
		Udea	lutealis			1		Common, Widespread
	Xanthorhoe	fluctuata	Garden carpet	1			Common, Widespread	
	Xanthorhoe	montanaata	Silver ground carpet	1		1	Common, Widespread	
DIPTERA		True Flies						
		Stratiomyidae	Soldier Flies					
		Beris	chalybata				1	Common, Widespread
		Chloromyia	formosa		1		1	Common, Widespread
		Stratiomys	potamida			1		Local Widespread
		Rhagionidae	Snipe Flies					
		Rhagio	tringarius		1			Common, Widespread
		Tabanidae	Horse Flies					
		Haematopota	pluvialis	Notch - horned cleg		1		Common, Widespread
		Asilidae	Robber Flies					
		Dioctria	rufipes		1			Common, Widespread
		Leptarthrus	brevirostris	Slender - footed robberfly	1			Local Widespread
		Machimus	atricapillus			1		Common, Widespread
		Syrphidae	Hoverflies					
		Cheilosia	illustrata		1	1		Common, Widespread
		Cheilosia	impressa		1			Common, Widespread
		Cheilosia	pagana			1		Common, Widespread
	Cheilosia	vulpina			1		Common, Widespread	
	Chrysotoxum	bicinctum		1	1		Common, Widespread	
	Chrysotoxum	festivum			1		Common, Widespread	
	Dasysyrphus	albostrigatus			1		Common, Widespread	
	Episyrphus	balteatus		1	1	1	Common, Widespread	
	Eristalis	pertinax		1			Common, Widespread	
	Eristalis	tenax		1	1	1	Common, Widespread	
	Eupeodes	corollae				1	Common, Widespread	
	Eupeodes	luniger		1	1		Common, Widespread	

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	26/06/2019	05/08/2019	04/06/2020	STATUS
		Leucozonia	laternaria			1		Common, Widespread
		Leucozonia	lucorum		1			Common, Widespread
		Melanostoma	scalare			1		Common, Widespread
		Pipizella	virens			1		Local, Widespread
		Platycheirus	albimanus		1	1		Common, Widespread
		Syrpitta	pipiens		1			Common, Widespread
		Syrphus	ribesii		1	1		Common, Widespread
		Syrphus	vitripennis		1	1	1	Common, Widespread
		Volucella	bombylans		1	1	1	Common, Widespread
		Volucella	pelluscens		1			Common, Widespread
	Tephritidae	Picture - winged Flies						
		Terellia	longicauda			1		Provisionally Nationally Scarce N
	Palloptheridae	Palloptherid flies						
		Palloptera	modesta			1		Common, Widespread
	Scathophagidae	Dung Flies						
		Scathophaga	stercoraria	Common yellow dung fly			1	Common, Widespread
	Tachinidae	Tachinid Flies						
		Macquartia	praefica		1			Common, Widespread
		Phasia	obesa			1		Common, Widespread
		Phasia	pusilla				1	Common, Widespread
HYMENOPTERA		Bees, Wasps, Ants & Relatives						
	Vespidae	Social Wasps						
		Dolichovespula	media	Median wasp		1		Nationally Scarce Na
	Apidae	Social & Cuckoo Bees						
		Bombus	lapidarius	Red - tailed bumblebee		1		Common, Widespread
		Bombus	lucorum	White - tailed bumblebee		1		Common, Widespread
		Bombus	lucorum/terrestris worker	White - tailed bumblebee			1	Common, Widespread
		Bombus	pascuorum	Common carder bee		1	1	Common, Widespread
		Bombus	vestalis	A cuckoo bumblebee		1		Common, Widespread
COLEOPTERA		Beetles						
	Cantharidae	Soldier Beetles						
		Cantharis	nigricans		1			Common, Widespread
		Rhagonycha	fulva			1		Common, Widespread
		Rhagonycha	limbata				1	Common, Widespread
	Chrysomelidae	Leaf Beetles						
		Phaedon	cochleariae			1		Common, Widespread
	Coccinellidae	Ladybirds						
		Coccinella	7 - punctata	Seven spot ladybird			1	Common, Widespread
		Harmonia	axyridis	Harlequin ladybird	1			Common, Widespread
	Oedemeridae	Oedemerid Beetles						
		Oedemera	nobilis		1	1		Common, Widespread

Site 2b

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	15/07/2019	04/06/2020	STATUS
ORTHOPTERA		Grasshoppers & Crickets					
		Chorthippus	brunneus	Field grasshopper	1		Common, Widespread
		Metrioptera	roeselii	Roesel's bush cricket	1		Common, Widespread
		Omocestes	viridulus	Common green grasshopper	1		Common, Widespread
DERMAPTERA		Earwigs					
		Forficula	auricularia	Common earwig	1		Common, Widespread
HEMIPTERA		True Bugs					
	Pentatomidae	Shield Bugs					
		Dolycoris	baccarum		1	1	Common, Widespread
LEPIDOPTERA		Butterflies & Moths					
		Aphantopus	hyperantus	Ringlet	1		Common, Widespread
		Coenonymphus	pamphilus	Small heath		1	Species of Principal Importance (NERC)
		Maniola	jurtina	Meadow brown	1	1	Common, Widespread
		Melanargia	galathea	Marbled white	1		Common, Widespread
		Ochlodes	faunus	Large skipper	1	1	Common, Widespread
		Pieris	brassicae	Large white	1		Common, Widespread
		Thymelicus	lineola	Essex skipper	1		Common, Widespread
		Thymelicus	sylvestris	Small skipper	1		Common, Widespread
		Chrysoteuchia	culmella		1		Common, Widespread
		Campptogramma	bilineata	Yellow shell		1	Common, Widespread
		Myelois	circumvoluta	Thistle ermine	1		Common, Widespread
		Tyria	jacobaeae	Cinnabar moth	1		Species of Principal Importance (NERC)
		Zygaena	filipendulae	Six - spot burnet	1		Common, Widespread
DIPTERA		True Flies					
	Tipulidae	Craneflies					
		Nephrotoma	flavescens		1		Common Widespread
		Tipula	lunata			1	Common, Widespread
	Stratiomyidae	Soldier Flies					
		Chloromyia	formosa		1		Common, Widespread
		Chorisops	tibialis		1		Common, Widespread
		Pachygaster	atra		1		Common, Widespread
	Tabanidae	Horse Flies					
		Haematopota	pluvialis	Notch - horned cleg	1		Common, Widespread
	Asilidae	Robber Flies					
		Leptarthus	brevirostris	Slender - footed robberfly	1		Local Widespread
		Leptogaster	cylindrica		1	1	Common, Widespread
	Dolichopodidae	Long - headed Flies					
		Dolichopus	trivialis			1	Common, Widespread
	Syrphidae	Hoverflies					
		Episyrphus	balteatus		1	1	Common, Widespread
		Eristalis	tenax		1	1	Common, Widespread
		Eupeodes	corollae			1	Common, Widespread
		Eupeodes	luniger		1	1	Common, Widespread
		Melangyna	umbellatarum		1		Common, Widespread
		Melanostoma	mellinum		1	1	Common, Widespread
		Melanostoma	scalare		1		Common, Widespread
		Platycheirus	albimanus		1		Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	15/07/2019	04/06/2020	STATUS
		Scaeva	pyrastris			1	Common, Widespread
		Sphaerophoria	scripta		1		Common, Widespread
		Sphaerophoria	taeniata			1	Common, Widespread
		Syrpitta	pipiens		1		Common, Widespread
		Syrphus	ribesii		1		Common, Widespread
		Syrphus	vitripennis		1		Common, Widespread
		Volucella	bombylans			1	Common, Widespread
		Volucella	pelluscens		1		Common, Widespread
		Xanthogramma	pedisequum			1	Common, Widespread
	Conopidae	Thick - headed Flies					
		Sicus	ferrugineus		1		Common, Widespread
	Tephritidae	Picture - winged Flies					
		Tephritis	vespertina		1	1	Common, Widespread
		Terellia	tussilaginis		1		Common, Widespread
	Scathophagidae	Dung Flies					
		Scathophaga	atercoraria	Common yellow dung fly		1	Common, Widespread
	Sciomyzidae	Snail Killing Flies					
		Limnia	unguicornis		1		Common, Widespread
		Pherbellia	cinerella		1	1	Common, Widespread
	Opomyzidae	Opomyzid flies					
		Opomyza	germinationis		1		Common Widespread
HYMENOPTERA		Bees, Wasps, Ants & Relatives					
	Halictidae	Mining & Cuckoo Bees					
		Halictus	tumulorum		1		Common, Widespread
	Apidae	Social & Cuckoo Bees					
		Apis	mellifera	Honey bee	1	1	Common, Widespread
		Bombus	lapidarius	Red - tailed bumblebee	1	1	Common, Widespread
		Bombus	pasuorum	Common carder bee	1	1	Common, Widespread
		Bombus	terrestris/lucorum worker	A bumblebee	1	1	Common, Widespread
COLEOPTERA		Beetles					
	Cantharidae	Soldier Beetles					
		Cantharis	lateralis		1		Common, Widespread
		Cantharis	nigra		1	1	Common, Widespread
		Rhagonycha	fulva		1		Common, Widespread
	Cerambycidae	Longhorn Beetles					
		Agapanthia	villosiviridescens		1		Local Widespread
		Leptura	melanura		1		Common, Widespread
	Coccinellidae	Ladybirds					
		Coccinella	7 - punctata	Seven - spot ladybird	1		Common, Widespread
	Elateridae	Click Beetles					
		Agriotes	acuminatus		1		Common, Widespread
	Malachiidae	Pollen Beetles					
		Malachius	bipustulatus			1	Common, Widespread
	Oedemeridae	Oedemerid Beetles					
		Oedemera	nobilis		1	1	Common, Widespread

Site 3

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	26 & 27/06/2019	15/07/2019	06/08/2019	STATUS
ORTHOPTERA		Grasshoppers & Crickets						
		Chorthippus	brunneus	Field grasshopper		1	1	Common, Widespread
		Chorthippus	parallelus	Meadow grasshopper		1		Common, Widespread
		Conocephalus	discolor					Common, Widespread
		Metrioptera	roeselii	Roesel's bush cricket	1		1	Common, Widespread
		Omocestes	viridulus	Common green grasshopper	1	1	1	Common, Widespread
HEMIPTERA		True Bugs						
	Acanthosomidae	Shield Bugs						
		Acanthosoma						Common, Widespread
		Elasmotethus						Common, Widespread
	Coreidae	Squash Bugs						
		Coriomeris	denticulatus		1			Common, Widespread
	Pentatomidae	Shield Bugs						
		Palomena	prasina	Green shieldbug			1	Common, Widespread
LEPIDOPTERA		Butterflies & Moths						
		Aphantopus	hyperantus	Ringlet		1		Common, Widespread
		Lycaena	phlaeas	Small copper			1	Common, Widespread
		Maniola	jurtina	Meadow brown	1	1	1	Common, Widespread
		Melanargia	galathea	Marbled white	1	1	1	Common, Widespread
		Ochlodes	faunus	Large skipper	1	1		Common, Widespread
		Pieris	brassicae	Large white	1	1		Common, Widespread
		Polyommatus	icarus	Common blue	1		1	Common, Widespread
		Thymelicus	lineola	Essex skipper		1		Common, Widespread
		Vanessa	atalanta	Red admiral	1		1	Common, Widespread
		Vanessa	cardui	Painted lady	1		1	Common, Widespread
		Epirrhoe	alternata	Common carpet			1	Common, Widespread
		Euclidia	glyphica	Burnet companion	1			Common, Widespread
		Myelois	circumvoluta	Thistle ermine	1			Common, Widespread
		Mythimna	impura	Smoky wainscot		1		
		Nemophora	metallica				1	Common, Widespread
		Pterophorus	pentadactyla	Common white plume	1			Common, Widespread
		Scotopteryx	chenopodiata	Shaded broad - bar			1	Common, Widespread
		Semiothisa	clathrata	Latticed heath	1			Common, Widespread
		Tyria	jacobaeae	Cinnabar moth	1		1	Species of Principal Importance (NERC)
		Udea	lutealis				1	Common, Widespread
		Zygaena	filipendulae	Six - spot burnet		1	1	Common, Widespread
		Zygaena	trifolii	Five - spot burnet	1			Common, Widespread
DIPTERA		True Flies						
	Stratiomyidae	Soldier Flies						
		Chloromyia	formosa		1			Common, Widespread
	Rhagionidae	Snipe Flies						
		Chrysopilus	asiliformis			1		Common, Widespread
		Rhagio	tringarius				1	Common, Widespread
	Tabanidae	Horse Flies						
		Haematopota	pluvialis	Notch - horned cleg	1	1		Common, Widespread
	Asilidae	Robber Flies						
		Leptathrus	brevirostris	Slender - footed robberfly	1			Local Widespread
		Leptogaster	cylindrica		1			Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	26 & 27/06/2019	15/07/2019	06/08/2019	STATUS
	Syrphidae	Hoverflies						
		Cheilosia	illustrata		1			Common, Widespread
		Cheilosia	vernalis		1			Common, Widespread
		Chrysogaster	solstitialis				1	Common, Widespread
		Chrysotoxum	bicinctum		1	1	1	Common, Widespread
		Episyrphus	balteatus		1	1	1	Common, Widespread
		Eristalis	arbustorum			1		Common, Widespread
		Eristalis	pertinax		1	1	1	Common, Widespread
		Eristalis	tenax		1	1	1	Common, Widespread
		Eupeodes	corollae		1			Common, Widespread
		Eupeodes	luniger		1	1		Common, Widespread
		Helophilus	pendulus			1		Common, Widespread
		Melanostoma	mellinum			1	1	Common, Widespread
		Merodon	equestris		1			Common, Widespread
		Myathropa	florea				1	Common, Widespread
		Pipizella	viduata		1			Common, Widespread
		Pipizella	virens		1			Local, Widespread
		Platycheirus	albimanus		1	1		Common, Widespread
		Platycheirus	clypeatus			1		Common, Widespread
		Rhingia	campestris				1	Common, Widespread
		Scaeva	pyrastris		1			Common, Widespread
		Sphaerophoria	scripta		1	1	1	Common, Widespread
		Syritta	pipiens		1	1	1	Common, Widespread
		Syrphus	ribesii			1	1	Common, Widespread
		Syrphus	vitripennis			1		Common, Widespread
		Volucella	bombylans		1			Common, Widespread
		Xanthandrus	comtus			1		Local, Widespread
		Xanthogramma	pedisequum		1			Common, Widespread
	Tephritidae	Picture - winged Flies						
		Chaetostomella	cylindrica		1	1	1	Common, Widespread
		Terellia	colon				1	Common, Widespread
		Terellia	longicauda				1	Provisionally Nationally Scarce N
		Terellia	ruficauda			1		Common, Widespread
		Terellia	tussilaginis			1		Common, Widespread
		Urophora	jaceana			1		Common, Widespread
	Ulidiidae	Ulidiid flies						
		Herina	longistylata		1	1		Common Widespread
	Pipunculidae	Big - headed flies						
		Verrallia	aucta		1			Common widespread
	Sciomyzidae	Snail Killing Flies						
		Coramacera	marginata		1			Common, Widespread
	Tachinidae	Tachinid Flies						
		Eriothrix	rufomaculatus				1	Common, Widespread
HYMENOPTERA		Bees, Wasps, Ants & Relatives						
	Vespidae	Social Wasps						
		Dolichovespula	media	Median wasp			1	Nationally Scarce Na
		Vespula	germanica	German wasp			1	Common, Widespread
		Vespula	vulgaris	Common wasp			1	Common, Widespread
	Crabronidae	Digger Wasps						
		Ectemnius	continuus				1	Common, Widespread
		Pemphredon	inornata			1		Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	26 & 27/06/2019	15/07/2019	06/08/2019	STATUS
	Apoidea	Bees						
	Colletidae	Mining & Yellow - faced Bees						
		Hylaeus	brevicornis		1			Common, Widespread
		Hylaeus	dilatatus			1		Common, Widespread
	Andrenidae	Mining Bees						
		Andrena	chrysoceles		1			Common, Widespread
		Andrena	dorsata				1	Common, Widespread
		Andrena	semilaevis		1			Common, Widespread
	Halictidae	Mining & Cuckoo Bees						
		Halictus	tumulorum		1	1		Common, Widespread
		Lasioglossum	fulvicorne			1	1	Common, Widespread
		Sphecodes	crassus			1		Nationally Scarce Nb
		Sphecodes	geoffrellus		1			Common, Widespread
		Sphecodes	hyalinatus			1		Common, Widespread
	Megachilidae	Solitary Bees						
		Megachile	centuncularis				1	Common, Widespread
		Osmia	bicolor		1	1		Nationally Scarce Nb
		Osmia	spinulosa		1			Common, Widespread
	Anthophoridae	Flower & Nomad Bees						
		Nomada	fabriciana		1			Common, Widespread
	Apidae	Social & Cuckoo Bees						
		Apis	mellifera	Honey bee	1	1		Common, Widespread
		Bombus	hortorum	Large garden bumblebee			1	Common, Widespread
		Bombus	hypnorum	Tree bumblebee	1			Recent colonist
		Bombus	lapidarius	Red - tailed bumblebee	1	1		Common, Widespread
		Bombus	lucorum	White - tailed bumblebee	1	1	1	Common, Widespread
		Bombus	pascurorum	Common carder bee	1	1	1	Common, Widespread
		Bombus	pratorum	Early bumblebee	1			Common, Widespread
		Bombus	terrestris	Buff - tailed bumblebee	1		1	Common, Widespread
		Bombus	terrestris/lucorum worker	A bumblebee		1	1	Common Widespread
COLEOPTERA		Beetles						
	Cantharidae	Soldier Beetles						
		Cantharis	cryptica		1			Common, Widespread
		Cantharis	nigra		1			Common, Widespread
		Rhagonycha	fulva			1	1	Common, Widespread
	Cerambycidae	Longhorn Beetles						
		Agapanthia	villosviridescens		1	1		Local Widespread
		Grammoptera	ruficornis		1			Common, Widespread
		Leptura	melanura		1			Common, Widespread
	Chrysomelidae	Leaf Beetles						
		Cryptocephalus	moraei		1			Local, Widespread
	Coccinellidae	Ladybirds						
		Coccinella	7 - punctata	Seven - spot ladybird		1	1	Common, Widespread
		Harmonia	axyridis	Harlequin ladybird	1			Common, Widespread
		Subcoccinella	24 - punctata	Twenty - four - spot ladybird		1	1	Common, Widespread
	Dascillidae	Orchid beetles						
		Dascillus	cervinus	Orchid beetle	1			Common Widespread
	Elateridae	Click Beetles						
		Athous	haemorrhoidalis		1			Common, Widespread
	Oedemeridae	Oedemerid Beetles						
		Oedemera	nobilis		1	1	1	Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	26 & 27/06/2019	15/07/2019	06/08/2019	STATUS
	Scarabaeidae	Chafers & Dung Beetles						
		Onthophagus	joannae		1			Common, Widespread
	Staphylinidae	Rove beetles						
		Staphylinus	olens	Devil's coach - horse		1		Common Widespread

Site 5

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	28/06/2019	16 & 17/07/2019	07/08/2019	05/06/2020	STATUS
ORTHOPTERA		Grasshoppers & Crickets							
		Chorthippus	parallelus	Meadow grasshopper		1	1	1	Common, Widespread
		Conocephalus	discolor	Long - winged conehead		1	1		Common, Widespread
		Leptophyes	punctatissima	Speckled bush cricket				1	Common, Widespread
		Metrioptera	roeselii	Roesel's bush cricket	1	1	1		Common, Widespread
		Omocestes	viridulus	Common green grasshopper	1	1	1	1	Common, Widespread
HEMIPTERA		True Bugs							
	Scutelleridae	Tortoise bugs							
		Eurygaster	testudinaria	Common tortoise bug		1			Common Widespread
ODONATA		Dragonflies & Damselflies							
	Libellulidae	Skimmers, Chasers & Darters							
		Orthetrum	cancellatum	Black - tailed skimmer	1				Common, Widespread
LEPIDOPTERA		Butterflies & Moths							
		Aglais	urticae	Small tortoiseshell				1	Common, Widespread
		Aphantopus	hyperantus	Ringlet	1	1			Common, Widespread
		Coenonympha	pamphilus	Small heath	1		1		Species of Principal Importance (NERC)
		Inachis	io	Peacock			1		Common, Widespread
		Lycaena	phlaeas	Small copper			1		Common, Widespread
		Maniola	jurtina	Meadow brown	1	1	1	1	Common, Widespread
		Melanargia	galathea	Marbled white	1	1			Common, Widespread
		Neozephyrus	quercus	Purple hairstreak		1			Common, Widespread
		Ochlodes	faunus	Large skipper	1			1	Common, Widespread
		Pararge	aegeria	Speckled wood	1				Common, Widespread
		Pieris	brassicae	Large white			1		Common, Widespread
		Polyommatus	icarus	Common blue				1	Common Widespread
		Pyronia	tithonus	Gatekeeper		1	1		Common, Widespread
		Thymelicus	lineola	Essex skipper		1			Common, Widespread
		Thymelicus	sylvestris	Small skipper		1			Common, Widespread
		Vanessa	atalanta	Red admiral	1				Common, Widespread
		Vanessa	cardui	Painted lady	1		1		Common, Widespread
		Campptogramma	bilineata	Yellow shell				1	Common, Widespread
		Tyria	jacobaeae	Cinnabar moth		1	1		Species of Principal Importance (NERC)
		Zygaena	filipendulae	Six - spot burnet			1		Common Widespread
DIPTERA		True Flies							
	Tipulidae	Crane Flies							
		Tipula	lunata					1	Common, Widespread
	Stratiomyidae	Soldier Flies							
		Chloromyia	formosa			1			Common, Widespread
		Pachygaster	atra			1			Common, Widespread
	Rhagionidae	Snipe Flies							
		Rhagio	tringarius				1		Common, Widespread
	Tabanidae	Horse Flies							
		Haematopota	pluvialis	Notch - horned cleg	1				Common, Widespread
		Tabanus	bromius					1	Common, Widespread
	Asilidae	Robber Flies							
		Dioctria	rufipes					1	Common, Widespread
		Leptarthrus	brevirostris	Slender - footed robberfly	1			1	Common, Widespread
		Leptogaster	cylindrica		1	1		1	Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	28/06/2019	16 & 17/07/2019	07/08/2019	05/06/2020	STATUS
		Machimus	atricapillus			1	1		Common, Widespread
	Bombyliidae	Bee Flies							
		Villa	cingulata	Downland Villa	1	1			Rare RDB 3
	Dolichopodidae	Long - headed Flies							
		Sciapus	contristans s.l.			1			Common, Widespread
	Syrphidae	Hoverflies							
		Chrysotoxum	bicinctum			1		1	Common, Widespread
		Episyrphus	balteatus		1	1		1	Common, Widespread
		Eristalis	interruptus			1	1	1	Common, Widespread
		Eristalis	pertinax					1	Common, Widespread
		Eristalis	tenax				1	1	Common, Widespread
		Eupeodes	corollae					1	Common, Widespread
		Eupeodes	luniger		1	1			Common, Widespread
		Helophilus	pendulus					1	Common, Widespread
		Melangyna	compositarum/labiatarum					1	Common, Widespread
		Melanostoma	mellinum		1	1	1	1	Common, Widespread
		Melanostoma	scalare					1	Common, Widespread
		Pipiza	noctiluca					1	Common, Widespread
		Platycheirus	albimanus		1				Common, Widespread
		Platycheirus	peltatus					1	Common, Widespread
		Rhingia	campestris				1	1	Common, Widespread
		Scaeva	pyrastris					1	Common, Widespread
		Sphaerophoria	scripta			1	1		Common, Widespread
		Syritta	pipiens				1		Common, Widespread
		Syrphus	ribesii		1				Common, Widespread
		Syrphus	vitripennis		1				Common, Widespread
		Volucella	bombylans					1	Common, Widespread
		Volucella	pelluscens			1		1	Common, Widespread
		Xanthogramma	pedisequum			1		1	Common, Widespread
	Conopidae	Thick - headed Flies							
		Physocephala	rufipes			1			Common, Widespread
	Tephritidae	Picture - winged Flies							
		Acdanthiophilus	helianthi				1		Nationally Scarce N
		Terellia	longicauda			1	1		Provisionally Nationally Scarce N
		Urophora	stylata		1				Common, Widespread
		Urophora	quadrifasciata				1		Common, Widespread
	Sciomyzidae	Snail Killing Flies							
		Limnia	unguicornis		1	1		1	Common, Widespread
	Palloptheridae	Palloptherid flies							
		Pallopthera	modesta				1		Common Widespread
	Scathophagidae	Dung Flies							
		Scathophaga	stercoraria	Common yellow dung fly				1	Common, Widespread
	Muscidae	House flies							
		Mesembrina	meridiana		1				Common Widespread
	Tachinidae	Tachinid Flies							
		Eriothrix	rufomaculatus				1		Common, Widespread
		Nowickia	ferox				1		Common, Widespread
HYMENOPTERA		Bees, Wasps, Ants & Relatives							
	Tiphiidae	Tiphiid Wasps							
		Tiphia	femorata				1		Common, Widespread
	Vespidae	Social Wasps							

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	28/06/2019	16 & 17/07/2019	07/08/2019	05/06/2020	STATUS
		Dolichovespula	media	Median wasp			1		Nationally Scarce Na
		Vespula	vulgaris	Common wasp			1		Common, Widespread
	Crabronidae	Digger Wasps							
		Crossocerus	pusillus			1			Common, Widespread
	Apoidea	Bees							
	Colletidae	Mining & Yellow - faced Bees							
		Hylaeus	communis			1			Common, Widespread
	Andrenidae	Mining Bees							
		Andrena	cineraria					1	Common, Widespread
	Halictidae	Mining & Cuckoo Bees							
		Halictus	tumulorum		1	1			Common, Widespread
		Lasioglossum	albipes		1				Common, Widespread
		Lasioglossum	calceatum				1		Common, Widespread
		Lasioglossum	leucozonium					1	Common, Widespread
	Mellitidae	Mining Bees							
		Melitta	leporina			1			Provisionally Nationally Scarce N
		Melitta	tricincta				1		Nationally Scarce Nb
	Megachilidae	Solitary Bees							
		Megachile	ligniseca				1		Common, Widespread
		Megachile	willughbiella					1	Common, Widespread
	Apidae	Social & Cuckoo Bees							
		Apis	mellifera	Honey bee			1	1	Common, Widespread
		Bombus	humilis	Brown - banded carder bee		1	1		Provisionally Nationally Scarce N and Species of Principal Importance (NERC)
		Bombus	hypnorum	Tree bumblebee				1	Common, Widespread
		Bombus	lapidarius	Red - tailed bumblebee	1	1	1	1	Common, Widespread
		Bombus	lucorum	White - tailed bumblebee			1	1	Common, Widespread
		Bombus	pascuorum	Common carder bee	1	1	1	1	Common, Widespread
		Bombus	pratorum	Early bumblebee				1	Common, Widespread
		Bombus	terrestris	Buff - tailed bumblebee			1	1	Common, Widespread
		Bombus	terrestris/lucorum worker	A bumblebee	1	1			Common, Widespread
COLEOPTERA		Beetles							
	Cantharidae	Soldier Beetles							
		Cantharis	rustica					1	Common, Widespread
		Rhagonycha	fulva		1	1	1		Common, Widespread
	Cerambycidae	Longhorn Beetles							
		Grammoptera	ruficornis					1	Common, Widespread
		Leptura	melanura		1				Common, Widespread
	Chrysomelidae	Leaf Beetles							
		Sermylassa	halensis			1	1		Common, Widespread
	Coccinellidae	Ladybirds							
		Harmonia	axyridis	Harlequin ladybird			1	1	Common, Widespread
		Subcoccinella	24 - punctata	Twenty-four spot ladybird			1	1	Common, Widespread
	Malachiidae	Pollen Beetles							
		Malachius	bipustulatus		1			1	Common, Widespread
	Oedemeridae	Oedemerid Beetles							
		Oedemera	nobilis		1	1		1	Common, Widespread
	Scarabaeidae	Dung Beetles & chafers							
		Phyllopertha	horticola					1	Common, Widespread

Site 6

ORDER	FAMILY	SCIENTIFIC NAME	ENGLISH NAME	28/06/2019	17/07/2019	07 & 08/08/2019	21/05/2020	STATUS	
ORTHOPTERA	Grasshoppers & Crickets								
		Chorthippus	brunneus	Field grasshopper		1		Common, Widespread	
		Chorthippus	parallelus	Meadow grasshopper		1		Common, Widespread	
		Conocephalus	discolor	Long - winged conehead			1	Common, Widespread	
		Leptophyes	punctatissima	Speckled bush cricket	1	1		Common, Widespread	
		Metrioptera	roeselii	Roesel's bush cricket	1	1	1	Common, Widespread	
		Omocestes	viridulus	Common green grasshopper		1	1	Common, Widespread	
DERMAPTERA	Earwigs								
		Forficula	auricularia	Common earwig			1	Common, Widespread	
HEMIPTERA	True Bugs								
	Pentatomidae	Shield Bugs							
		Palomena	prasina	Green shield bug		1		Common, Widespread	
ODONATA	Dragonflies & Damselflies								
	Coenagriidae	Damselflies							
		Ischnura	elegans	Common blue damselfly	1			Common, Widespread	
	Aeshnidae	Hawkers							
		Aeshna	mixta	Migrant hawker		1		Common, Widespread	
LEPIDOPTERA	Butterflies & Moths								
		Aglais	urticae	Small tortoiseshell		1		Common, Widespread	
		Aphantopus	hyperantus	Ringlet	1			Common, Widespread	
		Argynnis	aglaja	Dark green fritillary		1		Common, Widespread	
		Argynnis	paphia	Silver - washed fritillary			1	Common, Widespread	
		Gonepteryx	rhamni	Brimstone			1	Common, Widespread	
		Lycaena	phlaeas	Small copper			1	Common, Widespread	
		Maniola	jurtina	Meadow brown	1		1	Common, Widespread	
		Melanargia	galathea	Marbled white	1	1		Common, Widespread	
		Neozephyrus	quercus	Purple hairstreak		1	1	Common, Widespread	
		Ochlodes	faunus	Large skipper	1	1		Common, Widespread	
		Pieris	brassicae	Large white			1	1	Common, Widespread
		Pieris	napi	Green - veined white		1		1	Common, Widespread
		Polygonia	c - album	Comma	1		1		Common, Widespread
		Polyommatus	icarus	Common blue			1		Common, Widespread
		Pyronia	tithonus	Gatekeeper		1	1		Common, Widespread
		Thymelicus	lineola	Essex skipper		1	1		Common, Widespread
		Thymelicus	sylvestris	Small skipper		1	1		Common, Widespread
		Vanessa	atalanta	Red admiral	1	1			Common, Widespread
		Calostege	mi	Mother shipton				1	Common, Widespread
	Panomeria	tenebrata	Small yellow underwing				1	Common, Widespread	
	Scotopteryx	chenopodiata	Shaded broad - bar			1		Common Widespread	
	Tyria	jacobaeae	Cinnabar moth	1	1	1		Species of Principal Importance (NERC)	
	Zygaena	filipendulae	Six - spot burnet		1	1		Common Widespread	
DIPTERA	True Flies								
	Tipulidae	Crane Flies							
		Ctenophora	pectinicornis				1	Nationally Scarce N	
		Tipula	lunata				1	Common, Widespread	
	Stratiomyidae	Soldier Flies							
		Chloromyia	formosa		1			Common, Widespread	
	Pachygaster	atra		1			Common, Widespread		
	Rhagionidae	Snipe Flies							

ORDER	FAMILY	SCIENTIFIC NAME	ENGLISH NAME	28/06/2019	17/07/2019	07 & 08/08/2019	21/05/2020	STATUS
		Chrysopilus	asiliformis		1			Common, Widespread
		Rhagio	scolopaceus				1	Common, Widespread
	Asilidae	Robberflies						
		Dioctria	rufipes				1	Common, Widespread
	Bombyliidae	Bee Flies						
		Villa	cingulata	Downland Villa	1			Rare RDB 3
	Syrphidae	Hoverflies						
		Callicera	aurata		1			Nationally Scarce N
		Cheilosia	albitarsis s.l.				1	Common, Widespread
		Cheilosia	illustrata	1	1	1		Common, Widespread
		Cheilosia	soror		1			Common, Widespread
		Chrysotoxum	bicinctum		1			Common, Widespread
		Epistrophe	eligans				1	Common, Widespread
		Episyrphus	balteatus	1	1	1		Common, Widespread
		Eristalis	interruptus				1	Common, Widespread
		Eristalis	pertinax	1	1	1	1	Common, Widespread
		Eumerus	tenax	1	1	1		Common, Widespread
		Eupeodes	luniger	1			1	Common, Widespread
		Helophilus	pendulus	1		1	1	Common, Widespread
		Leucozonia	glaucia		1			Common, Widespread
		Leucozonia	laternaria	1				Common, Widespread
		Melanostoma	mellinum			1		Common, Widespread
		Myathropa	florea			1	1	Common, Widespread
		Platycheirus	albimanus			1	1	Common, Widespread
		Rhingia	campestris			1	1	Common, Widespread
		Sphaerophoria	scripta		1	1		Common, Widespread
		Sphaerophoria	taeniata			1		Common, Widespread
		Syritta	pipiens			1		Common, Widespread
		Syrphus	ribesii	1	1	1		Common, Widespread
		Syrphus	vitripennis	1		1		Common, Widespread
		Tropidia	scita	1			1	Common, Widespread
		Volucella	bombylans	1		1		Common, Widespread
		Volucella	inanis			1		Common, Widespread
		Volucella	inflata	1				Local, Widespread
		Volucella	pelluscens	1	1	1		Common, Widespread
		Volucella	zonaria			1		Common, Widespread
		Xanthogramma	pedisequum		1			Common, Widespread
	Conopidae	Thick - headed Flies						
		Conops	quadrifasciatus			1		Common, Widespread
		Physocephala	rufipes			1		Common, Widespread
		Sicus	ferrugineus	1	1	1		Common, Widespread
	Tephritidae	Picture - winged Flies						
		Acanthiophilus	helianthi			1		Nationally Scarce N
		Chaetorellia	jaceae		1		1	Common, Widespread
		Rhagoletis	alternata		1			Provisionally Nationally Scarce N
		Terellia	longicauda		1	1		Provisionally Nationally Scarce N
		Urophora	jaceana	1	1			Common, Widespread
		Urophora	quadrifasciata	1	1	1		Common, Widespread
	Tachinidae	Tachinid Flies						
		Eriothrix	rufomaculatus			1		Common, Widespread
		Nowickia	ferox			1		Common, Widespread
		Tachina	fera				1	Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME	ENGLISH NAME	28/06/2019	17/07/2019	07 & 08/08/2019	21/05/2020	STATUS
HYMENOPTERA		Bees, Wasps, Ants & Relatives						
	Chrysididae	Cuckoo Wasps						
		Trichrysis	cyanea		1	1		Common Widespread
	Tiphiidae	Tiphiid Wasps						
		Tiphia	femorata			1		Common, Widespread
	Pompilidae	Spider - hunting Wasps						
		Anoplius	nigerrimus			1		Common Widespread
		Dipogon	subintermedius	1				Local Widespread
	Eumenidae	Potter & Mason Wasps						
		Ancistrocerus	scoticus			1		Common, Widespread
		Symmorphus	bifasciatus			1		Local, Widespread
	Crabronidae	Digger Wasps						
		Cerceris	rybyensis		1	1		Common, Widespread
		Crossocerus	cetratus				1	Common, Widespread
		Crossocerus	megacephalus				1	Common, Widespread
		Ectemnius	continuus	1	1	1	1	Common, Widespread
		Ectemnius	lituratus		1	1		Common, Widespread
		Pemphredon	lethifera		1			Common, Widespread
		Psenulus	pallipes		1			Common, Widespread
	Apoidea	Bees						
	Colletidae	Mining & Yellow - faced Bees						
		Hylaeus	communis			1		Common, Widespread
	Andrenidae	Mining Bees						
		Andrena	cineraria				1	Common, Widespread
		Andrena	flavipes			1		Common, Widespread
		Andrena	nigroaenea				1	Common, Widespread
		Andrena	semilaevis	1			1	Common, Widespread
	Halictidae	Mining & Cuckoo Bees						
		Halictus	tumulorum			1	1	Common, Widespread
		Lasioglossum	albipes			1		Common, Widespread
		Lasioglossum	calceatum			1		Common, Widespread
		Lasioglossum	fulvicorne	1				Common, Widespread
	Lasioglossum	leucopus			1		Common, Widespread	
	Lasioglossum	leucozonium			1		Common, Widespread	
	Lasioglossum	malachurum		1			Nationally Scarce Nb	
Mellitidae	Mining Bees							
	Melitta	leporina		1			Provisionally Nationally Scarce N	
Megachilidae	Solitary Bees							
	Chelostoma	florisomne				1	Common, Widespread	
	Coelioxys	elongata		1			Local, Widespread	
	Megachile	ligniseca			1		Common, Widespread	
	Osmia	bicolor				1	Nationally Scarce Nb	
Anthophoridae	Mining & Nomad Bees							
	Nomada	flavoguttata				1	Common, Widespread	
	Nomada	lathburiana				1	Rare RDB 3	
Apidae	Social & Cuckoo Bees							
	Apis	mellifera	Honey bee	1		1	1	Common, Widespread
	Bombus	hortorum	Large garden bumblebee			1		Common, Widespread
	Bombus	hypnorum	Tree bumblebee			1		Recent colonist
	Bombus	lapidarius	Red - tailed bumblebee	1		1		Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	28/06/2019	17/07/2019	07 & 08/08/2019	21/05/2020	STATUS
		Bombus	lucorum	White - tailed bumblebee	1	1	1		Common, Widespread
		Bombus	pascuorum	Common carder bee		1	1		Common, Widespread
		Bombus	pratorum	Early bumblebee	1				Common, Widespread
		Bombus	terrestris	Buff - tailed bumblebee			1		Common, Widespread
COLEOPTERA		Beetles							
	Attelabidae	Weevils							
		Apoderus	coryli		1				Common Widespread
	Cantharidae	Soldier Beetles							
		Cantharis	nigricans					1	Common, Widespread
		Cantharis	rustiica					1	Common, Widespread
		Rhagonycha	fulva			1	1		Common, Widespread
		Rhagonycha	limbata		1			1	Common, Widespread
	Cerambycidae	Longhorn Beetles							
		Grammoptera	ruficornis					1	Common, Widespread
		Rutpela	maculata	Spotted longhorn beetle	1				Common, Widespread
	Chrysomelidae	Leaf Beetles							
		Cassida							Common, Widespread
		Chrysolina							Local, Widespread
		Chrysomela							Local, Widespread
		Donacia							Common, Wetland
	Coccinellidae	Ladybirds							
		Coccinella	7 - punctata	Seven - spot ladybird			1		Common, Widespread
		Harmonia	axyridis	Harlequin ladybird	1	1			Common, Widespread
	Elateridae	Click Beetles							
		Athous	haemorrhoidalis					1	Common, Widespread
	Malachiidae	Pollen Beetles							
		Malachius	bipustluatus					1	Common, Widespread
	Oedemeridae	Oedemerid Beetles							
		Oedemera	nobilis		1			1	Common, Widespread

Site 7

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	28/06/2019	17/07/2019	06 & 07/08/2019	21/05/2020 & 4/6/2020	STATUS
ORTHOPTERA		Grasshoppers & Crickets							
		Chorthippus	brunneus	Field grasshopper		1	1	1	Common, Widespread
		Chorthippus	parallelus	Meadow grasshopper		1	1		Common, Widespread
		Conocephalus	discolor	Long - winged conehead		1	1		Common, Widespread
		Metrioptera	roeseli	Roesel's bush cricket	1	1	1	1	Common, Widespread
		Omocestes	viridulus	Common green grasshopper	1	1	1	1	Common, Widespread
		Stenobothrus	lineatus	Stripe - winged grasshopper			1		Local Widespread
DERMAPTERA		Earwigs							
		Forficula	auricularia	Common earwig	1				Common, Widespread
HEMIPTERA		True Bugs							
	Pentatomidae	Shield Bugs							
		Dolycoris	baccarum	Sloe bug	1			1	Common, Widespread
	Scutelleridae	Tortoise bugs							
		Eurygaster	testudinaria			1	1		Common Widespread
	Aphrophoridae	Froghoppers							
		Cercopis	vulnerata	Common froghopper	1				Common Widespread
ODONATA		Dragonflies & Damselflies							
	Libellulidae	Skimmers, Chasers & Darters							
		Orthetrum	cancellatum	Black - tailed skimmer		1			Common, Widespread
LEPIDOPTERA		Butterflies & Moths							
		Aglais	urticae	Small tortoiseshell		1		1	Common, Widespread
		Aphantopus	hyperantus	Ringlet	1	1			Common, Widespread
		Aricia	agestis	Brown argus	1		1	1	Common, Widespread
		Boloria	euphrosyne	Pearl - bordered fritillary				1	Species of Principal importance (NERC)
		Callophrys	rubi	Green hairstreak				1	Common, Widespread
		Coenonympha	pamphilus	Small heath	1	1		1	Species of Principal Importance (NERC)
		Erynnis	tages	Dingy skipper				1	Species of Principal Importance (NERC)
		Lysandra	coridon	Chalkhill blue		1	1		Local Widespread
		Maniola	jurina	Meadow brown	1	1	1	1	Common, Widespread
		Melanargia	galathea	Marbled white	1	1	1		Common, Widespread
		Ochlodes	faunus	Large skipper	1	1	1		Common, Widespread
		Polygonia	c - album	Comma			1		Common, Widespread
		Polyommatus	icarus	Common blue	1		1	1	Common, Widespread
		Pyronia	tithonus	Gatekeeper		1	1		Common, Widespread
		Thymelicus	lineola	Essex skipper		1	1		Common, Widespread
		Thymelicus	sylvestris	Small skipper		1	1		Common, Widespread
		Vanessa	cardui	Painted lady	1		1		Common, Widespread
		Adscita	geryon	Cistus forester				1	Nationally Scarce Nb
		Odezia	atrata	Chimney sweeper				1	Local, Widespread
		Pleuroptya	ruralis	Mother of pearl		1	1		Common, Widespread
		Scotopteryx	chenopodiata	Shaded broad bar			1		Common, Widespread
		Semiothisa	clathrata	Latticed heath	1			1	Common, Widespread
		Tyria	jacobaeae	Cinnabar moth			1		Species of Principal Importance (NERC)
		Zygaena	filipendulae	Six - spot burnet		1	1		Common, Widespread
DIPTERA		True Flies							
	Stratiomyidae	Soldier Flies							
		Chorisops	tibialis			1			Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	28/06/2019	17/07/2019	06 & 07/08/2019	21/05/2020 & 4/6/2020	STATUS
		Pachygaster	atra			1			Common, Widespread
	Tabanidae	Horse Flies							
		Haematopota	pluvialis	Notch - horned cleg	1				Common, Widespread
	Asilidae	Robber Flies							
		Leptarthrus	brevirostris	Slender - footed robberfly	1				Local Widespread
		Machimus	atricapillus				1		Common, Widespread
		Machimus	rusticus			1			Nationally Scarce N
	Dolichopodidae	Long - headed Flies							
		Dolichopus	trivialis			1			Common, Widespread
	Syrphidae	Hoverflies							
		Cheilosia	illustrata		1				Common, Widespread
		Cheilosia	impressa				1		Common, Widespread
		Cheilosia	scutellata				1		Common, Widespread
		Cheilosia	soror				1		Common, Widespread
		Cheilosia	vulpina				1		Common, Widespread
		Chrysotoxum	bicinctum				1		Common, Widespread
		Dasysyrphus	albostratus				1		Common, Widespread
		Epistrophe	grossulariae		1	1	1		Common, Widespread
		Episyrphus	balteatus		1	1	1	1	Common, Widespread
		Eristalis	arbustorum		1				Common, Widespread
		Eristalis	interruptus			1	1		Common, Widespread
		Eristalis	pertinax				1		Common, Widespread
		Eristalis	tenax		1	1	1		Common, Widespread
		Eupeodes	corollae		1			1	Common, Widespread
		Eupeodes	luniger		1		1		Common, Widespread
		Ferdinandea	cuprea		1		1		Local, Widespread
		Helophilus	pendulus				1		Common, Widespread
		Meliscaeva	auricollis				1		Common, Widespread
		Melanostoma	mellinum			1	1		Common, Widespread
		Melanostoma	scalare				1		Common, Widespread
		Paragus	haemorrhous			1		1	Common, Widespread
		Platycheirus	albimanus		1				Common, Widespread
		Scaeva	pyrastris		1				Common, Widespread
		Sphaerophoria	scripta		1	1	1	1	Common, Widespread
		Syrpna	pipiens					1	Common, Widespread
		Syrphus	ribesii		1	1	1		Common, Widespread
		Syrphus	vitripennis		1	1	1		Common, Widespread
		Volucella	bombylans		1	1		1	Common, Widespread
	Conopidae	Thick - headed Flies							
		Thecophora	atra			1	1	1	Local, Widespread
	Tephritidae	Picture - winged Flies							
		Tephritis	neesii			1			Common, Widespread
		Terellia	longicauda			1	1		Provisionally Nationally Scarce N
		Terellia	ruficauda			1		1	Common, Widespread
		Terellia	serratulae				1		Common, Widespread
		Terellia	tussilaginis			1			Common, Widespread
		Urophora	jaceana			1			Common, Widespread
		Urophora	quadrifasciata				1		Common, Widespread
	Sciomyzidae	Snail Killing Flies							
		Coramacera	marginata		1	1	1		Common, Widespread
		Limnia	unguicornis		1	1			Common, Widespread
		Pherbellia	cinerella		1	1		1	Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	28/06/2019	17/07/2019	06 & 07/08/2019	21/05/2020 & 4/6/2020	STATUS
	Tachinidae	Tachinid Flies							
		Nowickia	ferox				1		Common, Widespread
		Phasia	pusilla			1			Common, Widespread
HYMENOPTER A		Bees, Wasps, Ants & Relatives							
	Tiphiidae	Tiphiid Wasps							
		Tiphia	femorata				1		Common, Widespread
	Pompilidae	Spider - hunting Wasps							
		Anoplius	nigerrimus					1	Common, Widespread
	Vespidae	Social Wasps							
		Dolichovespula	media	Median wasp				1	Nationally Scarce Na
		Vespula	vulgaris	Common wasp	1		1		Common, Widespread
	Crabronidae	Digger Wasps							
		Lindeni	albilabris			1			Common, Widespread
	Apoidea	Bees							
	Andrenidae	Mining Bees							
		Andrena	bicolor			1			Common, Widespread
		Andrena	cineraria					1	Common, Widespread
		Andrena	dorsata				1		Common, Widespread
		Andrena	flavipes				1		Common, Widespread
		Andrena	minutula			1			Common, Widespread
		Andrena	trimmerana				1		Nationally Scarce Nb
	Halictidae	Mining & Cuckoo Bees							
		Halictus	tumulorum		1	1	1	1	Common, Widespread
		Lasioglossum	albipes			1	1		Common, Widespread
		Lasioglossum	calceatum				1		Common, Widespread
		Lasioglossum	fulvicorne		1	1	1	1	Common, Widespread
		Lasioglossum	leucopus				1	1	Common, Widespread
		Lasioglossum	leucozonium		1			1	Common, Widespread
		Lasioglossum	morio			1	1	1	Common, Widespread
		Lasioglossum	pauxillum		1	1			Nationally Scarce Na
		Lasioglossum	villosulum		1			1	Common, Widespread
		Lasioglossum	zonulum				1		Common, Widespread
		Sphecodes	ephippius				1		Common, Widespread
		Sphecodes	geoffrellus					1	Common, Widespread
		Sphecodes	gibbus					1	Common, Widespread
	Mellitidae	Mining Bees							
		Melitta	haemorrhoidalis				1		Provisionally Nationally Scarce N
	Megachilidae	Solitary Bees							
		Osmia	aurulenta					1	Common, Widespread
		Osmia	bicolor		1	1		1	Nationally Scarce Nb
		Osmia	spinulosa		1	1	1	1	Common, Widespread
	Anthophoridae	Flower & Nomad Bees							
		Nomada	flavoguttata				1		Common, Widespread
		Nomada	fucata				1		Nationally Scarce Na
	Apidae	Social & Cuckoo Bees							
		Apis	mellifera	Honey bee	1	1	1	1	Common, Widespread
		Bombus	humilis	Brown - banded carder bee			1		Provisionally Nationally Scarce N and Species of Principal Importance (NERC)
		Bombus	hypnorum	Tree bumblebee	1				Recent colonist
		Bombus	lapidarius	Red - tailed bumblebee	1	1	1	1	Common, Widespread
		Bombus	lucorum	White - tailed bumblebee	1		1		Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	28/06/2019	17/07/2019	06 & 07/08/2019	21/05/2020 & 4/6/2020	STATUS
		Bombus	pascuorum	Common carder bee	1	1	1	1	Common, Widespread
		Bombus	pratorum	Early bumblebee				1	Common, Widespread
		Bombus	terrestris	Buff - tailed bumblebee			1		Common, Widespread
		Bombus	terrestris/lucorum worker	A bumblebee	1	1		1	Common, Widespread
COLEOPTERA		Beetles							
	Cantharidae	Soldier Beetles							
		Cantharis	rustica					1	Common, Widespread
		Rhagonycha	fulva		1	1			Common, Widespread
	Cerambycidae	Longhorn Beetles							
		Leptura	melanura		1				Common, Widespread
	Chrysomelidae	Leaf Beetles							
		Cryptocephalus	aureolus		1		1	1	Local, Widespread
		Cryptocephalus	bipunctatus					1	Nationally Scarce Nb
		Epitrix	atropae					1	Nationally Scarce Nb
	Coccinellidae	Ladybirds							
		Coccinella	7 - punctata	Seven - spot ladybird		1			Common, Widespread
		Propylea	14 - punctata	Fourteen- spot ladybird		1			Common, Widespread
		Subcoccinella	24 - punctata	Twenty - four- spot ladybird		1			Common, Widespread
	Curculionidae	Weevils							
		Cleopomiarus	graminis				1		Nationally Scarce Nb
	Dascillidae	Orchid beetles							
		Dascillus	cervinus		1				Common Widespread
	Oedemeridae	Oedemerid Beetles							
		Oedemera	nobilis		1	1	1	1	Common, Widespread
	Malachiidae	Pollen Beetles							
		Malachius	bipustulatus					1	Common, Widespread
	Mordellidae	Flower Beetles							
		Variimorda	villosa		1				Nationally Scarce Nb
	Scarabaeidae	Dung Beetles & Chafers							
		Omaloplia	ruricola					1	Nationally Scarce Nb
		Phyllopertha	horticola					1	Common, Widespread
MOLLUSCA		Slugs & Snails							
		Helix	pomatia	Roman snail		1	1	1	Schedule 5 protected

Site 8

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	26/06/2019	15/07/2019	06/08/2019	20/05/2020	STATUS
ORTHOPTERA		Grasshoppers & Crickets							
		Chorthippus	brunneus	Field grasshopper			1		Common, Widespread
		Chorthippus	parallelus	Meadow grasshopper		1			Common, Widespread
		Leptophyes	punctatissima	Speckled bush cricket			1		Common, Widespread
HEMIPTERA		Matrioptera	roeselii	Roesel's bush cricket			1		Common, Widespread
		True Bugs							
		Pentatomidae	Shield Bugs						
	Dolycoris	baccarum	Sloe bug				1	Common, Widespread	
LEPIDOPTERA		Butterflies & Moths							
		Aglais	urticae	Small tortoiseshell		1			Common, Widespread
		Aphantopus	hyperantus	Ringlet	1				Common, Widespread
		Aricia agestis	Brown Argus					1	Common, Widespread
		Coenonympha	pamphilus	Small heath				1	Species of Principal Importance (NERC)
		Lycaena	phlaeas	Small copper				1	Common, Widespread
		Maniola	jurtina	Meadow brown	1	1	1		Common, Widespread
		Ochlodes	faunus	Large skipper	1				Common, Widespread
		Pararge	aegeria	Speckled wood		1	1		Common, Widespread
		Pieris	brassicae	Large white		1	1		Common, Widespread
		Pieris	napi	Green - veined white			1	1	Common, Widespread
		Polygonia	c - album	Comma		1			Common, Widespread
		Pyronia	tithonus	Gatekeeper		1			Common, Widespread
		Thymelicus	sylvestris	Small skipper		1			Common, Widespread
		Vanessa	cardui	Painted lady	1				Common, Widespread
		Autographa	gamma	Silver Y				1	Common, Widespread
		Pleuroptya	ruralis	Mother of pearl			1		Common, Widespread
		Petrophora	chlorosata	Brown silver - line				1	Common, Widespread
	Tyria	jacobaeae	Cinnabar moth	1		1		Species of Principal Importance (NERC)	
DIPTERA		True Flies							
		Tipulidae	Craneflies						
			Nephrotoma	flavipalpis				1	Common, Widespread
		Stratiomyidae	Soldier Flies						
			Chloromyia	formosa	1	1			Common, Widespread
			Pachygaster	atra	1	1			Common, Widespread
		Rhagionidae	Snipe Flies						
			Chrysopilus	cristatus	1				Common, Widespread
			Rhagio	tringarius	1	1	1		Common, Widespread
		Tabanidae	Horse Flies						
			Haematopota	pluvialis	Notch - horned cleg	1			Common, Widespread
		Dolichopodidae	Long - headed Flies						
			Poecilobothrus	nobilitatus			1		Common, Widespread
		Syrphidae	Hoverflies						
		Cheilosia	albitarsis				1	Common, Widespread	
		Chrysogaster	solstitialis				1	Common, Widespread	
		Chrysotoxum	bicinctum			1		Common, Widespread	
		Dasysyrphus	albostrigatus				1	Common, Widespread	
		Episyrphus	balteatus	1	1	1		Common, Widespread	
		Eristalis	arbustorum			1		Common, Widespread	

ORDER	FAMILY	SCIENTIFIC NAME	ENGLISH NAME	26/06/2019	15/07/2019	06/08/2019	20/05/2020	STATUS
		Eristalis	interruptus		1	1		Common, Widespread
		Eristalis	pertinax			1		Common, Widespread
		Eristalis	tenax	1		1		Common, Widespread
		Eupeodes	luniger	1				Common, Widespread
		Ferdinandea	cuprea			1		Local, Widespread
		Helophilus	pendulus	1		1		Common, Widespread
		Melanostoma	mellinum		1	1		Common, Widespread
		Platycheirus	albimanus	1				Common, Widespread
		Rhingia	campestris				1	Common, Widespread
		Sphaerophoria	scripta	1	1			Common, Widespread
		Sphaerophoria	taeniata		1			Common, Widespread
		Syritta	pipiens		1	1		Common, Widespread
		Syrphus	ribesii	1	1	1		Common, Widespread
		Syrphus	vitripennis	1				Common, Widespread
		Volucella	pelluscens			1		Common, Widespread
		Volucella	zonaria			1		Common, Widespread
		Xylota	segnis	1				Common, Widespread
	Tephritidae	Picture - winged Flies						
		Tephritis	vespertina	1	1		1	Common, Widespread
		Terellia	tussilaginis			1		Common, Widespread
	Opomyzidae	Opomyzid flies						
		Opomyza	florum			1		Common Widespread
		Opomyza	petrei	1				Common Widespread
	Scathophagidae	Dung flies						
		Scathophaga	atercoraria	1	1			Common Widespread
	Sciomyzidae	Snail Killing Flies						
		Limnia	unguicornis		1		1	Common, Widespread
		Tetanocera	elata	1				Common, Widespread
	Tachinidae	Tachinid Flies						
		Eriothrix	rufomaculatus			1		Common, Widespread
HYMENOPTERA		Bees, Wasps, Ants & Relatives						
	Vespidae	Social Wasps						
		Vespula	germanica	German wasp		1		Common, Widespread
		Vespula	vulgaris	Common Wasp		1		Common, Widespread
	Crabronidae	Digger Wasps						
		Oxybelus	uniglumis		1			Local, Widespread
	Apoidea	Bees						
	Colletidae	Mining & Yellow - faced Bees						
		Hylaeus	communis		1	1		Common, Widespread
		Hylaeus	confusus			1		Common, Widespread
	Halictidae	Mining & Cuckoo Bees						
		Lasioglossum	fulvicorne			1		Common, Widespread
	Apidae	Social & Cuckoo Bees						
		Apis	mellifera	Honey bee		1	1	Common, Widespread
		Bombus	lapidarius	Red - tailed bumblebee	1	1	1	Common, Widespread
		Bombus	lucorum	White - tailed bumblebee			1	Common, Widespread
		Bombus	pascuorum	Common carder bee	1	1	1	Common, Widespread
		Bombus	terrestris	Buff - tailed bumblebee			1	Common, Widespread
		Bombus	lucorum/terrestris worker	a bumblebee	1	1	1	Common, Widespread
COLEOPTERA		Beetles						
	Cantharidae	Soldier Beetles						
		Cantharis	decepiens					Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	26/06/2019	15/07/2019	06/08/2019	20/05/2020	STATUS
		Cantharis	lateralis		1				Common, Widespread
		Cantharis	rustica					1	Common, Widespread
		Rhagonycha	fulva			1	1		Common, Widespread
	Chrysomelidae	Leaf Beetles							
		Epitrix	atropae					1	Nationally Scarce Nb
	Coccinellidae	Ladybird Beetles							
		Coccinella	7 - punctata	Seven spot ladybird				1	Common, Widespread
	Elateridae	Click Beetles							
		Athous	bicolor			1			Common, Widespread
	Malachiidae	Pollen Beetles							
		Malachius	bipustulatus					1	Common, Widespread
	Oedemeridae	Oedemerid Beetles							
		Oedemera	nobilis		1			1	Common, Widespread
	Pyrochroidae	Cardinal Beetles							
		Pyrochroa	coccinea	Black - headed cardinal			1		Nationally Scarce Nb

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ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	27/06/2019	16/07/2019	06/08/2019	STATUS
ORTHOPTERA		Grasshoppers & Crickets						
		Chorthippus	brunneus	Field grasshopper			1	Common, Widespread
		Chorthippus	parallelus	Meadow grasshopper		1	1	Common, Widespread
		Metrioptera	roeselii	Roesel's bush cricket		1	1	Common, Widespread
		Omocestes	viridulus	Common green grasshopper		1	1	Common, Widespread
HEMIPTERA		True Bugs						
	Pentatomidae	Shield Bugs						
		Dolycoris	baccarum	Sloe bug	1			Common, Widespread
LEPIDOPTERA		Butterflies & Moths						
		Aphantopus	hyperantus	Ringlet		1		Common, Widespread
		Aricia agestis	Brown argus				1	Common, Widespread
		Coenonympha	pamphilus	Small heath	1			Species of Principal Importance (NERC)
		Maniola	jurtina	Meadow brown	1	1		Common, Widespread
		Melanargia	galathea	Marbled white	1	1		Common, Widespread
		Pieris	brassicae	Large white		1		Common, Widespread
		Polyommatus	icarus	Common blue	1		1	Common, Widespread
		Pyronia	tithonus	Gatekeeper			1	Common, Widespread
		Thymelicus	lineola	Essex skipper		1		Common, Widespread
		Thymelicus	sylvestris	Small skipper		1		Common, Widespread
		Vanessa	cardui	Painted lady	1	1	1	Common, Widespread
		Agrophylla	tristella				1	Common, Widespread
		Autographa	gamma	Silver Y	1			Common, Widespread
		Chrysoteucella	culmella			1		Common, Widespread
		Epirrhoe	alternata	Common carpet			1	Common, Widespread
		Euclidia	glyphica	Burnet companion	1			Common, Widespread
		Lygephila	pastinum	Blackneck	1			Common, Widespread
		Nemophora	metallica			1	1	Local Widespread
		Syncopacma	larseniella			1		Local Widespread
		Thalpophila	matura	Straw underwing			1	Common, Widespread
		Tyria	jacobaeae	Cinnabar moth		1		Species of Principal Importance (NERC)
		Zygaena	filipendulae	Six - spot burnet			1	Common, Widespread
DIPTERA		True Flies						
	Stratiomyidae	Soldier Flies						
		Chloromyia	formosa		1			Common, Widespread
		Pachygaster	atra		1	1		Common, Widespread
	Tabanidae	Horse Flies						
		Haematopota	pluvialis	Notch - horned cleg	1			Common, Widespread
	Asilidae	Robber Flies						
		Leptogaster	cylindrica		1	1		Common, Widespread
		Machimus	atricapillus			1		Common, Widespread
	Syrphidae	Hoverflies						
		Cheilosia	proxima				1	Common, Widespread
		Episyrphus	balteatus			1		Common, Widespread
		Eristalis	arbustorum				1	Common, Widespread
		Eristalis	tenax		1	1	1	Common, Widespread
		Eupeodes	luniger		1	1		Common, Widespread
		Melangyna	umbellatarum				1	Common, Widespread
		Melanostoma	mellinum				1	Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	27/06/2019	16/07/2019	06/08/2019	STATUS
		Orthonevra	nobilis				1	Common, Widespread
		Pipizella	viduata			1		Common, Widespread
		Platycheirus	albimanus		1	1		Common, Widespread
		Scaeva	pyrastris			1		Common, Widespread
		Sphaerophoria	scripta		1	1	1	Common, Widespread
		Sphaerophoria	taeniata				1	Common, Widespread
		Syrpna	pipiens		1	1		Common, Widespread
		Syrphus	ribesii		1			Common, Widespread
	Conopidae	Thick - headed Flies						
		Sicus	ferrugineus			1		Common, Widespread
		Thecophora	atra				1	Local, Widespread
	Tephritidae	Picture - winged Flies						
		Oxyna	nebulosa			1		Rare RDB 3
		Tephritis	neesii			1		Common, Widespread
		Terellia	ruficauda		1	1		Common, Widespread
		Terellia	tussilaginis			1		Common, Widespread
		Urophora	jaceana		1	1		Common, Widespread
		Urophora	quadrifasciata		1			Common, Widespread
	Opomyzidae	Opomyzid flies						
		Opomyza	germinationis		1			Common Widespread
	Pallopteridae	Pallopterid flies						
		Palloptera	modesta			1		Common Widespread
	Sciomyzidae	Snail Killing Flies						
		Limnia	unguicornis				1	Common, Widespread
	Tachinidae	Tachinid Flies						
		Phasia	obesa		1		1	Common, Widespread
		Tachina	grossa		1			Common, Widespread
HYMENOPTERA		Bees, Wasps, Ants & Relatives						
	Tiphiidae	Tiphiid Wasps						
		Tiphia	femorata				1	Common, Widespread
	Crabronidae	Digger Wasps						
		Cerceris	rybyensis			1	1	Common, Widespread
		Ectemnius	continuus			1		Common, Widespread
	Apoidea	Bees						
	Colletidae	Mining & Yellow - faced Bees						
		Colletes	daviesanus			1		Common, Widespread
		Hylaeus	signatus			1		Nationally Scarce Nb
	Andrenidae	Mining Bees						
		Andrena	bicolor				1	Common, Widespread
		Andrena	dorsata			1		Common, Widespread
		Andrena	minutula			1		Common, Widespread
	Halictidae	Mining & Cuckoo Bees						
		Halictus	tumulorum			1	1	Common, Widespread
		Lasioglossum	albipes		1	1		Common, Widespread
		Lasioglossum	calceatum			1	1	Common, Widespread
		Lasioglossum	fulvicorne		1		1	Common, Widespread
		Lasioglossum	leucopus				1	Common, Widespread
		Lasioglossum	leucozonium				1	Common, Widespread
		Lasioglossum	morio					Common, Widespread
	Megachilidae	Solitary Bees						
		Chelostoma	campanularum			1		Local, Widespread
		Osmia	spinulosa			1		Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	27/06/2019	16/07/2019	06/08/2019	STATUS
	Apidae	Social & Cuckoo Bees						
		Apis	mellifera	Honey bee	1	1	1	Common, Widespread
		Bombus	lapidarius	Red - tailed bumblebee	1	1	1	Common, Widespread
		Bombus	lucorum	White - tailed bumblebee	1		1	Common, Widespread
		Bombus	pascuorum	Common carder bee	1		1	Common, Widespread
		Bombus	terrestris	Buff - tailed bumblebee			1	Common, Widespread
COLEOPTERA		Beetles						
	Cantharidae	Soldier Beetles						
		Rhagonycha	fulva			1	1	Common, Widespread
	Coccinellidae	Ladybirds						
		Subcoccinella	24 - punctata	Twenty - four - spot ladybird			1	Common, Widespread
	Oedemeridae	Oedemerid Beetles						
		Oedemera	nobilis		1			Common, Widespread
	Scarabaeidae	Chafers & Dung Beetles						
		Geotrupes	spiniger				1	Common, Widespread

Site 10

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	27/06/2019	16/07/2019	08/08/2019	20/05/2020 & 05/06/2020	STATUS
ORTHOPTERA		Grasshoppers & Crickets							
		Chorthippus	brunneus	Field grasshopper		1	1		Common, Widespread
		Chorthippus	parallelus	Meadow grasshopper			1		Common, Widespread
		Conocephalus	discolor	Long - winged conehead			1		Common Widespread
		Leptophyes	punctatissima	Speckled bush cricket				1	Common, Widespread
		Metrioptera	roeselii	Roesel's bush cricket		1	1		Common, Widespread
		Omocestes	viridulus	Common green grasshopper	1	1	1	1	Common, Widespread
HEMIPTERA		True Bugs							
	Pentatomidae	Shield Bugs							
		Dolycoris	baccarum	sloe bug	1		1	1	Common, Widespread
	Scutelleridae	Tortoise bugs							
		Eurygaster	testudinaria	Common tortoise bug		1	1		Common Widespread
LEPIDOPTERA		Butterflies & Moths							
		Aglais	urticae	Small tortoiseshell	1				Common, Widespread
		Aphantopus	hyperantus	Ringlet	1	1			Common, Widespread
		Aricia	agestis	Brown argus	1		1	1	Common, Widespread
		Callophrys	rubi	Green hairstreak				1	Common, Widespread
		Coenonympha	pamphilus	Small heath	1	1	1	1	Species of Principal Importance (NERC)
		Erynnis	tages	Dingy skipper				1	Species of Principal Importance (NERC)
		Inachis	io	Peacock			1		Common, Widespread
		Lysandra	coridon	Chalkhill blue			1		Local Widespread
		Maniola	jurtina	Meadow brown	1	1	1	1	Common, Widespread
		Melanargia	galathea	Marbled white	1	1	1		Common, Widespread
		Ochlodes	faunus	Large skipper	1	1	1	1	Common, Widespread
		Pieris	brassicae	Large white				1	Common, Widespread
		Pieris	napi	Green - veined white				1	Common, Widespread
		Polygonia	c - album	Comma			1		Common, Widespread
		Polyommatus	icarus	Common blue	1		1		Common, Widespread
		Pyronia	tithonus	Gatekeeper		1	1		Common, Widespread
		Thymelicus	lineola	Essex skipper		1	1		Common, Widespread
		Thymelicus	sylvestris	Small skipper		1	1		Common, Widespread
		Vanessa	cardui	Painted lady			1		Common, Widespread
		Adscita	geryon	Cistus forester	1			1	Nationally Scarce Nb
		Callistege	mi	Mother Shipton	1			1	Common, Widespread
		Euclidia	glyphica	Burnet companion	1			1	Common, Widespread
		Nemophora	metallica				1		Local Widespread
		Odezia	atrata	Chimney sweeper	1				Common, Widespread
		Pseudopanthera	macularia	Speckled yellow	1			1	Common, Widespread
		Pyrausta	nigrata				1		Common Widespread
		Semiothisa	clathrata	Latticed heath	1				Common, Widespread
		Tyria	jacobaeae	Cinnabar moth	1				Species of Principal Importance (NERC)
		Zygaena	filipendulae	Six - spot burnet			1		Common, Widespread
DIPTERA		True Flies							
	Tipulidae	Craneflies							
		Nephrotoma	flavescens		1				Common Widespread
	Stratiomyidae	Soldier Flies							

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	27/06/2019	16/07/2019	08/08/2019	20/05/2020 & 05/06/2020	STATUS
		Chloromyia	formosa		1	1			Common, Widespread
		Pachygaster	atra				1		Common, Widespread
	Tabanidae	Horse Flies							
		Haematopota	pluvialis	Notch - horned cleg	1	1			Common, Widespread
	Rhagionidae	Snipe Flies							
		Rhagio	tringarius					1	Common, Widespread
	Asilidae	Robber Flies							
		Leptarthrus	brevirostris	Slender - footed robberfly	1				Local Widespread
		Leptogaster	guttiventris		1	1			Local Widespread
	Dolichopodidae	Long - headed Flies							
		Hercostomus	gracilis			1			Common, Widespread
		Sciapus	contristans s.l.			1			Common, Widespread
	Syrphidae	Hoverflies							
		Cheilosia	illustrata		1		1		Common, Widespread
		Cheilosia	proxima				1		Common, Widespread
		Cheilosia	scutellata				1		Common, Widespread
		Cheilosia	vernalis					1	Common, Widespread
		Chrysotoxum	bicinctum		1	1	1	1	Common, Widespread
		Chrysotoxum	festivum				1		Common, Widespread
		Chrysotoxum	verralli			1			Common, Widespread
		Dasysyrphus	venustus		1				Common, Widespread
		Episyrphus	balteatus			1	1	1	Common, Widespread
		Eristalis	arbustorum		1				Common, Widespread
		Eristalis	interruptus					1	Common, Widespread
		Eristalis	pertinax					1	Common, Widespread
		Eristalis	tenax		1		1	1	Common, Widespread
		Eupeodes	corollae		1				Common, Widespread
		Eupeodes	luniger		1		1	1	Common, Widespread
		Helophilus	pendulus					1	Common, Widespread
		Helophilus	trivittatus				1		Common, Widespread
		Leucozona	laternaria				1		Common, Widespread
		Melangyna	compositarum		1		1	1	Common, Widespread
		Meliscaeva	auricollis		1				Common, Widespread
		Melanostoma	mellinum			1	1	1	Common, Widespread
		Melanostoma	scalare				1		Common, Widespread
		Myathropa	florea				1		Common, Widespread
		Orthonevra	nobilis				1		Common, Widespread
		Pipizella	viduata					1	Common, Widespread
		Platycheirus	albimanus		1	1		1	Common, Widespread
		Scaeva	pyrastris		1				Common, Widespread
		Scaeva	selenitica		1				Local, Widespread
		Sphaerophoria	interrupta				1		Common, Widespread
		Sphaerophoria	scripta		1	1	1		Common, Widespread
		Syrpitta	pipiens		1	1	1	1	Common, Widespread
		Syrphus	ribesii		1	1	1		Common, Widespread
		Syrphus	vitripennis		1	1		1	Common, Widespread
		Volucella	bombylans					1	Common, Widespread
		Volucella	pelluscens			1	1		Common, Widespread
		Xanthogramma	pedisequum					1	Common, Widespread
	Tephritidae	Picture - winged Flies							
		Chaetostomella	cylindrica				1		Common, Widespread

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	27/06/2019	16/07/2019	08/08/2019	20/05/2020 & 05/06/2020	STATUS
		Terellia	longicauda			1	1		Provisionally Nationally Scarce N
		Terellia	ruficauda			1			Common, Widespread
		Terellia	tussilaginis			1	1		Common, Widespread
		Urophora	quadrifasciata				1		Common, Widespread
	Ulidiidae	Ulidiid flies							
		Herina	longistylata		1	1			Common Widespread
	Opomyzidae	Opomyzid flies							
		Opomyza	petrei			1			Common Widespread
	Scathophagidae	Dung flies							
		Scathophaga	stercoraria		1				Common Widespread
	Sciomyzidae	Snail Killing Flies							
		Coramacera	marginata			1			Common, Widespread
	Tachinidae	Tachinid Flies							
		Nowickia	ferox			1	1		Common, Widespread
		Phasia	hemiptera				1		Common, Widespread
		Phasia	pusilla					1	Common, Widespread
HYMENOPTERA		Bees, Wasps, Ants & Relatives							
	Chrysididae	Cuckoo Wasps							
		Trichrysis	cyanea		1				Common Widespread
	Tiphiidae	Tiphiid Wasps							
		Tiphia	femorata				1		Common, Widespread
	Vespidae	Social Wasps							
		Vespa							Local, Widespread
		Dolichovespula	media	Median wasp			1		Nationally Scarce Na
		Vespula	germanica	German wasp	1				Common, Widespread
		Vespula	vulgaris	Common wasp		1			Common, Widespread
	Crabronidae	Digger Wasps							
		Crossocerus	megacephalus				1		Common, Widespread
		Ectemnius	lituratus				1		Common, Widespread
		Pemphredon	inornata				1		Common, Widespread
	Apoidea	Bees							
	Andrenidae	Mining Bees							
		Andrena	chrysoceles		1				Common, Widespread
		Andrena	flavipes					1	Common, Widespread
		Andrena	haemorrhoea		1			1	Common, Widespread
		Andrena	nitida		1			1	Common, Widespread
		Andrena	semilaevis					1	Common, Widespread
	Halictidae	Mining & Cuckoo Bees							
		Halictus	tumulorum		1			1	Common, Widespread
		Lasioglossum	albipes		1		1		Common, Widespread
		Lasioglossum	fulvicorne		1		1		Common, Widespread
		Lasioglossum	leucopus			1		1	Common, Widespread
		Lasioglossum	villosulum		1				Common, Widespread
		Sphecodes	rubicundus					1	Nationally Scarce Na
	Mellitidae	Mining Bees							
		Melitta	haemorrhoidalis				1		Provisionally Nationally Scarce N
	Megachilidae	Solitary Bees							
		Megachile	versicolor			1			Common, Widespread
		Osmia	bicolor		1			1	Nationally Scarce Nb
		Osmia	spinulosa		1	1			Common, Widespread
	Apidae	Social & Cuckoo Bees							

ORDER	FAMILY	SCIENTIFIC NAME		ENGLISH NAME	27/06/2019	16/07/2019	08/08/2019	20/05/2020 & 05/06/2020	STATUS
		Apis	mellifera	Honey bee	1	1	1	1	Common, Widespread
		Bombus	hortorum	Garden bumblebee				1	Common, Widespread
		Bombus	hypnorum	Tree bumblebee	1			1	Recent colonist
		Bombus	lapidarius	Red - tailed bumblebee	1	1	1	1	Common, Widespread
		Bombus	lucorum	White - tailed bumblebee			1		Common, Widespread
		Bombus	pascuorum	Common carder bee	1		1		Common, Widespread
		Bombus	pratensis	Early bumblebee				1	Common, Widespread
		Bombus	terrestris	Buff - tailed bumblebee			1		Common, Widespread
		Bombus	terrestris/lucorum worker	a bumblebee	1	1		1	Common, Widespread
COLEOPTERA		Beetles							
	Cantharidae	Soldier Beetles							
		Cantharis	rustica					1	Common, Widespread
		Rhagonycha	fulva			1	1		Common, Widespread
	Cerambycidae	Longhorn Beetles							
		Agapanthia	villosviridescens					1	Local, Widespread
		Leptura	melanura		1				Common, Widespread
		Phytoecia	cylindrica					1	Local, Widespread
	Chrysomelidae	Leaf Beetles							
		Cryptocephalus	aureolus		1	1		1	Local, Widespread
	Coccinellidae	Ladybirds							
		Coccinella	7 - punctata	Seven - spot ladybird	1	1	1		Common, Widespread
		Harmonia	axyridis	Harlequin ladybird	1	1	1		Common, Widespread
		Propylea	14 - punctata	Fourteen - spot ladybird		1			Common, Widespread
	Elateridae	Click Beetles							
		Athous	haemorrhoidalis					1	Common, Widespread
	Malachiidae	Pollen Beetles							
		Malachius	bipustulatus		1				Common, Widespread
	Oedemeridae	Oedemerid Beetles							
		Oedemera	nobilis		1	1	1	1	Common, Widespread
	Scarabaeidae	Chafers & Dung Beetles							
		Omaloplia	ruricola		1				Nationally Scarce Nb
		Phyllopertha	horticola		1			1	Common, Widespread

Appendix 2 Invertebrate Status Definitions and Relevant Legislation

RDB 1 - Endangered

Taxa in danger of extinction and whose survival is unlikely if causal factors continue operating.

- Species which are known or believed to occur as only a single population within one 10km square of the National Grid.
- Species which only occur in habitats known to be particularly vulnerable.
- Species which have shown a rapid or continuous decline over the last twenty years and are now estimated to exist in five or fewer 10km squares.
- Species which are possibly extinct but have been recorded in the 20th century and if rediscovered would need protection.

RDB 2 - Vulnerable

Taxa believed likely to move into the endangered category in the near future if the causal factors continue operating.

- Species declining throughout their range.
- Species in vulnerable habitats.

RDB 3 - Rare

Taxa with small populations that are not at present Endangered or Vulnerable, but are at risk.

- Species which are estimated to exist in only fifteen or fewer post 1970 10km squares. This criterion may be relaxed where populations are likely to exist in over fifteen 10km squares but occupy small areas of especially vulnerable habitat.

Nationally Scarce (Na)

Taxa which do not fall within the RDB categories but which are none - the - less uncommon in Great Britain and thought to occur in 30 or fewer 10km squares of the National Grid.

Nationally Scarce (Nb)

Taxa which do not fall within the RDB categories but which are none - the - less uncommon and thought to occur in between 31 and 100 10km squares of the national Grid.

Nationally Scarce (N)

Species which are estimated to occur within the range of 16 to 100 10km squares.

Local

These species may have a restricted geographical range in the UK, for example a requirement for warmth (southern species - usually denoted by species that occur wholly or mainly South of the Severn - Wash line), or cooler environments (northern species occurring wholly or mainly North of the Severn - Wash line) or upland species occurring only in more montane regions in the UK e.g. Dartmoor, Scottish Highlands or Snowdonia. However, within these geographic ranges such species may occur in some abundance in a variety of habitats. Alternatively, some local species have a wide geographical national distribution but occur only in a specific habitat type due to foraging or nesting requirements. For example, some species breed only in sand, or collect pollen and/or nectar only from plants occurring on chalk grassland or their larval development is dependant upon fen conditions or water seepages. Nonetheless, local species may be abundant within areas supporting their specific requirements, differentiating them from Nationally Scarce or threatened species which often have a combination of very exacting geographical and microhabitat requirements.

Common and Widespread

This denotes species that occur over a wide geographical area in the UK, and which have fairly undemanding requirements in terms of habitat type for larval development. Examples include species which develop in decaying vegetation, feed on aphids, live in stems of scrubby plants with no specific host requirement, feed on a variety of grasses or develop in any type of water body (even puddles). Alternatively, they may be mass migrants from continental Europe - some hoverflies e.g. *Episyrphus balteatus* or some common *Eupeodes* species arrive in millions each year and have no exacting habitat requirements.

Species of Principal Importance in England

The Natural Environment and Rural Communities (NERC) Act came into force on 1st October 2006. Section 41 (S41) of the Act requires the Secretary of State to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. The England Biodiversity List is used to guide decision-makers such as public bodies, including local and regional authorities, in implementing their duty under section 40 of the NERC Act 2006, to have regard to the conservation of biodiversity in England, when carrying out their normal functions. There are currently 413 terrestrial invertebrate species of principal importance included on the England Biodiversity List.

Wildlife and Countryside Act 1981 (as amended)

A number of invertebrate species are listed Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) (see table below). Large blue, Fisher’s estuarine moth and Snail, Lesser Whirlpool Ram’s-horn Schedule 2 of the Conservation of Habitats and Species Regulations 2017. Where species are listed as fully protected under Schedule 5 of the Wildlife and Countryside Act or under Schedule 2 of the Conservation of Habitats and Species Regulations it is an offence to:

- Deliberately capture, injure or kill any such animal;
- Deliberately disturb any such animal, including in particular any disturbance which is likely:
 - To impair its ability to survive, breed, or rear or nurture their young;
 - To impair its ability to hibernate or migrate;
 - To affect significantly the local distribution or abundance of that species;
- Damage or destroy a breeding site or resting place of any such animal;
- Intentionally or recklessly disturb any of these animals while it is occupying a structure or place that it uses for shelter or protection; or
- Intentionally or recklessly obstruct access to any place that any of these animals uses for shelter or protection.

The following species are listed Schedule 5 of the Wildlife and Countryside Act 1981:

Scientific Name	English Name	Sections of Act Applicable
<i>Apatura iris</i>	Purple emperor	Sale only S.9(5)
<i>Argynnis adippe</i>	High brown fritillary	Full protection
<i>Aricia artaxerxes</i>	Northern brown argus	Sale only S.9(5)
<i>Boloria euphrosyne</i>	Pearl-bordered fritillary	Sale only S.9(5)
<i>Carterocephalus palaemon</i>	Chequered skipper	Sale only S.9(5)
<i>Coenonympha tullia</i>	Large heath	Sale only S.9(5)
<i>Cupido minimus</i>	Small blue	Sale only S.9(5)
<i>Erebia epiphron</i>	Mountain ringlet	Sale only S.9(5)
<i>Eurodryas aurinia</i>	Marsh fritillary	Full protection
<i>Hamearis lucina</i>	Duke of Burgundy	Sale only S.9(5)
<i>Hesperia comma</i>	Silver-spotted	Sale only S.9(5)
<i>Leptidea sinapis</i>	Wood white	Sale only S.9(5)

Scientific Name	English Name	Sections of Act Applicable
<i>Lycaena dispar</i>	Large copper	Full protection
<i>Lysandra bellargus</i>	Adonis blue	Sale only S.9(5)
<i>Lysandra coridon</i>	Chalkhill blue	Sale only S.9(5)
<i>Maculinea arion</i>	Large blue	Full protection
<i>Melitaea cinxia</i>	Glanville fritillary	Sale only S.9(5)
<i>Mellicta athalia</i>	Heath fritillary	Full protection
<i>Nymphalis polychloros</i>	Large tortoiseshell	Sale only S.9(5)
<i>Papilio machaon</i>	Swallowtail	Full protection
<i>Plebejus argus</i>	Silver-studded blue	Sale only S.9(5)
<i>Strymonidia pruni</i>	Black hairstreak	Sale only S.9(5)
<i>Strymonidia w-album</i>	White-letter hairstreak	Sale only S.9(5)
<i>Thecla betulae</i>	Brown hairstreak	Sale only S.9(5)
<i>Thymelicus acteon</i>	Lulworth skipper	Sale only S.9(5)
Moths		
<i>Acosmetia caliginosa</i>	Reddish buff	Full protection
<i>Bembecia chrysidiformis</i>	Fiery clearwing	Full protection
<i>Gortyna borelii</i>	Fisher's estuarine moth	Full protection
<i>Pareulype berberata</i>	Barberry carpet	Full protection
<i>Siona lineata</i>	Black-veined	Full protection
<i>Thalera fimbrialis</i>	Sussex emerald	Full protection
<i>Thetidia smaragdaria</i>	Essex emerald	Full protection
<i>Zygaena viciae</i>	New Forest burnet	Full protection
Beetles		
<i>Chrysolina cerealis</i>	Rainbow leaf beetle	Full protection
<i>Curimopsis nigrita</i>	Mire pill beetle	Damage/destruction of place of shelter/protection S.9(4)(a) only
<i>Graphoderus zonatus</i>	Water beetle	Full protection
<i>Hydrochara caraboides</i>	Lesser silver water beetle	Full protection
<i>Hypebaeus flavipes</i>	Beetle	Full protection
<i>Limoniscus violaceus</i>	Violet click beetle	Full protection
<i>Lucanus cervus</i>	Stag beetle	Sale only S.9(5)
<i>Paracymus aeneus</i>	Water beetle	Full protection
Hemipteran bugs		
<i>Cicadetta montana</i>	New Forest cicada	Full protection
Crickets		
<i>Decticus verrucivorus</i>	Wart-biter	Full protection
<i>Gryllotalpa gryllotalpa</i>	Mole cricket	Full protection
<i>Gryllus campestris</i>	Field cricket	Full protection

Scientific Name	English Name	Sections of Act Applicable
Dragonflies		
<i>Aeshna isosceles</i>	Norfolk aeshna	Full protection
<i>Coenagrion mercuriale</i>	Southern damselfly	Full protection
Spiders		
<i>Dolomedes plantarius</i>	Fen raft spider	Full protection
<i>Eresus niger (cinaberinus)</i>	Ladybird spider	Full protection
Crustaceans		
<i>Austropotamobius pallipes</i>	White-clawed crayfish	Taking S.9(1) (part); sale S.9(5)
<i>Chirocephalus diaphanus</i>	Fairy shrimp	Full protection
<i>Gammarus insensibilis</i>	Lagoon sand shrimp	Full protection
<i>Triops cancriformis</i>	Apus	Full protection
Molluscs		
<i>Atrina fragilis</i>	Fan mussel	Killing & injuring S.9(1); possession S9(2); sale S.9(5)
<i>Caecum armoricum</i>	De Folin's lagoon snail	Full protection
<i>Catinella arenaria</i>	Sandbowl snail	Full protection
<i>Margaritifera margaritifera</i>	Pearl mussel	Full protection
<i>Myxas glutinosa</i>	Glutinous snail	Full protection
<i>Paludinella littorina</i>	Lagoon snail	Full protection
<i>Tenellia adpersa</i>	Lagoon sea slug	Full protection
<i>Thyasira gouldi</i>	Northern hatchet-shell	Full protection
<i>Helix pomatia</i>	Roman Snail	in respect of section 9(1), (2) and (5) only and with respect to England only

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.21
Roman Snail Survey Technical Report 2019

28 September 2020

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Foreword

This report investigates the presence of Roman snails in suitable habitat up to 2 km from the proposed scheme. It presents the results of day scoping assessments and nocturnal torchlight surveys for Roman snails carried out in 2019. The report also includes incidental records from 2018 and 2019, and the results of a 2017 desk study.

Executive Summary

This report sets out the results of the Roman snail surveys undertaken in 2019 to provide baseline data for the species up to 2 kilometres of the proposed scheme.

Two recent records (within the past 15 years) of Roman snail were returned from within the 2km search radius by GCER in 2017 and four in 2020. Day scoping assessments identified suitable habitat for Roman snail within the proposed scheme boundary. Nocturnal surveys identified the presence of Roman snail at two discrete locations: Location 1: Cold Slad Lane, north of the A417; and Location 2: Birdlip Quarry (disused). Incidental records of Roman snail/shells have also been identified to the south of Location 1 and the A417 near Grove Farm and within Crickley Hill SSSI.

Access limitations prevented the entire proposed scheme being surveyed. For this reason, presence is assumed in unsurveyed habitats considered reasonably likely to support Roman snail based upon habitat type (with reference to aerial imagery and existing Phase 1 habitat data) and connectivity to habitats where presence is confirmed.

1 Introduction

1.1 Purpose of this Document

1.1.1 The objectives of this report are to collate and review existing records for Roman snails *Helix pomatia* within 2 kilometres of the proposed scheme, and to present the methods, constraints and findings of field surveys for Roman snails undertaken in 2019. Based on this data, an assessment of the potential impacts of the proposed scheme on Roman snail will be provided.

1.2 Legislation

1.2.1 The Roman snail is included within Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). It is protected in relation to Section 9(1), (2) and (5), making it an offence to:

- intentionally kill, injure or take (including taking by hand) a Roman snail;
- possess or control a live or dead Roman snail, or any part of one; or
- sell, offer for sale or advertise for, live or dead Roman snails.

1.2.2 Licences are available from Natural England to allow activities that would otherwise cause an offence. There is no provision under the Act to issue licences for the purpose of development; however, in some development circumstances, Natural England will consider issuing a licence to allow the taking and translocation of Roman snail under the conservation purpose provided in the Act. If a conservation licence is sought, the following tests would need to be satisfied:

- the activity proposed is lawful, with relevant planning permission granted;
- the development and the likely impacts on Roman snails could not have reasonably been avoided; and
- the translocation of Roman snail would produce a conservation benefit. As a minimum, a demonstration of no loss or decline of the Roman snail population is required.

1.3 Status of Roman snails at the national level

1.3.1 Roman snail is a naturalised species to the UK, primarily found on the North Downs, the Chilterns and the Cotswolds and Mendip Hill fringes (see Figure 1). The species is thought to have suffered a historical decline as a result of habitat loss and deterioration of calcareous grassland and of taking for consumption¹. Roman snails are vulnerable to habitat loss as they have slow rates of reproduction and poor powers of natural dispersal².



Figure 1 Distribution map for the Roman snail, Kerney (1999)

1.4 Roman snail ecology

- 1.4.1 Within the UK, Roman snails are strongly associated with lime-rich, loose, free-draining soils. They inhabit steep scarp slopes and valley sides, the grassland margins of wood, on broad woodland rides or in mixed scrub and grassland and on railway cuttings, chalk pits and hedges, with a preference for south-facing slopes³. While the species will favour dense, tall vegetation which provides cover from predation, open ground is also required for egg-laying behaviour which involves burrowing down into friable soils to create hatcheries⁴.
- 1.4.2 Roman snails are normally active from May to August (although warm and wet weather can extend this timeframe) with a peak in activity in May and June⁴. Mating will occur from May onwards and can occur several times throughout the active season. Reproductive success is low and UK populations are observed to feature a small proportion of juvenile snails⁴.

- 1.4.3 Roman snails tend to aggregate in high numbers and typically will only travel within a 30m radius in their lifetimes, this low dispersal is likely to explain the absence of Roman snail from habitats which seem to be suitable³. Weather has a marked effect upon activity levels of the species with warm humid weather producing the highest activity levels³ and the greatest activity levels of adult Roman snails may be observed on humid summer days while the juveniles are typically more nocturnal⁴.
- 1.4.4 Roman snails hibernate over winter when temperatures become colder in excavated holes under dead vegetation such as grass and leaf litter⁴, remaining in hibernation until spring.

2 Methodology

2.1 Desk study

- 2.1.1 Roman snail record data within 2 kilometres of the proposed scheme boundary were obtained from the Gloucestershire Centre for Environmental Records Centre (GCER) in February 2017. An update to this desk study was requested in December 2019 and received in January 2020.

2.2 Field survey

- 2.2.1 There is currently no standardised or published survey methodology for Roman snail. However, from discussions with Natural England, it is understood that a combination of a daytime search and nocturnal torchlight survey in suitable weather conditions is sufficient to enable an assessment of presence or probable absence of Roman snail at a site. It is considered good practice that nocturnal surveys are undertaken in wet weather or within 24 hours following rainfall and not in temperatures exceeding 25°C⁵.
- 2.2.2 All surveys were undertaken by experienced Arup ecologists: Alys Black, Steven Mills, Hannah Whitfield and Livvy Cropper. Any survey techniques that involved temporarily taking snails (i.e. picking up for examination) were undertaken by Alys Black who is an experienced Roman snail surveyor and licence holder (Licence number 2019-40095-SCI-SCI).
- 2.2.3 Walkover surveys of all accessible potentially suitable habitat within the proposed scheme were carried out between 01 and 15 of October 2019. Weather data and survey dates are provided in Appendix A, Table 2. Surveyed habitats typically included grassland margins along field boundaries, hedgerows, woodland and a disused quarry. Where possible, a daytime hand search of suitable habitats was carried out at this time. Areas of habitat with limited suitability for Roman snail were also identified at this time and discounted from further survey. Some areas of land were not subject to specific daytime searches as the areas had already been visited several times by Arup ecologists during the summer of 2019 for other surveys. Where sufficient information was available from other ecology surveys to conclude that habitats were unlikely to support Roman snail, further daytime habitat assessments were deemed unnecessary.
- 2.2.4 Where live snails and/or shells were not encountered during the daytime survey, but habitat was considered suitable for Roman snail, a subsequent nocturnal torchlight survey was undertaken to determine presence or likely absence. The torchlight surveys were carried out between 14 and 17 of October 2019.

2.2.5 The daytime surveys consisted of systematically assessing habitats to record their suitability for supporting Roman snails as well as performing visual searches for snails and carrying out hand searches where possible. The torchlight surveys focussed upon hand searching through ground vegetation, parting dense areas by hand. Any live snails and shells which were encountered were recorded. The tendency for Roman snail to aggregate³ makes hand searching a viable survey technique.

2.3 Survey constraints

2.3.1 Access from landowners was not secured at several land parcels within the proposed scheme to facilitate these surveys. Due to health and safety concerns (being adjacent to roads or on dangerous terrain) it was not possible to access several land parcels. Habitat not surveyed is shown on PEI Report Figure 8.13

2.3.2 Within land parcels where access was possible, some areas of very dense vegetation could not be fully searched. Where Roman snails have not been identified during the surveys, this does not guarantee absence. However, it is considered that sufficient survey effort was employed to ascertain presence or likely absence.

2.3.3 Surveys were carried out in October and the species is most active from May to August. However, conversations with the Natural England invertebrate specialist have confirmed that surveys in October are valid, if carried out under suitable weather conditions. The surveys *were* carried out under suitable weather conditions (either during or after rain and in suitable temperatures) however it should be noted that lower numbers of snails may have been recorded than would be evident earlier in the active season.

3 Results

3.1 Desk study

3.1.1 The 2017 data search as part of this assessment returned two records for Roman snail. One originates from Ullenwood (2016) 503m north and one from Witcombe Wood (2009) 954m west of the proposed scheme. The 2019 data search as part of this assessment returned four records for Roman snail. One originates from within the proposed scheme adjacent to Dog Lane (2019) and is for 6 – 20 snails found on a footpath in Crickley Hill (2019) and another is also for 6-20 snails within the proposed scheme at Crickey Hill (2018). One originates from within the proposed scheme in proximity to the Birdlip Quarry (disused) (2019) and one from Ullenwood (2019) approximately 1.9km north.

3.2 Field survey

3.2.1 The proposed scheme comprises a range of grassland habitats with scrub, coniferous and broadleaved woodland and ruderal vegetation also present in addition to areas of hard standing. Areas accessed and included in the field survey are shown on the Roman Snail Survey Extent Plan in PEI Report Figure 8.13. The suitability of the habitats accessed is shown on Roman Snail Survey Results Plan in PEI Report Figure 8.14.

3.2.2 No Roman snail were found during the day scoping surveys. Roman snails were identified in two separate locations during nocturnal torchlight surveys:

- Location 1: Cold Slad Lane
- Location 2: Birdlip Quarry (disused)

3.2.3 The locations where Roman snails were recorded during the survey are shown in the A.2 Roman Snail Survey Results at PEI Report Figure 8.14. The results are summarised below, with photographs showing typical habitats present at each location at Appendix B. Grid references for the snail locations are also shown in Table 1.

Table 1 Grid references for Roman snails found during nocturnal surveys

Site	Grid Reference	Live Adults	Live Juveniles	Adult Shells	Juvenile Shells
Cold Slad Lane	51.841410, - 2.107694	0	0	2	0
Cold Slad Lane	51.841031, - 2.107054	0	0	2	0
Cold Slad Lane	51.839618, - 2.108701	0	0	1	0
Cold Slad Lane	51.841097, - 2.107982	0	0	1	0
Cold Slad Lane	51.841335, - 2.108008	0	0	2	0
Cold Slad Lane	51.841540, - 2.108268	0	0	2	0
Cold Slad Lane	51.841312, - 2.108344	0	0	1	0
Cold Slad Lane	51.841307, - 2.108272	0	0	3	0
Cold Slad Lane	51.840483, - 2.107794	0	0	12	0
Cold Slad Lane	51.840726, - 2.106027	0	0	2	0
Cold Slad Lane	51.841146, - 2.107431	3	0	0	0
Birdlip Quarry	51.821897,- 2.0782994	0	1	0	1

Location 1 – Cold Slad Lane

3.2.4 During nocturnal torchlight surveys, adult Roman snails and shells were recorded within the study area in the woodland block south of Cold Slad Lane in addition to the tussocky grassland fields leading down to the A417. Shells were also identified beyond a coniferous woodland block, directly adjacent to the A417. Overall, three live adult Roman snails and 28 adult snail shells were found within the location. These were found spread throughout, in both the woodland and grassland habitats.

Location 2 – Birdlip Quarry (disused)

3.2.5 No adult Roman snails or shells were identified during the nocturnal torchlight surveys. One live juvenile and one juvenile shell were identified within the

grassland habitats towards the north of the quarry site and adjacent to the proposed scheme boundary during the nocturnal survey.

3.3 Incidental records

3.3.1 Several incidental records of Roman snails have been reported within the proposed scheme between 2018 and 2020. These are provided within PEI Report Figure 8.14, unless otherwise specified in the description of these records below.

- Roman snails were identified within the proposed scheme area in 2018 during other surveys. Seventeen records were reported at Location 1 and within the Crickley Hill SSSI.
- Roman snails were identified at Location 1 during a walkover of the site on 09 August 2019 by Alys Black and Hannah Whitfield in relation to planned ground investigation works. Twenty-eight live adult snails and eight adult shells were recorded.
- Roman snails were identified at Location 1 during vegetation clearance (under Ecological Clerk of Works) on 12 and 13 September 2019 to facilitate the ground investigation works. Sixteen adult Roman snails and 11 juveniles were found at Location 1. No grid references were recorded for these incidental records and they are not represented within the mapping. Photographs are provided at Appendix B.
- Roman snail shells were identified at 19 locations during invertebrate surveys carried out between June and August 2019, at and to the south of Location 1 and within the Crickley Hill SSSI.
- Roman snails (21 adults) were identified at one location during invertebrate surveys carried out in June 2020, to the north of Cold Slad Lane.

4 Conclusion

4.1.1 Roman snail has been confirmed in two discrete locations within the proposed scheme during surveys in 2019. Adults, juveniles and shells were found at Location 1 (Cold Slad Lane, north of the A417) and a juvenile snail and a juvenile shell at Location 2 (The Birdlip Quarry (disused)). Incidental records of Roman snail/shells have also been identified between 2018 and 2020 at Location 1 and the surrounds, and shells to the south of the A417 near Grove Farm and within the Crickley Hill SSSI.

4.1.2 Access limitations prevented the entire proposed scheme being surveyed. For this reason, presence is assumed in unsurveyed habitats considered reasonably likely to support Roman snail based upon habitat type (with reference to aerial imagery and existing Phase 1 habitat data) and connectivity to habitats where presence is confirmed. Suitable habitats for Roman snail are present at various locations throughout the proposed scheme. This habitat mainly comprises long undisturbed, tussocky grassland, rough grassland and broadleaved or mixed woodland.

4.1.3 The Roman snail is protected from being intentionally killed or injured under The Wildlife & Countryside Act 1981 (as amended). Therefore, any works which intentionally or caused harm to Roman snails would be illegal. If development proposals will impact land that supports Roman Snail, or is likely to support Roman snail, then a mitigation strategy and licence from Natural England is likely to be required in order to avoid an offence. Any translocation of Roman snail

should provide a conservation benefit. As a minimum, a demonstration of no loss or decline of the Roman snail population is required.

- 4.1.4 Under the current design, habitats with confirmed and assumed Roman snail presence will necessarily be lost and there are no alternative proposals that would have a lesser impact upon the species. It is anticipated that it will be possible to retain the majority of the confirmed habitat at Location 1, however some losses will occur in the habitats directly adjacent to the A417 at this location. In addition, it is anticipated that significant losses will be necessary at the confirmed habitat at Location 2. Losses are also anticipated in adjacent assumed habitats. Detailed impact assessment and mitigation measures will be addressed in the Biodiversity chapter of the Environmental Statement.

References

- ¹ Joint Nature Conservation Committee (2007) Second Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2001 to December 2006. Peterborough: JNCC. Available from: www.jncc.gov.uk/article17. Accessed on 07/11/19
- ² Kerney M P (1999) The Atlas of the Land & Freshwater Molluscs of Britain and Ireland. Harley Books, Colchester
- ³ Pollard E (1975) Aspects of the Ecology of *Helix pomatia* L. Journal of Animal Ecology, 44: 305-329th
- ⁴ Alexander K N A (1994) The Roman Snail *Helix pomatia* L in Gloucestershire and its conservation. The Gloucestershire Naturalist 7: 9
- ⁵ Natural England Technical Information Note TIN103: Roman Snails and Development (2011)

Appendices

Appendix A Weather data and survey dates

Table 2 Weather conditions during Roman snail surveys

Date	Survey Type	Surveyors	Weather Conditions
05/08/2019	Day Scoping Survey	Alys Black, Hannah Whitfield	11°C, 80% cloud cover, no precipitation, wind 3 (Beaufort scale)
23/09/2019	Day Scoping Survey	Hannah Whitfield	14°C 20% cloud cover, no precipitation, wind 5 (Beaufort scale)
01/10/2019	Day Scoping Survey	Alys Black, Hannah Whitfield	15°C, 60% cloud cover, light precipitation, wind 4 (Beaufort scale)
02/10/2019	Day Scoping Survey	Alys Black, Hannah Whitfield	9°C, 10% cloud cover, no precipitation, wind 3 (Beaufort scale)
09/10/2019	Torchlight Survey	Alys Black, Hannah Whitfield	9°C, 60% cloud cover, no precipitation, wind 3 (Beaufort scale)
11/10/2019	Day Scoping Survey	Steven Mills, Hannah Whitfield	14°C, 100% cloud cover, light precipitation, wind 5 (Beaufort scale)
14/10/2019	Torchlight Survey	Steven Mills, Hannah Whitfield	10°C, 100% cloud cover, no precipitation, wind 1 (Beaufort scale)
15/10/2109	Day Scoping Survey	Livvy Cropper, Hannah Whitfield	10°C, 100% cloud cover, no precipitation, wind 2 (Beaufort scale)
16/10/2019	Torchlight Survey	Alys Black, Hannah Whitfield	12°C, 80% cloud cover, no precipitation, wind 1 (Beaufort scale)
17/10/2019	Torchlight Survey	Steven Mills, Hannah Whitfield	10°C, 50% cloud cover, no precipitation, wind 1 (Beaufort scale)

Appendix B Site photographs

Photographs of the habitats within Locations 1 and 2 and Roman snails found during field visits in summer 2019



Photograph 1 – Typical grassland habitats within Location 1



Photograph 2 – Typical habitat within Location 1



Photograph 3 – Roman snail at Location 1



Photograph 4 – Typical habitat within Location 2



Photograph 5 – Typical habitat within Location 2



Photograph 6 – Juvenile Roman snail at Location 2

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.22
Aquatic Invertebrate Survey Report

28 September 2020

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Foreword

The section of the A417 near Birdlip, known as the A417 Missing Link, forms the only section of single carriageway on the A417 and is located in the Cotswolds Area of Outstanding Natural Beauty (AONB). The single carriageway section exists between the Brockworth bypass and the Cowley roundabout. This section regularly experiences congestion, causing delays and pollution. This scheme aims to improve journey times and safety issues associated with this section of the road network.

This report sets out the results of aquatic invertebrate field surveys undertaken in November 2019 and May 2020. The objective of these 2019 and 2020 surveys was to collect quantifiable data from Norman's Brook as it is being realigned by the scheme. Desk study data from the River Frome, River Churn, Horsbere brook and Painswick stream also informs the assessment. This report should be read in conjunction with the other aquatic survey reports associated with the scheme (namely the 2020 Fish Habitat Appraisal Report, 2019 White-Clawed Crayfish Technical Report, 2019 Great Crested Newt Survey Report, 2019 Otter Report and 2019 Water Vole Report) to gain a full appreciation of the overall aquatic and semi-aquatic species assemblages across the scheme.

Executive summary

The scheme would provide 3.4 miles (5.5km) of new dual carriageway for the A417; PEI report Figure 2.1-General Arrangement. The new dual carriageway would connect the existing A417 Brockworth bypass with the existing dual carriageway on the A417, south of Cowley, known as the A417 Missing Link. This scheme aims to improve journey times and safety issues associated with this section of the road network. This report presents the methodology and baseline survey data recorded from review of environmental records from 2000 to 2019 and field surveys conducted in 2019 to 2020 across the scheme.

Following a record search, 13 species of conservation value were found within the scheme and wider river network.

Baseline invertebrate samples were taken from seven sites using industry standard kick sampling and manual hand-searching methods in line with best practice (European Committee of Standardisation, 2014).

Baseline data identified the presence of nationally notable invertebrate species in Norman's Brook and tributaries of the River Churn. The invasive non-native species (INNS) signal crayfish was recorded in tributaries of the River Frome and the River Churn. Invertebrate community conservation value ranged from low to very high across the survey sites.

All sites should be subject to further survey and it is advised that field surveys in autumn 2020 occur in the specified sites to inform the understanding of local WFD status under UKTAG guidelines.

A complete assessment of potential impacts to macroinvertebrate communities will be undertaken within the Environmental Impact Assessment for the scheme, along with details of mitigation such as alternative habitat creation, and compensation measures as appropriate.

1 Introduction

1.1 Purpose of this document

- 1.1.1 This document is a report which details baseline data for aquatic macroinvertebrates collected from desk studies and field survey carried out in autumn 2019 and spring 2020. This report informs the Ecological Impact assessment (EclA) and Water Framework Directive Assessment (WFDA) of the A417 Missing Link Scheme 'the scheme'.

1.2 Scope of the report

- 1.2.1 This technical report outlines the survey scoping, methodology and results for aquatic macroinvertebrates for the scheme. It is beyond the scope of this report to outline an assessment of effects or detail the need for measures to avoid or mitigate effects on the ecological features discussed. These will be addressed in the Biodiversity chapter of the PEI report.

2 Methodology

2.1 Overview

2.1.1 Details of the methodology used for establishing the ecological baseline for aquatic macroinvertebrates are provided below.

2.2 Survey guidance

2.2.1 The following survey guidance has been considered in the methodology design. Any deviation from this guidance is noted in section 2.4.

2.2.2 Best practice guidance for the undertaking of aquatic macroinvertebrate surveys and assessment provided in BS EN ISO 10870:2012 (European Committee of Standardization, 2014).

2.2.3 Macroinvertebrate sampling and taxonomic analysis was undertaken in accordance the Environment Agency's standard macroinvertebrate sampling and analysis manual – BT001 (Murray-Bligh, 1999) and standard River Invertebrate Prediction and Classification System (RIVPACS) procedures (EU-STAR, 2004).

2.2.4 Macroinvertebrate sample analysis was undertaken to RIVPACS Taxonomic Level 5 (TL5), as described in the SNIFFER (Scotland and Northern Ireland Forum for Environmental Research) document Further Development of River Classification Tool (Davy-Bowker et al., 2010).

Desk study

2.2.5 Macroinvertebrate data was obtained via a data request from the Environment Agency (EA). Data was requested from six waterbodies which either fall within the scheme or within the wider river network. The desk study documents any notable and protected macroinvertebrates present in this EA data.

2.2.6 Data was received from the following sites:

- River Churn - source to Perrots Brook (WFD ID: GB106039029810);
- River Frome - source to Ebley Mill (WFD ID:GB109054032470);
- Horsebere Brook - source to confluence River Severn (WFD ID: GB109054032760);
- Hatherley Brook – source to River Severn (WFD ID: GB109054032801);
- Painswick Stream - source to confluence Stroudwate (WFD ID: GB109054032460); and
- Norman's Brook - source to confluence Hatherley Brook (WFD ID: GB109054032780).

2.3 Survey scoping and design

2.3.1 Prior to field surveys commencing, scoping activities were undertaken by the aquatic ecology lead for the project to identify rivers and streams within the scheme boundary (PEI report Figure 2.1) and the wider river network. Scoping activities included site visits, a review of desk study information, Ordnance Survey mapping, aerial imagery, available information on the scheme and consultation with various stakeholders including the EA, Natural England and Highways England.

2.3.2 In order to determine the baseline condition for macroinvertebrates, seven sites were selected based on the results of scoping. This forms the Macroinvertebrate Survey Area (PEI report Figure 8.21). Survey sites were selected to be

representative of the rivers within the scheme boundary and wider river network and located to capture the spatial variation in habitat available within these localities.

2.3.3 The following waterbodies were identified as requiring field surveys for macroinvertebrates:

- Norman's Brook:
 - 3 sites surveyed
- Tributary of the River Churn:
 - 2 sites surveyed
- Tributary of the River Frome:
 - 2 sites surveyed

2.3.4 Survey locations are shown in PEI report Figure 8.21 and the Table 2.1 below.

Table 2.1 Sample sites, associated waterbodies and grid references where field surveys occurred in 2019

Sample site	Waterbody	NGR
AQ1	Norman's Brook	SO 91322 16454
AQ2	Norman's Brook	SO 92512 15678
AQ3	Tributary of River Frome	SO 94387 13340
AQ4	Tributary of River Frome	SO 94678 12757
AQ5	Tributary of River Churn	SO 96441 15529
AQ6	Tributary of River Churn	SO 95009 16256
AQ7	Norman's Brook	SO 92690 15698

2.3.5 To enable an integrated understanding of the aquatic ecology baseline, where practicable, macroinvertebrate survey sites were aligned with surface water quality monitoring locations and hydrological monitoring locations. Observations from River Habitat Surveys (RHS) undertaken in 2019 were also used to identify appropriate macroinvertebrate sampling sites. This information was used to identify the presence of pools, riffles, flowing water biotypes and to determine whether these biotypes were representative of the wider reach being assessed.

2.3.6 Due to a lack of records within the scheme boundary, EA desk study data (PEI Report Figure 8.20), was also included to provide further understanding of the catchments in proximity of the scheme. This includes data from two waterbodies;

- Painswick Stream; and
- Horsbere Brook.

2.4 Field survey methodology

Field surveys

2.4.1 In accordance with British Standards (BS EN ISO 10870:2012) all samples comprised three minutes of kick sampling, where sediment is disturbed forcefully by foot and the released material caught in a square pond net, and a one-minute manual search. The one-minute manual search included sweeping of the water surface to capture surface-dwelling macroinvertebrates and a search of cobbles,

stones and woody debris to capture species that may be attached to the submerged substrates.

2.4.2 Environmental data pertaining to the sampling area, banks and surrounding area were collected alongside each sample. These data included the predictor variables (watercourse width, depth, substrate composition) required for River Invertebrate Classification Tool (RICT) analysis (EU-STAR, 2004). Site photos were also taken and have been shown as Photograph 1 Photographs taken on site during 2019 field surveys and Photograph 2 Photographs taken on site during 2020 field surveys - Appendix A of this report.

2.4.3 Labelled sample pots were stored in a cool box (kept between 1-3°C) until preservation later that day in Industrial Methylated Spirit (IMS).

Survey period

2.4.4 Autumn macroinvertebrate samples were collected on 28th and 29th November 2019 in accordance with the autumn macroinvertebrate sampling season (September to November).

2.4.5 Spring macroinvertebrate samples were collected on 19th and 20th May 2020 in accordance with the spring macroinvertebrate sampling season (March to May).

Survey conditions

2.4.6 All samples were collected in periods of normal flow.

2.5 Data analysis methodology

Sample analysis

2.5.1 Macroinvertebrate samples were analysed in the laboratory to RIVPACS Taxonomic Level 5 (TL5) (Davy-Bowker et al., 2010). For each given sample, the taxa present and their abundance were recorded. This is predominantly to species-level with exceptions where this would either involve disproportionate effort (for example aquatic worms) or it is not possible (for example many true fly larvae). Within this framework, individuals were identified to the highest taxonomic level possible given their life stage and condition. This level of taxonomic identification enabled calculation of biological indices (described below), the detection of non-native species, and species of conservation value.

Biological indices overview

2.5.2 The resulting datasets were used to calculate the following biological indices, which were used to evaluate the condition and/or conservation value of the sampled macroinvertebrate communities:

- Whalley, Hawkes, Paisley and Trigg Average Score Per Taxon (WHPT ASPT) (WFD-UKTAG, 2014) – an index used to assess the general degradation of rivers.
- Whalley, Hawkes, Paisley and Trigg No. of Taxa (WHPT NTAXA) (WFD-UKTAG, 2014) – the number of taxa which score within the WHPT system.
- The Lotic Invertebrate Index Flow Evaluation (LIFE) index (Extence et al., 1995) – an index used to assess whether riverine macroinvertebrate communities are sensitive to low flow pressure.
- Proportion of Sediment-sensitive invertebrates (PSI) index (Extence et al., 2011) – an index used to assess whether macroinvertebrate communities are affected by deposition of fine sediment.

- Community Conservation Index (CCI) (Chadd and Extence, 2004) – used to evaluate the conservation value of freshwater macroinvertebrate communities.

Protected and Notable Species

2.5.3 Recorded species were cross-referenced with the following lists to identify UK taxa with a conservation designation:

- Bern Convention on the Conservation of European Wildlife and Natural Habitats (1979)
- Habitats Directive (1992)
- Natural Environment and Rural Communities Act 2006 - Species of Principal Importance in England (section 41)
- The Conservation of Habitats and Species Regulations 2010
- The IUCN Red List of Threatened Species (2020)
- Wildlife and Countryside Act 1981 (as amended) Schedules 1, 5 and 8 (protected birds, animals and plants)

2.5.4 Taxa were also cross referenced with species listed under the Wildlife and Countryside Act (WCA) 1981 Schedule 9, Invasive Freshwater shrimps and Isopods (Freshwater Biological Association, 2012) and the Great Britain Non-native Species Secretariat website (2020) to identify macroinvertebrate invasive non-native species recorded at the survey sites.

2.5.5 The CCI system was used to indicate the conservation value of waterbodies with regards to macroinvertebrates. The system takes account of the richness of the invertebrate community and the rarity of species within it (on a scale of 1 to 9), to generate a single CCI score for the sample. This score equates to one of five conservation value categories shown below in Table 2.2. CCI scores from EA monitoring sites are shown in Table B.2 - Appendix B of this report. Field results from this analysis are shown in Table 3.2.

Table 2.2 Community conservation categories

CCI Score	Conservation categories
0 – 5.0	Low conservation value
>5.0 – 10.0	Moderate conservation value
>10.0 – 15.0	Fairly high conservation value
>15.0 – 20	High conservation value
>20.0	Very high conservation value

Water Framework Directive Data Analysis

2.5.6 Following WFD-UKTAG (2014) guidance and using the River Invertebrate Classification Tool (RICT), WHPT ASPT and WHPT NTAXA values were processed to produce ecological quality ratios (EQRs) at each site, which were then used to provide indicative WFD statuses. This provides an indication of the extent to which the macroinvertebrate communities have been impacted by human activities at each site.

2.5.7 RICT was used to provide EQR and WFD status values for sites based on spring and autumn data separately. These data could not be combined due to spring and autumn surveys being carried out in different years.

Table 2.3 WFD class boundaries for macroinvertebrates

Class	WHPT NTAXA EQR	WHPT ASPT EQR	Description
High	≥0.80	≥0.97	Near natural conditions
Good	0.68 – 0.80	0.86 – 0.97	Slight change from natural conditions as a result of human activity
Moderate	0.56 – 0.68	0.72 – 0.86	Moderate change from natural conditions as a result of human activity
Poor	0.47-0.56	0.59 – 0.72	Major change from natural conditions as a result of human activity
Bad	<0.47	<0.59	Severe change from natural conditions as a result of human activity

2.6 Deviations, constraints and limitations

- 2.6.1 WFD-UKTAG (2014) guidance requires macroinvertebrate sampling to be undertaken in spring and autumn of the same year to allow a combined annual WFD classification to be generated.
- 2.6.2 A combined annual WFD classification has not been generated because data collection was only possible in autumn 2019 and spring 2020. These data provide a sufficient baseline to assess the macroinvertebrate assemblages present in the study area. Single season WFD classifications are generated in place of combined annual WFD classifications.
- 2.6.3 Typically, environmental record searches consider records up to 10 years old, however, to find sufficient data to inform the baseline for some areas, records were considered for a longer period dating back to 2000. This is considered a limitation as more up-to-date data was not available for these areas. The age of data for these areas may mean that some results are not fully representative of current conditions within the watercourse.

3 Results

3.1 Desk study results

- 3.1.1 The EA data provided records of thirteen invertebrate species of conservation value within 2 km of the scheme boundary; as detailed in Table B.1 - Appendix B of this report. One Invasive Non-Native Species (INNS) were also reported within the scheme boundary and are detailed in Table B.1, Appendix B, and highlighted in red. CCI scores for each river sample has been shown in Table B.2, Appendix B.
- 3.1.2 EA macroinvertebrate survey sites for the period 2000 to 2019 and their locations are shown in PEI Report Figure 8.20. Site ID and Site name are shown in the Table 3.1 below.

Table 3.1 Site names and their EA monitoring site ID

Site ID	Site name
35164	U/S Colesbourne
35765	Colesbourne (old site)
36222	North Cerney
89727	Butler's Farm, Colesbourne
48318	Stratford Park
51904	Edgeworth Mill Farm
170423	U/S Millbrook Academy
170424	Millbrook Academy
170425	Brockworth Sports Ground
159488	Halfway Bridge

3.2 Field survey results

- 3.2.1 Invertebrate samples were collected in autumn 2019 and spring 2020 at the seven sites, totalling 14 invertebrate samples. Observed WHPT, PSI, and LIFE scores for each sample are shown in Table B.3. CCI scores for each river sample are displayed in Table 3.2 below.
- 3.2.2 INNS and species of conservation value recorded during baseline surveys are detailed in Table 3.3 Species of conservation value found during baseline surveys and full biological indices created from EA baselines studies are noted in Table B.4 - Appendix B of this report.

Table 3.2 CCI scores generated from baseline surveys

Waterbody	Site name	CCI autumn 2019	Conservation Value autumn 2019	CCI spring 2020	Conservation Value spring 2020
Norman's Brook	AQ1	12.73	Fairly high	6.30	Moderate
	AQ2	20.56	Very high	20.46	Very high
	AQ7	10.38	Fairly high	10.00	Fairly high
Tributary of the River Frome	AQ3	3.67	Low	10.50	Fairly high
	AQ4	8.50	Moderate	6.00	Moderate
Tributary of the River	AQ5	11.11	Fairly high	7.69	Moderate

Churn	AQ6	17.18	High	10.45	Fairly high
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Table 3.3 Species of conservation value and INNS recorded in baseline surveys

Site	Scientific name	Common name	Designation(s)
AQ2	<i>Hydropsyche fulvipes</i>	Net-spinning caddisfly	Nationally notable
AQ2, AQ5, AQ6, AQ7	<i>Rhyacophila fasciata</i>	Northern caddisfly	Nationally notable
AQ2	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable
AQ5	<i>Pacifastacus leniusculus</i>	Signal Crayfish	Wildlife and Countryside Act, Section 9, Part 1

3.3 Water Framework Directive Data Analysis

3.3.1 WFD EQRs were generated through RICT for spring and autumn data from each site. Table 3.4 displays EQR values for WHPT NTAXA and WHPT ASPT indices within each season as well as indicative WFD statuses derived from these EQR values.

Table 3.4 Ecological Quality Ratios and Indicative Water Framework Directive Statuses

Site	Spring			Autumn		
	WHPT NTAXA EQR	WHPT ASPT EQR	Indicative WFD Status	WHPT NTAXA EQR	WHPT ASPT EQR	Indicative WFD Status
AQ1*	0.67	0.88	Moderate	0.68	0.96	Moderate
AQ2*	0.78	0.84	Moderate	1.14	0.95	Good
AQ3*	0.73	0.73	Moderate	0.68	0.67	Poor
AQ4	0.47	1.01	Bad	0.53	1.03	Poor
AQ5	0.85	0.97	Good	0.75	0.88	Good
AQ6*	0.64	0.75	Moderate	0.62	0.88	Moderate
AQ7*	0.98	0.82	Moderate	1.03	0.96	Good

*Sites where RICT classifications have low suitability within the model

3.3.2 The RICT model is designed to generate EQR values on rivers which are naturally permanently flowing. As some of the sites are located close to their source and may therefore not support permanent flow, RICT has indicated a low suitability for these sites to produce reliable EQR values. These sites are indicated within the table. In these instances it is advised that interpretation of the baseline quality of the macroinvertebrate community at these sites relies on raw index scores rather than EQR values.

3.4 Data analysis results

Norman's Brook

3.4.1 The WFD waterbody 'Norman's Bk - source to conf Hatherley Bk' (GB109054032780) was Classified by the EA as 'good' for the macroinvertebrate element in 2016 Cycle 2. This suggests that the macroinvertebrate communities

within this waterbody may be slightly deviated from pristine quality due to human activities.

- 3.4.2 Three sites on Norman's Brook were sampled in autumn 2019 and spring 2020 (AQ1, AQ2 and AQ7).
- 3.4.3 Site AQ1 produced CCI scores of 12.73 and 6.3 in autumn and spring respectively. This indicates that it supports invertebrate communities of a fairly high conservation value. The WHPT NTAXA scores were calculated to be 13 and 14 in autumn and spring respectively. The WHPT ASPT score was calculated to be 5.27 and 5.15 in autumn and spring respectively. This data reflects a community of moderate diversity and good proportions of invertebrate sensitive to general degradation. No INNS or species of conservation value were found during baseline surveys.
- 3.4.4 Site AQ2 produced CCI scores of 20.56 and 20.46 in autumn and spring respectively. This indicates that it supports invertebrate communities of a very high conservation value. The WHPT NTAXA scores were calculated to be 18 and 14 in autumn and spring respectively. The WHPT ASPT scores were calculated to be 5.71 and 5.36 in autumn and spring respectively. This data reflects a community of good diversity and good proportions of invertebrate sensitive to general degradation. Three species of conservation value were recorded at AQ2; the net-spinning caddisfly *Hydropsyche fulvipes*, the Northern caddisfly *Rhyacophila fasciata* and the riffle beetle *Riolus subviolaceus*. All three species are considered to be nationally notable.
- 3.4.5 Site AQ7 produced CCI scores of 10.38 and 10 in autumn and spring respectively. This indicates that it supports invertebrate communities of a fairly high conservation value. The WHPT NTAXA scores were calculated to be 16 and 13 in autumn and spring respectively. The WHPT ASPT scores were calculated to be 5.74 and 4.62 in autumn and spring respectively. This data reflects a community of moderate diversity and moderate to poor proportions of invertebrates sensitive to general degradation. The nationally notable Northern caddisfly was recorded at this site. No INNS were found during baseline surveys.
- 3.4.6 The EA provided data for one site on Norman's Brook, 'Halfway bridge, ID: 159488', spanning through 2013 to 2016. CCI scores for this site varied from 3.75 to 7.92. During baseline surveys at the EA site 'Halfway Bridge, ID: 159488', no INNS or species of conservation value were recorded.

River Frome

- 3.4.7 The WFD waterbody 'Frome - source to Ebley Mill' (GB109054032470) was classified by the EA as 'high' for the macroinvertebrate element in 2016 Cycle 2. This suggests that the macroinvertebrate communities within this waterbody represent those found in near-natural conditions.
- 3.4.8 Two sites on tributaries of the River Frome were sampled in autumn 2019 (Sites AQ3 and AQ4).
- 3.4.9 Site AQ3 produced CCI scores of 3.67 and 10.5 in autumn and spring respectively. This indicates that it supports invertebrate communities of a fairly high conservation value. The WHPT NTAXA scores were calculated to be 10 in autumn and spring. The WHPT ASPT scores were calculated to be 3.82 and 5.92 in autumn and spring respectively. This data reflects a community of poor diversity and poor to good proportions of invertebrates sensitive to general

degradation. No INNS or species of conservation value were found during baseline surveys.

- 3.4.10 Site AQ4 produced CCI scores of 8.5 and 6 in autumn and spring respectively. This indicates that it supports invertebrate communities of moderate conservation value. The WHPT NTAXA EQR values indicate low macroinvertebrate community diversity in autumn and spring which were consistent with bad and poor WFD status. The WHPT ASPT EQR values indicate good proportions of taxa sensitive to general degradation, consistent with good WFD status. No INNS or species of conservation value were found during baseline surveys.
- 3.4.11 EA invertebrate for 'Edgeworth Mill Farm, ID: 51904' spanned from 2009 to 2019. 'Edgeworth Mill Farm' had CCI scores varying between a low of 7 (classified as moderate, 2009) and a high of 19.6 (classified as high, 2017). A search of existing EA data for the River Frome identified the presence of:
- one nationally notable and IUCN (pre 1994) rare species - *Rhyacophila fasciata*;
 - one nationally rare species - *Synagapetus dubitans*;
 - two nationally scarce and notable species - *Riolus subviolaceus*, and *Riolus cupreus*;
 - two nationally notable species - *Tinodes unicolor*, and *Wormalida subnigra*; and
 - one nationally scarce species - *Hydropsyche saxonica*.
- 3.4.12 The invasive signal crayfish *Pacifastacus leniusculus* listed under the Wildlife and Countryside Act (as amended) Section 9, Part 1 was also recorded at this site in 2017.

River Churn

- 3.4.13 The WFD waterbody 'Churn – source to Perrots brook' (GB106039029810) was classified by the EA as 'high' for the macroinvertebrate quality element in 2016 Cycle 2. This suggests that the macroinvertebrate communities within this waterbody are characteristic of those found in near-natural conditions.
- 3.4.14 Two sites on tributaries of the River Churn were sampled. In autumn 2019 (Sites AQ5 and AQ6).
- 3.4.15 Site AQ5 produced CCI scores of 11.11 and 7.69 in autumn and spring respectively. This indicates that it supports invertebrate communities of a fairly high conservation value. The WHPT NTAXA EQR values indicate macroinvertebrate community diversity in autumn and spring which were consistent with good WFD status. The WHPT ASPT EQR values indicate good proportions of taxa sensitive to general degradation, consistent with good WFD status. The invasive signal crayfish listed under the Wildlife and Countryside Act (as amended) Section 9, Part 1 was recorded at this site. The nationally notable Northern caddisfly was also recorded at this site.
- 3.4.16 Site AQ6 produced CCI scores of 17.18 and 10.45 in autumn and spring respectively. This indicates that it supports invertebrate communities of high conservation value. The WHPT NTAXA scores were calculated to be 13 and 18 in autumn and spring respectively. The WHPT ASPT scores were calculated to be 5.46 and 5.2 in autumn and spring respectively. This data reflects a community of moderate to good diversity and moderate to good proportions of invertebrates sensitive to general degradation. The nationally notable Northern caddisfly was recorded at this site. No INNS were found during baseline surveys.

3.4.17 Existing EA data was available for four sites on the River Churn, named 'Upstream Colesbourne, ID: 35164', 'Colesbourne (old site), ID: 35765', 'North Cerney, ID: 36222' and 'Butlers Farm, Colesbourne, ID: 89727'. Data sets span from 2001 to 2019. CCI scores from these sites varied between 6.25 ('North Cerney, ID: 36222', 08/05/2013) to 49 ('North Cerney, ID: 36222', 04/10/2004).. Baseline surveys conducted by the EA have recorded eight invertebrate species of conservation value:

- One species IUCN (pre 1994) - Rare, UK Biodiversity Action Plan, and Natural Environment Communities Act 2006 - Species of Principal Importance species *Pisidium tenuilineatum*;
- one UK Biodiversity Action Plan, and Natural Environment Communities Act 2006 - Species of Principal Importance species *Nigrobaetis niger*;
- two nationally notable and nationally scarce species *Riolus subviolaceus*, and *Riolus cupreus*;
- three nationally scarce species *Hydatophylax infumatus*, *Potamophylax rotundipennis*, and *Sialis nigripes*; and
- one notable species *Tinodes unicolor*.

3.4.18 No INNS were recorded.

Horsebere Brook

3.4.19 No baseline surveys were carried out in this waterbody due to distance from scheme. EA data has been included for context.

3.4.20 The WFD waterbody 'Horsebere brook – source to confluence River Severn' (GB106039029810) was classified as 'good' for the macroinvertebrate quality element in 2016 Cycle 2. This suggests that the macroinvertebrate communities within this waterbody may be slightly deviated from pristine quality due to human activities.

3.4.21 EA data existed for three sites on Horsebere Brook; Horsebere brook named 'u/s Millbrook Academy, ID: 170423', 'Millbrook Academy, ID: 170424' and 'Brockworth Sports Ground, ID: 170425'. The WHPT NTAXA varied between 5.17 to 5.75 and the WHPT ASPT varied between 15 to 27. The highest LIFE score recorded was 8.2 ('Millbrook Academy; ID 17424') and the lowest was 7.63 ('Brockworth Sports Ground, ID: 170425'). The PSI score varied from 53.85; moderately sedimented to 72.41; slightly sedimented. CCI scores indicated species of low ('Millbrook Academy, ID 170424':3.6) and moderate ('Brockworth Sports Ground, ID: 170425' scored 5.56; 'U/s Millbrook Academy, ID: 170423' scored 7.5) conservation value.

3.4.22 No species of conservation value were recorded. At all three sites, the INNS Jenkins' spire snail was recorded.

Painswick Stream

3.4.23 Despite no baseline surveys being carried out at this site due to distance from scheme, existing EA data has been included for context.

3.4.24 The WFD waterbody 'Painswick stream – source to confluence Stroudwater' (GB109054032460) was included as it forms part of the Frome catchment. This waterbody was classified by the EA as 'high' for the macroinvertebrate quality element in 2016 Cycle 2. This suggests that the macroinvertebrate communities within this waterbody represent those found in near-natural conditions.

- 3.4.25 'Stratford park, ID: 48318' was sampled in May 2000 and found to have a WHPT NTAXA of 17 and WHPT ASPT of 5.79. In the same year, in September the site was recorded to have a WHPT NTAXA of 18 and a WHPT ASPT of 5.77. No CCI scores were recorded at this site.
- 3.4.26 No species of conservation value were recorded during baseline surveys. No INNS were recorded at this site.

4 Conclusion

- 4.1.1 In the desk study data search, 13 aquatic macroinvertebrate species of conservation value were identified within the study area. Sites sampled in the tributaries of the River Frome in autumn 2019 and spring 2020 supported macroinvertebrate communities of low to fairly high conservation value based on CCI scores. Sites sampled in the tributaries of the River Churn supported macroinvertebrate communities of moderate to high conservation value based on CCI scores.
- 4.1.2 The INNS signal crayfish was recorded on the tributary of the River Churn during 2020 baseline surveys and on the River Frome within Environment Agency data.
- 4.1.3 The sites sampled in Norman's Brook supported communities of moderate to very high conservation value based on CCI scores.
- 4.1.4 Field sampling in Norman's Brook recorded the presence of two nationally notable caddisfly species (*Hydropsyche fulvipes* and *Rhyacophila fasciata*) and one nationally notable riffle beetle *Riolus subviolaceus*.
- 4.1.5 Based on the data available, the macroinvertebrate communities supported by Norman's Brook and associated springheads are considered to be of very high conservation value.
- 4.1.6 It is advised that further surveys are conducted in autumn 2020, to complete the baseline study, allow comparison between years and better understand the conservation value of the macroinvertebrate communities of Norman's Brook.
- 4.1.7 If development proposals will impact watercourses that support nationally notable macroinvertebrate species or macroinvertebrate communities of conservation value, then a mitigation will be required to protect the integrity and conservation value of macroinvertebrate communities.
- 4.1.8 Detailed impact assessment and mitigation measures will be addressed in the Biodiversity chapter of the Environmental Statement.

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Appendix A - Photographs

Photograph 1 Photographs taken on site during 2019 field surveys



Site A1: Norman's Brook with Carex sp.



Site A2: Norman's Brook with faster flow



Site A3: Springhead supplying River Frome



Site A4: Tributary of the River Frome with clay/cobble



Site A5: Tributary of the River Churn woods



Site A6: Tributary of the River Churn with surrounding



Site A7: Springhead supplying Norman's Brook

Photograph 2 Photographs taken on site during 2020 field surveys



Site A1: Norman's Brook with 90% shading of channel.



Site A2: Norman's Brook with cascade sequence



Site A3: Springhead supplying River Frome showing poaching shallow channel



Site A4: Tributary of the River Frome with



Site A5: Tributary of the River Churn with woody debris



Site A6: Tributary of the River Churn with soft



Site A7: Springhead with Carex sp.

Appendix B – Tables

Table B.1 Species of conservation value with INNS highlighted in red

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
Churn	Upstream Colesbourne	SO9958413257	01-Oct-01	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
				Hydatophylax infumatus	Northern caddisfly	Nationally scarce
	Colesbourne (old site)	SP0052913224	27-Mar-02	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
				Hydatophylax infumatus	Northern caddisfly	Nationally scarce
	North Cerney	SP0190807912	15-Apr-09	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
				25-Nov-09	Riolus subviolaceus	Riffle beetle
			25-May-10	Potamophylax rotundipennis	Northern caddisfly	Nationally scarce
				Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
			20-Oct-10	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
				Hydatophylax infumatus	Northern caddisfly	Nationally scarce
			28-Mar-11	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
			26-Sep-11	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
			26-Mar-12	Potamophylax rotundipennis	Northern caddisfly	Nationally scarce
			28-Sep-12	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
08-May-13	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce			
05-May-15	Riolus cupreus	Riffle beetle	Nationally notable, Nationally scarce			

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
				<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			02-Sep-15	<i>Riolus cupreus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
				<i>Pisidium tenuilineatum</i>	Fine-lined pea mussel	IUCN (pre 1994) - Rare, UK Biodiversity Action Plan speices, Natural Environment Communities Act 2006 - Species of Principal Importance
			20-Apr-16	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
			07-Oct-16	<i>Riolus cupreus</i>	Riffle beetle	Nationally notable, Nationally scarce
			24-May-18	<i>Pisidium tenuilineatum</i>	Fine-lined pea mussel	IUCN (pre 1994) - Rare, UK Biodiversity Action Plan speices, Natural Environment Communities Act 2006 - Species of Principal Importance
				<i>Tinodes unicolor</i>	Tube-maker caddisfly	Nationally notable
	Butlers Farm, Colesbourne	SO9916613287	29-Nov-02	<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce
<i>Sialis nigripes</i>				Lacewing	Nationally scarce	
<i>Hydatophylax infumatus</i>				Northern caddisfly	Nationally scarce	
06-May-03			<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce	
28-Nov-03			<i>Riolus subviolaceus</i>	Riffle beetle	Nationally notable, Nationally scarce	

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
			26-May-04	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
			04-Oct-04	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
			22-Apr-05	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
			13-Mar-06	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
			23-Nov-06	Hydatophylax infumatus	Northern caddisfly	Nationally scarce
			10-Apr-08	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
			23-Oct-08	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
				Hydatophylax infumatus	Northern caddisfly	Nationally scarce
			15-Apr-09	Nigrobaetis niger	Southern iron blue	UK Biodiversity Action Plan species, Natural Environment Communities Act 2006 - Species of Principal Importance
			25-Nov-09	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
			25-May-10	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
				Potamophylax rotundipennis	Northern caddisfly	Nationally scarce
			20-Oct-10	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
				Hydatophylax infumatus	Northern caddisfly	Nationally scarce
			28-Mar-11	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
				Sialis nigripes	Lacewing	Nationally scarce

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
			26-Mar-12	Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
Frome	Edgeworth Mill Farm	SO9524706705	10-Nov-09	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
			25-May-12	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
				Rhyacophila fasciata	Green sedge	Nationally notable, IUCN (pre-1994) - Rare
			13-Sep-12	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
			11-Mar-15	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
				Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
			11-Apr-17	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
				Riolus cupreus	Riffle beetle	Nationally notable, Nationally scarce
				Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
				Tinodes unicolor	Tube-maker caddisfly	Nationally notable
			18-Oct-17	Hydropsyche saxonica	Netspinning caddisfly	Nationally scarce
Pacifastacus leniusculus	Signal crayfish	Wildlife and Countryside Act, Section 9, Part 1				

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
				Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
				Tinodes unicolor	Tube-maker caddisfly	Nationally notable
			18-Oct-17	Hydropsyche saxonica	Netspinning caddisfly	Nationally scarce
				Pacifastacus leniusculus	Signal crayfish	Wildlife and Countryside Act, Section 9, Part 1
				Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
				Tinodes unicolor	Tube-maker caddisfly	Nationally notable
			21-May-18	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
				Riolus cupreus	Riffle beetle	Nationally notable, Nationally scarce
				Riolus subviolaceus	Riffle beetle	Nationally notable, Nationally scarce
				Tinodes unicolor	Tube-maker caddisfly	Nationally notable
			06-Nov-18	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
				Sialis nigripes	Lacewing	Nationally scarce
				Tinodes unicolor	Tube-maker caddisfly	Nationally notable
				Wormaldia subnigra	Finger nepped caddis fly	Nationally rare
			13-May-19	Oxycera pardalina	Hill soldier	Nationally notable, IUCN (pre 1994) - Vulnerable
				Pacifastacus leniusculus	Signal crayfish	Wildlife and Countryside Act, Section 9, Part 1

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
				Synagapetus dubitans	Saddle-Case Makers	Nationally rare
				Tinodes unicolor	Tube-maker caddisfly	Nationally notable
				Riolus cupreus	Riffle beetle	Nationally notable, Nationally scarce
				Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
			11-Oct-19	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
				Tinodes unicolor	Tube-maker caddisfly	Nationally notable
Norman's Brook	Halfway Bridge	SO8777321699	04-Apr-13	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
			13-Nov-13	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
			03-Mar-16	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
			06-Sep-16	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
Painswick Stream	Stratford Park	SO8473005590	16-May-00	N/A	N/A	N/A
			13-Sept-00	N/A	N/A	N/A
Horsebere Brook	Upstream Millbrook Academy	SO8994316438	08-Oct-13	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)
	Millbrook Academy	SO8984516492	08-Oct-13	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)

Waterbody	Site name	NGR	Date	Scientific name	Common name	Designation
	Brockworth Sports Ground	SO8957816684	08-Oct-13	Potamopyrgus antipodarum	New Zealand mud snail	GB Non-Native Species Secretariat (2019)

Table B.2 CCI scores generated from EA data with unevaluated records in purple

Waterbody	Site name	Date	CCI score	Conservation value
Horsebere Brook	Upstream Millbrook Academy	08/10/2013	7.5	Moderate
	Millbrook Academy	08/10/2013	3.6	Low
	Brockworth Sports Ground	08/10/2013	5.56	Moderate
Painswick	Stratford Park	16/05/2000	Unrecorded	Unevaluated
		13/09/2000	Unrecorded	Unevaluated
Churn	Upstream Colesbourne	01/10/2001	15.31	High
	Colesbourne (old site)	27/03/2002	22.81	Very high
	North Cerney	15/04/2009	12.13	Fairly high
		25/11/2009	13.5	Fairly high
		25/05/2010	12.12	Fairly high
		20/10/2010	17.5	High
		28/03/2011	11.59	Fairly high
		26/09/2011	18.52	High
		26/03/2012	17.74	High
		28/09/2012	8.91	Moderate
		08/05/2013	9.32	Moderate
		17/09/2013	6.25	Moderate
		05/05/2015	16.19	High
		02/09/2015	26.67	Very high
		20/04/2016	15.52	High
07/10/2016	20.63	Very high		
10/03/2017	11.67	Fairly high		

Waterbody	Site name	Date	CCI score	Conservation value
		18/10/2017	11.58	Fairly high
		24/05/2018	27.59	Very high
		16/11/2018	12.22	Fairly high
		21/05/2019	10.83	Fairly high
	Butlers Farm, Colesbourne	29/11/2002	15.88	High
		06/05/2003	12.32	Fairly high
		28/11/2003	11.43	Fairly high
		26/05/2004	21.46	Very high
		04/10/2004	10.28	Fairly high
		22/04/2005	10.28	Fairly high
		13/09/2005	9.69	Moderate
		13/03/2006	8.33	Moderate
		23/11/2006	9.44	Moderate
		10/04/2008	16.45	High
		23/10/2008	16	High
		15/04/2009	14.9	Fairly high
		25/11/2009	8.57	Moderate
		25/05/2010	10.91	Fairly high
		20/10/2010	14.27	Fairly high
		28/03/2011	11	Fairly high
03/10/2011	6.88	Moderate		
26/03/2012	13.42	Fairly high		
28/09/2012	7.37	Moderate		
Frome	Edgeworth Mill Farm	03/10/2001	Unrecorded	Unevaluated

Waterbody	Site name	Date	CCI score	Conservation value
		20/05/2002	Unrecorded	Unevaluated
		01/04/2003	Unrecorded	Unevaluated
		17/09/2003	Unrecorded	Unevaluated
		25/04/2006	Unrecorded	Unevaluated
		05/10/2006	Unrecorded	Unevaluated
		19/03/2009	Unrecorded	Unevaluated
		10/11/2009	7	Moderate
		25/05/2012	8.67	Moderate
		13/09/2012	10.5	Fairly high
		11/03/2015	14.29	Fairly high
		11/04/2017	19.6	High
		18/10/2017	17	High
		18/10/2017	17.68	High
		21/05/2018	16.58	High
		06/11/2018	10.83	Fairly high
		13/05/2019	19.44	High
		11/10/2019	11.36	Fairly high
Norman's Brook	Halfway Bridge	04/04/2013	3.82	Low
		13/11/2013	5.91	Moderate
		03/03/2016	3.75	Low
		06/09/2016	7.92	Moderate

Table B.3 Biological Indices Scores from Autumn 2019 and Spring 2020

Waterbody	Site name	Year	Season	WHPT NTAXA	WHPT ASPT	LIFE Score	PSI
Norman's Brook	AQ1	2019	autumn	13	5.26	7.55	60.00
	AQ2	2019	autumn	18	5.70	8.00	65.85
	AQ7	2019	autumn	16	5.74	8.14	72.50
Tributary of the River Frome	AQ3	2019	autumn	10	3.82	7.60	50.00
	AQ4	2019	autumn	11	5.69	8.30	81.48
Tributary of the River Churn	AQ5	2019	autumn	13	5.01	8.00	60.00
	AQ6	2019	autumn	13	5.46	8.42	79.31

Waterbody	Site name	Year	Season	WHPT NTAXA	WHPT ASPT	LIFE Score	PSI
Norman's Brook	AQ1	2020	spring	14	5.15	7.90	68.18
	AQ2	2020	spring	14	5.36	7.87	52.78
	AQ7	2020	spring	13	4.62	7.56	43.48
Tributary of the River Frome	AQ3	2020	spring	10	5.92	7.89	66.67
	AQ4	2020	spring	17	5.95	7.67	61.29
Tributary of the River Churn	AQ5	2020	spring	14	4.90	7.85	62.50
	AQ6	2020	spring	18	5.20	7.67	39.47

Table B.4 Biological indices generated from EA baselines

Waterbody	Site	NGR	Date	WHPT ASPT	WHPT NTAXA	LIFE	PSI
Churn	Upstream Colesbourne	SO9958413257	01/10/2001	5.94	33	7.63	53.57
	Colesbourne (old site)	SP0052913224	27/03/2002	6.26	33	8.03	63.49
	North Cerney	SP0190807912	15/04/2009	6.26	35	8.02	64.41
			25/11/2009	5.91	32	7.92	60.32
			25/05/2010	6.33	29	7.86	59.02
			20/10/2010	6.56	38	7.93	70.42
			28/03/2011	6.36	34	7.97	63.33
			26/09/2011	6.49	33	8	74.55
26/03/2012	6.28	37	7.8	66.67			

			28/09/2012	6.24	25	8.14	71.43
			08/05/2013	6.47	26	8	66.67
			17/09/2013	6.13	20	8.17	70.45
			05/05/2015	7.03	31	8.29	78.95
			02/09/2015	6.36	23	8.18	72.73
			20/04/2016	6.86	27	8.42	77.55
			07/10/2016	6.8	28	8.45	80
			10/03/2017	6.47	30	8.46	71.67
			18/10/2017	6.6	23	8.61	76.19
			24/05/2018	6.26	26	8.27	69.39
			16/11/2018	6.17	27	8.35	70.83
			21/05/2019	6.3	18	8.41	86.67
	Butlers Farm, Colesbourne	SO9916613287	29/11/2002	5.77	28	7.62	51.06
			06/05/2003	6.41	29	7.87	69.23
			28/11/2003	6.37	36	8.28	73.13
			26/05/2004	6.49	37	8.28	70
			04/10/2004	6.66	24	8.27	79.55
			22/04/2005	6.68	24	8.19	76.6
			13/09/2005	5.23	18	7.19	35.71
			13/03/2006	6.72	23	8.61	86.36
			23/11/2006	6.28	25	8.12	73.91
			10/04/2008	6.64	24	8.08	62.79
			23/10/2008	5.87	36	7.63	54.1
			15/04/2009	6.59	33	7.83	62
			25/11/2009	2.6	22	7.39	46.34

			25/05/2010	5.92	26	7.48	51.11
			20/10/2010	5.85	32	7.64	53.7
			28/03/2011	5.91	26	7.26	46.15
			03/10/2011	5.18	23	6.81	34.15
			26/03/2012	5.89	29	7.3	48.84
			28/09/2012	5.42	24	7.26	48.89
Painswick Stream	Stratford Park	SO8473005590	16/05/2000	5.79	17	7.64	69.23
			13/09/2000	5.77	18	7.73	75.86
Frome	Edgeworth Mill Farm	SO9530006700	03/10/2001	6.5	30	7.4	67.35
			20/05/2002	6.37	27	8	76.79
			01/04/2003	7.39	27	7.88	81.13
			17/09/2003	6.2	31	7.19	60.38
			25/04/2006	6.62	29	7.7	74.55
			05/10/2006	6.13	22	7.75	68.57
		SO9524706705	19/03/2009	6.29	19	8.11	81.58
			10/11/2009	6.81	32	7.8	67.8
			25/05/2012	6.17	21	8.18	67.44
			13/09/2012	6.62	32	8.13	71.93
			11/03/2015	6.6	30	8.05	69.09
			11/04/2017	7.02	25	8.32	86.36
			18/10/2017	6.43	31	8	66
			18/10/2017	6.56	29	8.06	67.39
			21/05/2018	6.16	25	8.18	69.05
			06/11/2018	6.38	24	8.04	65.12
			13/05/2019	6.78	30	8.28	67.86

			11/10/2019	5.83	17	8	55.17
Horsebere Brook	Upstream Millbrook Academy	SO8994316438	08/10/2013	5.55	27	8.04	63.27
	Millbrook Academy	SO8984516492	08/10/2013	5.75	15	8.2	72.41
	Brockworth Sports Ground	SO8957816684	08/10/2013	5.17	27	7.63	53.85
Norman's Brook	Halfway Bridge	SO8777321699	04/04/2013	4.65	18	6.79	55.17
			13/11/2013	4.6	29	7	40
			03/03/2016	4.53	22	6.92	47.73
			06/09/2016	4.69	27	7.19	50

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.23
Fish Habitat Assessment Report

28 September 2020

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Foreword

The section of the A417 near Birdlip, known as the A417 Missing Link, forms the only section of single carriageway on the A417 and is located in the Cotswolds Area of Outstanding Natural Beauty (AONB). The single carriageway section exists between the Brockworth bypass and the Cowley roundabout. This section regularly experiences congestion, causing delays and pollution. This scheme aims to improve journey times and safety issues associated with this section of the road network.

This report sets out the results of fish habitat mapping and River Habitat Surveys undertaken in October 2019 and January 2020. The objective of these surveys was to collect data from Norman's Brook as it is being realigned by the scheme. Data from tributaries of the River Frome and River Churn, Horsbere Brook and Painswick Stream also informs the assessment. This report should be read in conjunction with the other aquatic survey reports for the scheme (namely the 2020 Aquatic Macroinvertebrate Report, 2019 White-Clawed Crayfish Technical Report, 2019 Great Crested Newt Survey Report, 2019 Otter Report and 2019 Water Vole Report) to gain a full appreciation of the overall aquatic and semi-aquatic species assemblages across the scheme.

Executive Summary

The scheme would provide 3.4 miles (5.5km) of new dual carriageway for the A417; PEI Report Figure 2.1-General Arrangement. The new dual carriageway would connect the existing A417 Brockworth bypass with the existing dual carriageway on the A417, south of Cowley, known as the A417 Missing Link. This scheme aims to improve journey times and safety issues associated with this section of the road network. This report presents the methodology and baseline survey data recorded from a review of existing fisheries records, as well as River Habitat Surveys (RHS) and fish habitat surveys conducted in 2019 to 2020 across the scheme.

A framework of international (European), national and local legislation and planning policy guidance exists to protect and conserve fish assemblages.

River Habitat Surveys were undertaken following the methods set out in the River Habitat Survey in Britain and Ireland – Field Survey Guidance Manual: 2003 Version 1 (Environment Agency, 2003). The quantitative mapping of fish habitat was conducted by a suitably qualified aquatic ecology specialist using industry standard techniques.

RHS analysis concluded that the rivers surveyed are “Severely Modified” as a result of realignment and the presence of artificial features such as culverts, bridges and weirs. Despite this they provide functional freshwater habitat. Norman's Brook, upstream of the existing A417, was calculated to be of “High” habitat quality compared to similar rivers in the RHS database. Norman's Brook downstream of the A417 and a Tributary of Horsbere Brook were calculated to be of “Low” habitat quality compared to similar rivers in the RHS database.

Fish habitat within the survey sites is fragmented by significant weirs and culverts, many of which are considered to be impassable to all fish species (with the potential exception of European eel). Nevertheless, diverse and varied habitats were recorded with the potential to support all life stages of salmonids, and potentially coarse fish. These habitats have the potential could sustain isolated populations if present.

A complete assessment of potential impacts to fish communities will be undertaken within the Environmental Impact Assessment for the scheme, which will detail mitigation and compensation measures as appropriate, such as alternative habitat creation.

1 Introduction

1.1 Purpose of this document

1.1.1 This document details baseline data for fish, collected from desk studies, fish habitat surveys and River Habitat Surveys (RHS) carried out in October 2019 and January 2020. This report informs the Environmental Impact Assessment (EIA) and Water Framework Directive Assessment (WFDA) of the A417 Missing Link Scheme 'the scheme'.

1.2 Scope of the report

1.2.1 This technical report outlines the survey scoping, methodology and results of a fisheries desk study, fish habitat assessment and RHS surveys for the scheme. It is beyond the scope of this report to outline an assessment of effects or detail the need for measures to avoid or mitigate effects on the ecological features discussed. These will be addressed in the Biodiversity chapter of the updated Environmental Statement.

2 Methodology

2.1 Overview

2.1.1 Details of the methodology used for establishing the ecological baseline for freshwater fish and river habitat are provided below.

2.2 Survey guidance

2.2.1 The following survey guidance has been considered in the methodology design. Any deviation from standard industry practice is noted in Section 2.7 of this report.

- Water Framework Directive – UK Technical Advisory Group (WFD-UKTAG). (2008). Rivers Assessment Methods Fish Fauna (Fisheries Classification Scheme 2 (FCS2)).
- EA Fisheries Technical Manual 4 – Restoration of riverine salmon habitats (Hendry and Cragg-Hine, 1997).
- River Habitat Survey in Britain and Ireland – Field Survey Guidance Manual: 2003 Version 1 (Environment Agency, 2003).

2.3 Desk study

2.3.1 An environmental desk study was undertaken to identify records of fish for watercourses within the scheme, and the wider catchment.

2.3.2 Freshwater fish records were obtained via data request from the Environment Agency (EA). Data was requested from six waterbodies which either fall within the scheme and wider catchment.

2.3.3 The EA also provided Fisheries Classification System Version 2 (FCS2) modelling outputs for rivers within the scheme and local area. The FCS2 tool is a Bayesian statistical model, which classifies the quality of a sites fish assemblage based on the observed fish catch compared to the expected catch of an undisturbed site.

2.3.4 The comparison of observed against expected values produces an Ecological Quality Ratio (EQR), which is used to classify the quality of fish populations as High, Good, Moderate, Poor or Bad. These EQR scores are generated under the same parameters used by the Water Framework Directive (WFD) for assessing biological quality elements. EQR scores were not generated for RHS or for the results of the field surveys.

2.3.5 Data was requested from:

- River Churn (source to Perrots Brook) (WFD ID: GB106039029810);
- River Frome - source to Ebley Mill (WFD ID: GB109054032470);
- Horsbere Brook - source to confluence River Severn (WFD ID: GB109054032760);
- Painswick Stream – source to confluence Stroudwater (WFD ID: GB109054032460); and
- Norman's Brook - source to confluence Hatherley Brook (WFD ID: GB109054032780).
- Hatherley Brook - source to confluence River Severn (WFD ID: GB109054032801)

2.4 Survey scoping and design

2.4.1 Prior to field surveys commencing, scoping activities were undertaken by a suitably qualified and experienced aquatic ecologist to identify rivers and streams within the scheme boundary and wider river network. Scoping activities included: a review of desk study information; Ordnance Survey mapping and aerial imagery; site visits; and consultation with various stakeholders including local conservation groups, Gloucestershire Wildlife Trust, Natural England (NE) and the EA.

2.4.2 Field survey sites outlined in Table 2.1 and shown in PEI Report Figure 8.6 were selected which are representative of the relevant watercourses and capture the spatial variation in habitat. To enable an integrated understanding of the aquatic ecology baseline, survey site locations were also aligned with the Surface Water Quality Monitoring locations and survey sites for other aquatic ecology receptors (i.e. macroinvertebrates).

Table 2.1 Fish habitat and River Habitat Survey sites

Site number	Watercourse name	Survey type	Grid reference
1	Norman's Brook	RHS and Fish habitat assessment	SO 92836 15723 to SO 92382 15706
2	Norman's Brook	RHS and Fish habitat assessment	SO 91342 16295 to SO 91130 16693
3	Horsbere Brook	RHS and Fish habitat assessment	SO 91367 15494 to SO 90992 15545
4	Tributary of River Churn	Fish habitat assessment	SO 94570 16497 to SO 95993 16015
5	Tributary of River Churn	Fish habitat assessment	SO 94544 14807 to SO 96193 15340
6	Tributary of River Frome	Fish habitat assessment	SO 93911 13370 to SO 94834 12187

2.5 River Habitat Survey

- 2.5.1 In broad terms, RHS is a method designed to characterise and assess the physical structure of freshwater streams and rivers. The RHS system is based on information from major baseline surveys of streams and rivers in the UK and the Isle of Man. It has four distinct components: (1) standard methodology for field survey; (2) a computer database, for result comparison; (3) methods for assessing habitat quality; and (4) methodology for describing the extent of artificial channel modification. Field surveys were undertaken following the guidance laid out in the River Habitat Survey in Britain and Ireland – Field Survey Guidance Manual: 2003 Version 1 (Environment Agency, 2003).
- 2.5.2 RHS is carried out along a 500m length of channel. Observations are made at ten equally spaced spot-checks. At the end of the survey, a sweep-up of the whole 500m stretch occurs to complement spot-check data. The sweep-up is to include any features not occurring at the spot-check locations. Information on the surrounding land-use and valley form provide additional context.
- 2.5.3 All surveys were undertaken by an accredited RHS surveyor, trained by the EA.

Data analysis

- 2.5.4 Using the application of a set of rules to RHS data, artificial modification to the physical structure of the channel can be expressed as a Habitat Modification Score (HMS). HMS is based upon the type and extent of artificial features at the RHS site.
- 2.5.5 HMS can be used at a site level to audit predicted or actual impacts resulting from channel works. The spot check and sweep-up data collected from RHS is entered into the RAPID database (developed by the Centre for Ecology and Hydrology) enabling the calculation of an HMS and as a result, a Habitat Modification Class (HMC). Points are based on the relative impact of modification on habitat features. At each spot-check scores are assigned for evidence of modification such as sectioning, reinforcement and weirs. HMC's generated as a result of HMS are outlined in Table 2.2 with a description of the level of modification for each class provided.

Table 2.2 Habitat modification class and habitat modification score

Habitat Modification Class (HMC)	HMC description	Habitat modification score
1	Pristine/semi-natural	0-16
2	Predominantly unmodified	17-199
3	Obviously modified	200-499
4	Significantly modified	500-1399
5	Severely modified	1400+

2.5.6 The HMS score relates only to modification of the channel, while the Habitat Quality Assessment (HQA) score is a broad measure of the diversity and 'naturalness' of the physical (habitat) structure of a site. The HQA score is determined by the presence and extent of habitat features of known wildlife interest recorded during the field survey. Rare features, such as large waterfalls and extensive fallen trees result in additional points.

2.5.7 For HQA scores to be meaningfully interpreted they are subject to context analysis. Context analysis consists of comparing a site HQA score to the distribution of HQA scores for sites of similar type using a nearest neighbour approach. The method, approved by the EA, uses a statistical recombination of map-derived attributes representing known drivers of geomorphological change (i.e. specific stream power and shear stress; Jeffers, 1998) to select 150 sites of a similar type. A site is then assessed according to its position within the distribution of HQA scores for the 150 sites. The bottom quintile of the distribution represents very low habitat quality and the top quintile very high quality (Table 2.3).

Table 2.3 Habitat Quality Assessment class descriptions

HQA Score - Context Analysis Quintile	HQA Class	Habitat modification score
81 – 100%	1	Very high
61 – 80%	2	High
41 – 60%	3	Moderate
21 – 40%	4	Low
0 – 20%	5	Very low

2.6 Fish habitat assessment

2.6.1 Fish habitat mapping was undertaken at several sites (PEI Report Figure 8.6). The methodology used to map fish habitat was designed by a suitably qualified aquatic ecologist, to provide an overview of the potential of a river to support juvenile and adult fish.

- 2.6.2 Habitat descriptions (Table 2.4) are adapted from the EA Fisheries Technical Manual 4 - Restoration of riverine salmon habitats (Hendry and Cragg-Hine, 1997). Juvenile lamprey habitat definitions are based on descriptions in Conserving Natura 2000 Rivers: Monitoring the River, Brook and Sea Lamprey (Harvey and Cowx, 2003).
- 2.6.3 The main objective of the method is to obtain a detailed representation of the precise location, extent, condition and juxtaposition of habitats within the wetted width of the river. This is recorded by walking the riverbank and annotating high resolution maps with the habitats present. Crucially, the 'habitat' types for salmonids (e.g. fry, parr etc.), as opposed to 'flow' types, are recorded. Fish habitat types are defined by the interaction of the following variables: water depth; water velocity; substrate composition; and cover.

Table 2.4 Fish habitat definitions

Habitat type	Definition
Spawning gravel	Ideally stable (but not compacted) gravel. Mean grain size <25mm for trout and up to 80mm for salmon. 'Fines' (<2mm grain size) to be less than 20% by weight. Water depth 17-76cm. Velocity 25-90cm/s.
Fry habitat	Shallow fast flowing (50-65cm/s) water (predominantly run and riffle). Water depth <20cm. Substrate pebble and cobble dominated.
Parr habitat	Fast flowing water generally with a broken surface (predominantly run and riffle). Water depth 20-40cm. Substrate cobble and boulder dominated.
Mixed juvenile	A combination of fry and parr habitat. Fast flowing water generally with a broken surface (predominantly run and riffle) Water depth <40cm Substrate cobble and boulder dominated with few pebbles.
Pools (adult)	No perceptible flow, smooth surface. Water depth usually > 60cm. Substrate typically fine; often not visible.
Glides (adult)	Smooth surface with little turbulence. Water depth typically <30cm. Substrate generally fine dominated by pebbles and fines.
Juvenile lamprey habitat	Optimal habitat: stable, fine sediment or sand >15cm deep, low water velocity and the presence of organic detritus. Sub-optimal habitat: shallow sediment, often patchy and interspersed among coarser substrate. Also includes areas of organic detritus overlying bedrock, submerged tree roots trapping organic material, submerged silt banks, silt-dominated cattle drinks, and submerged bankside vegetation rooted in sand/silt.

- 2.6.4 Further to in-stream habitat, additional features of the watercourse were recorded and mapped where present, to provide a broader understanding of the watercourse and any pressures which may alter the suitability of the river for aquatic communities (fish, macrophytes, diatoms and macroinvertebrates). This included:
- in-stream and riparian habitat features such as width, depth, exposed substrate, bars, macrophytes, spawning redds and coarse woody debris;
 - in-stream obstacles to fish passage including natural obstacles, weirs, sluices, dams, flap gates, culverts and fords;

- point and diffuse sources of catchment pollution including domestic and industrial discharges or runoff, arable fields, livestock fields and forestry plantations; and
- river abstractions and details on fish screening facilities.

2.7 Limitations and survey constraints

- 2.7.1 The fish habitat assessment and the RHS surveys were carried out during October 2019 and January 2020. This is outside of the optimal survey season for RHS due to the seasonal nature of in-channel and riparian plants.
- 2.7.2 Some small sections of survey sites for fish habitat assessment were not accessible due to landowner permissions, physical barriers or health and safety constraints.
- 2.7.3 EA fish monitoring sites were not available within the scheme. As an alternative, sites were selected at the nearest geographic location to the scheme.

3 Results

3.1 Desk study

- 3.1.1 The location of records returned for the EA monitoring sites can be seen in PEI Report Figure 8.5. No records were returned for either the River Churn (source to Perrots Brook; WFD ID: GB106039029810) or Normans Brook (source to confluence Hatherley Brook; WFD ID: GB109054032780).
- 3.1.2 The EA data provided records of the following fish species, with species of conservation importance highlighted in red:
- **Brown trout *Salmo trutta***; Natural Environment and Rural Communities (NERC) Act - Species of Principal Importance, 2006. UK Biodiversity Action Plan (BAP) - JNCC, 2007.
 - **European eel *Anguilla anguilla***; IUCN – Critically Endangered, 2001. NERC Act - Species of Principal Importance, 2006. UK BAP - JNCC, 2007.
 - Common bream *Abramis brama*
 - Common carp *Cyprinus carpio*
 - Roach *Rutilus rutilus*
 - Perch *Perca fluviatilis*
 - Roach x bream hybrid *Rutilus rutilus x Abramis brama*
 - **Brook lamprey *Lampetra planeri***; Habitat Directive – Annex ii species, 2003.
 - **Lamprey sp. *ammocoetes***; Habitat directive – Annex ii species, 2003.
 - Three-spined stickleback *Gasterosteus aculeatus*
 - Pike *Esox lucius*
 - Tench *Tinca tinca*
 - Flounder *Platichthys flesus*
 - Gudgeon *Gobio gobio*
 - **Bullhead *Cottus gobio***; Habitat Directive - Annex ii species, 2003.
 - Dace *Leuciscus leuciscus*
 - Stone loach *Barbatula barbatula*
- 3.1.3 A summary of the desk study data by watercourse is described below.

Painswick Stream (source to confluence Stroudwater Brook)

- 3.1.4 This water body was classified as 'Moderate' for fish in 2016 under the WFD Cycle 2 classification. The pressures on the catchment preventing it from achieving 'Good' status are industrial pollution, and agriculture and rural land management.
- 3.1.5 Data from five EA fisheries monitoring sites on the Painswick Stream were available: Site 21611, Site 21608, Site 21606, Site 12219 and Site 6317.
- 3.1.6 The upstream most site, Site 21611, is 4.2km downstream of the source and has been surveyed three times over the past 20 years. Species diversity was low, with only brown trout recorded at this location.
- 3.1.7 Site 21608 is 5.1km downstream of the source and has been surveyed once in the last 20 years. Species diversity was low, with only brown trout being recorded at this location.
- 3.1.8 Site 21606 is 7km downstream of the source and has been surveyed twice in the past 20 years. Species diversity was low, with only brown trout and European eel being recorded at this location. In 2011, FCS2 analysis was run on data from Site 21606 giving an EQR of 0.3482, corresponding to a WFD status of Moderate for fish.
- 3.1.9 Site 12219 is 11.1km downstream of the source and has been surveyed once in the last 20 years. The species diversity was highest at this site (within the waterbody) with common bream, common carp, roach, perch and roach x bream hybrid being recorded at this location.
- 3.1.10 Site 6317 is 11.6km downstream of the source and has been surveyed twice in the past 20 years. Species diversity was low, with only brown trout and perch being recorded at this location. In 2011, FCS2 analysis was run on data from Site 21606 giving an EQR of 0.3072, corresponding to a WFD status of Moderate for the site in relation to fish.

Frome – source to Ebley Mill

- 3.1.11 This waterbody was classified as 'Good' for fish in 2016 under the WFD Cycle 2 classifications. Data from eight EA fisheries monitoring sites on the Frome (source to Ebley Mill) were analysed: Site 35933 Site 39210, Site 6236, Site 22431, Site 31122, Site 22531, Site 6290 and Site 3493.
- 3.1.12 Site 35933 is the furthest upstream, is 5.8km downstream of the source and has been surveyed three times in the last 20 years. Species diversity was low, with only brown trout, brook lamprey and Lamprey sp. ammocoetes being recorded at this location.
- 3.1.13 Site 39210 is 7.4km downstream of the source and has been surveyed three times in the last 20 years. Species diversity was low, with 3-spined stickleback, brown trout and European bullhead being recorded at this location. In 2015, FCS2 analysis was run on data from Site 39210 giving an EQR of 0.5784, corresponding to a WFD status of Good for the site in relation to fish.
- 3.1.14 Site 6236 is 15.6km downstream of the source and has been surveyed six times in the last 20 years. Species diversity was high at this site, with 3-spined stickleback, brown trout, European bullhead, brook lamprey, lamprey sp. and roach being recorded at this location. In 2013, FCS2 analysis was run on data

from Site 6236 giving an EQR of 0.5006, corresponding to a WFD status of Good for the site in relation to fish.

- 3.1.15 Site 22431 is 19.0km downstream of the source and has been surveyed once in the last 20 years. Species diversity was low at this site, with only brown trout being recorded at this location.
- 3.1.16 Site 31122 is 19.6km downstream of the source and has been surveyed five times in the last 20 years. Species diversity was low at this site, with only brown trout and European eel being recorded at this location.
- 3.1.17 Site 22531 is 22.3km downstream of the source and has been surveyed once in the last 20 years. Species diversity was low at this site, with only brown trout and European eel being recorded at this location.
- 3.1.18 Site 6290 is 24.5km downstream of the source and has been surveyed once in the last 20 years. Species diversity was low at this site, with only brown trout and European eel being recorded at this location.
- 3.1.19 Site 3493 is 24.9km downstream of the source and has been surveyed six times in the last 20 years. Species diversity was high at this site, with 3-spined stickleback, brown trout, European eel, lamprey sp., perch, pike and roach.

Horsbere Brook (source to confluence River Severn)

- 3.1.20 This waterbody was classified as 'Poor' for fish in 2016 under the WFD Cycle 2 classifications. The pressures on the catchment preventing it from achieving 'Good' or 'Moderate' status are barriers and impoundments. Data from six EA fisheries monitoring sites on Horsbere Brook were analysed: Site 50167, Site 50166, Site 30451, Site 30452, Site 13387 and Site 10278.
- 3.1.21 The most upstream site, Site 50167, is 3.1km downstream of the source and has been surveyed once in the last 20 years. Species diversity was average at this site, with brown trout, European eel, perch and roach being recorded at this location.
- 3.1.22 Site 50166 is 3.6km downstream of the source and has been surveyed once in the last 20 years. Species diversity was average at this site, with brown trout, European eel, perch and roach being recorded at this location.
- 3.1.23 Site 30451 is 6.3km downstream of the source and has been surveyed three times in the last 20 years. Species diversity was low at this site, with European eel, tench and roach being recorded at this location. In 2013, FCS2 analysis was run on data from Site 30451 giving an EQR of 0.039, corresponding to a WFD status of Poor for the site in relation to fish.
- 3.1.24 Site 30452 is 8.2km downstream of the source and has been surveyed once in the last 20 years. Species diversity was low at this site, with European eel, gudgeon and tench being recorded at this location.
- 3.1.25 Site 13387 is 10.4km downstream of the source and has been surveyed twice in the last 20 years. Species diversity was low at this site, with only European eel being recorded at this location. In 2012, FCS2 analysis was run on data from Site 13387 giving an EQR of 0.3436, corresponding to a WFD status of Moderate for the site in relation to fish.

- 3.1.26 Site 10278 is 11.8km downstream of the source and has been surveyed once in the last 20 years. Species diversity was low at this site, with only gudgeon being recorded at this location.

Hatherley Brook (source to River Severn)

- 3.1.27 This waterbody was classified as ‘Good’ for fish in 2016 under the WFD Cycle 2 classifications. Data from two fisheries monitoring sites on Hatherley Brook were analysed: Site 4345 and Site 10276.
- 3.1.28 The most upstream site, Site 4345, is 12.0km downstream of the source and has been surveyed once in the last 20 years. Species diversity was average at this site, with bream, common carp, perch and roach being recorded at this location.
- 3.1.29 Site 10276 is 12.7km downstream of the source and has been surveyed twice in the last 20 years. Species diversity was high at this site, with 3-spined stickleback, dace, European eel (glass eel, elver and adult), flounder, gudgeon and stone loach being recorded at this location.

3.2 River Habitat Survey

- 3.2.1 RHS surveys were conducted on three reaches of waterbodies within the scheme and wider catchment. The results are summarised below, with the full data provided in Appendix A.

Site 1 – Upstream of A417 (SO9285615723)

- 3.2.2 This section of Norman’s Brook is classified as “Severely Modified” (Class 5, HMS = 4055). The HMS is driven by the presence of weirs, culverts and the artificial bed and bank materials associated with them. Despite its modified state, the natural features within the river corridor and high habitat diversity result in a HQA score of 64. This places this section of river in HQA Class 2, indicating that it is of “High” habitat quality, when compared to similar rivers in the RHS database. The overall habitat quality score is driven by high sub-scores for vegetation structure, number of flow types and the variety of substrates present. The watercourse flows through broadleaved woodland. Channel vegetation included liverworts and emergent reeds.

Site 2 – Downstream of A417 (SO9134216295)

- 3.2.3 This section of Norman’s Brook is classified as “Severely Modified” (Class 5, HMS = 2170). The HMS is driven by the presence of channel realignment, culverts, bridges and the artificial bed and bank materials associated with them. The HQA score of 39 places this section of river in HQA Class 4, indicating that it is of “Low” habitat quality, when compared to similar rivers in the RHS database. The overall low habitat quality score is driven by the absence of natural channel and bank features, and the due to the low diversity of substrates present. The watercourse flows through tall herbs and scrub. Channel vegetation included liverworts, emergent broad-leaved herbs and emergent reeds.

Site 3 – Tributary of Horsbere Brook (SO9136715494)

- 3.2.4 The surveyed section of this river is classified as “Severely Modified” (Class 5, HMS = 2000). The HMS is driven by the presence of channel realignment and culverts. The HQA score of 44 places this section of river in HQA Class 4, indicating that it is of “Low” habitat quality, when compared to similar rivers in the RHS database. The overall low habitat quality score is driven by the absence of

natural bank features, and the low diversity in substrate type and in-channel plants recorded. The watercourse is characterised by a realigned and culverted channel flowing through irrigated land. Channel vegetation was limited to liverworts.

3.3 Fish habitat assessment

3.3.1 The results of the fish habitat assessment are detailed in PEI Report Figures 8.7-8.12. Details of the barriers to fish passage recorded are provide in Table 3.1 with their location shown in PEI Report Figures 8.7 to 8.12. Photographs taken during the surveys are provided in Appendix B.

Site 1: Norman's Brook - Upstream of A417

3.3.2 Site 1 (PEI Report Figure 8.7) is situated on Norman's Brook near to Dog Lane, upstream of the existing A417. At the time of the survey the river was in a flow fed by autumnal rain and groundwater. This site is in a rural setting with the surrounding land use used for recreational and agricultural activities. The riparian habitat is comprised of scrub, wet woodland, marginal vegetation and semi-improved grassland.

3.3.3 Fish habitat within the Site 1 survey area is fragmented by several man-made weirs and other barriers, as described in Table 3.1. The dominant habitat across the reach was mixed juvenile (fry and parr habitats), with some potential lithophilic spawning (gravel) habitat recorded downstream of the weirs.

3.3.4 Whilst habitat suitable for mixed juvenile fish (salmonid fry and parr) and potential salmonid spawning habitat was recorded, it is considered highly unlikely that this reach provides spawning habitat for salmonids migrating from the wider catchment due to the high number of impassable weirs. However, there is potential for the reach to support an isolated population of brown trout and bullhead.

Site 2: Normans Brook - Downstream of A417

3.3.5 Fish habitat within the Site 2 (PEI Report Figure 8.8) survey area is heavily fragmented by a number of weirs and other obstacles, as described in Table 3.1. This site is in a semi-rural setting with the surrounding land use used for agricultural activities and residential housing. Organic matter had accumulated around several weirs, causing low flow and a build-up of wide, shallow water behind the weirs. Downstream of these, run was the dominate flow type across the reach with pools present.

3.3.6 This reach has a range of habitats with the potential to support a mixed coarse and salmonid population, as well as lamprey.

Site 3: Horsbere Brook

3.3.7 Fish habitat within the Site 3 (PEI Report Figure 8.9) survey area is fragmented by a number of weirs and culverts, as described in Table 3.1. Several areas were inaccessible to survey. The only habitat type recorded at this site was mixed juvenile and adult habitat was absent.

3.3.8 This reach has the potential to support juvenile salmonids and bullhead.

Site 4: Tributary of River Churn

3.3.9 Fish habitat within the Site 4 (PEI Report Figure 8.10) survey area was predominantly unsuitable for fish due to low water levels, however there was a small amount of mixed juvenile habitat present. No barriers to fish passage were identified on site.

3.3.10 This reach is unlikely to support a significant fish assemblage, due to shallow depth, low flow and the silt dominated substrate.

Site 5: Tributary of River Churn

3.3.11 Fish habitat within the Site 5 (PEI Report Figure 8.11) survey area is fragmented by several barriers and weirs, as described in Table 3.1. The dominant habitat recorded was mixed juvenile, with some deeper parr habitat present. There is a pool at the downstream end of the reach providing some adult habitat.

3.3.12 This reach has potential to support a mixed coarse fish and salmonid population.

Site 6: Tributary of River Frome

3.3.13 Fish habitat within the Site 6 (PEI Report Figure 8.12) survey area is fragmented by weirs and culverts, as described in Table 3.1. All habitat upstream of the pool is considered to be of poor quality, consisting of agricultural drainage ditches that are heavily managed. The dominant habitat type recorded was mixed juvenile, with some potential some spawning habitat noted at the downstream end of the site. However, immediately downstream of this habitat, there is a series of five weirs obstructing fish passage.

3.3.14 This reach is disconnected from the wider catchment due to a series of weirs and is therefore considered to be accessible to migratory fish from the wider catchment. However, there is potential for the reach to support isolated populations of brown trout and bullhead.

3.3.15 Details of the barriers to fish passage recorded are provide in Table 3.1 with their location shown in PEI Report Figures 8.7 to 8.12.

Table 3.1 Barriers to fish passage

Site and reference for ID	ID	Barrier type	Description
1 (A)	AB1	Natural barrier	Log jam, 0.7m long and 0.7m diameter
	AB2	Natural barrier	Wooded, stepped drop with organic matter accumulation behind obstruction.
	AW1	Man-made weir	Stepped weir. Varies between 0.5m to 1.0m drops
	AW2	Man-made weir	Stepped weir. Varies between 0.5m to 1.0m drops
	AW3	Man-made weir	Stepped weir. Varies between 0.5m to 1.0m drops
	AW4	Man-made weir	Stepped weir. Varies between 0.5m to 1.0m drops
	AW5	Man-made weir	Stepped weir. Varies between 0.5m to 1.0m drops
	AW6	Man-made weir	Stepped weir. Varies between 0.5m to 1.0m drops
	AW7	Man-made weir	Stepped weir. Varies between 0.5m to 1.0m drops
	AW8	Man-made weir	Stepped weir. Varies between 0.5m to 1.0m drops
	AW9	Man-made weir	Stepped weir. Varies between 0.5m to 1.0m drops
	AW10	Man-made weir	Concrete 2.5m weir. Barrier to all fish passage except potentially eel.
AC1	Culvert	Outflow culvert at end of survey reach. Roughly 20m long with continuation from site.	

	AC2	Culvert	Inflow culvert connecting to AC1. 8.0m long and 5.0m in diameter. Increase in flow velocity at this point.
	AC3	Culvert	Culvert after AW10. 0.7m height, 0.3m width and approximately 50m long. High flow velocity at this point.
	AC4	Culvert	Culvert with no access. 0.5m height, 0.7m width and approximately 12m long. No fish passage through culvert
2 (B)	BW1	Natural	Assumed natural although close to managed areas where a bridge is present; unable to view properly due to habitat overgrowth. Approximately 0.5m width and 0.5m drop (including pool).
	BW2	Natural	Long, natural obstruction. 1.5m width and 2.0m length with white water forming at the bottom.
	BW3	Natural	Stepped, likely to be clay or bedrock formation. Approximately 0.5m width and 0.75m drop (including pool).
	BC1	Culvert	Culvert located at the start of the reach. Approximately 0.5m diameter. Unknown length. Outflow from CC2
	BC2	Culvert	Culvert under road. Approximately 3.0m length and 0.5m diameter. Inflow into CC1.
	BC3	Culvert	Culvert under housing/commercial buildings. Small, stepped weir at culvert exit, likely artificial concrete base. Approximately 0.75m diameter. Outflow from CC4.
	BC4	Culvert	Culvert under housing/commercial buildings. Approximately 0.75m diameter and 7.0m length. Channel prior to culvert is modified and reinforced with concrete and steel, encouraging faster flow through culvert entrance. Inflow into CC3.
	BC5	Culvert	Assumed culvert under residential buildings. Culvert not visible, so no observations can be made.
	BC6	Culvert	Culvert under residential driveway. Approximately 0.5m diameter and 4.0m length. Assumed inflow into CC5.
BC7	Culvert	Culvert at end of survey reach. Unknown dimensions.	
3 (C)	CW1	Natural	Natural obstruction, 0.5m width with 0.5m drop. Weir is stepped in nature with a small drop.
	CB1	Barrier	Organic matter accumulation spanning the full channel width. 0.5m width and approximately 0.3m in height/depth.
	CB2	Barrier	Dry stone wall. Unknown age, moss growing on the face. 0.75m width and 1.25m depth. Most likely used for passage of livestock between fields. Unlikely to allow passage for fish.
	CB3	Natural barrier	Tree fall with large trunk spanning channel width. Organic matter accumulation behind tree trunk. Approximately 1.5m width and 2.0m height.
	CC1	Culvert	Piped culvert, approximately 0.5m diameter. Unknown length
	CC2	Culvert	Piped culvert, approximately 0.5m diameter. Unknown length
	CC3	Culvert	Piped culvert, approximately 0.5m diameter. Approximately 5.0m length and is believed to connect to BC4 and BC5. High flow exiting pipe.

	CC4	Culvert	Piped culvert, approximately 0.5m diameter. Unknown length. Believed to connect to BC3 and BC5.
	CC5	Culvert	Piped culvert, approximately 0.5m diameter. Unknown length. Believed to connect to BC3 and BC4.
	CC6	Culvert	Piped culvert under road, approximately 0.5m diameter. Unknown length.
4 (D)	DC, DW or DB; N/A	N/A	Restrictions to passage such as weirs or natural barriers were not noted at this site. A culvert was noted at the beginning of the site but this was not mapped as it was outside of the survey area.
5 (E)	EB1	Barrier	Lots of logs and woody debris. Natural barrier to fish passage and migration.
	EB2	Barrier	Fallen bridge fencing causing organic matter accumulation in channel and restricting fish passage. Related to EB3
	EB3	Barrier	Fallen bridge fencing causing organic matter accumulation in channel and restricting fish passage. Related to EB2
	EB4	Barrier	Fallen bridge within the channel causing barrier to fish passage.
	EW1	Man-made weir	Artificial, concrete weir holding back the pond. No passage of any fish apart from eel.
	EC1	Culvert	Culvert leading into Clerk's Patch woodlands.
6 (F)	FW1	Man-made weir	Artificial weir, 1.0m drop including pools.
	FW2	Weir	No comments made
	FW3	Man-made weir	Sloped artificial weir. Approximately 6.0m long, angle of 20 degrees and a drop of 0.5m.
	FW4	Man-made weir	Sloped artificial weir. Unknown length with and angle of 50 degrees. Drop of 0.75m including pool. Impassable to all fish.
	FW5	Weir	No comments made
	FW6	Weir	No comments made
	FC1	Culvert	Culverted section of pipe, assumed to be linked to FC1
	FC2	Culvert	Culverted section with pipe roughly 0.5m diameter. No estimations made to length of piped section
<p>ID key:</p> <ul style="list-style-type: none"> • Site name (A, B, C, D, E or F); • obstruction type (B = barrier, W = weir or C = culvert); and • number recorded (1 – 10) <p>For example; An ID labelled AB1 indicates the first barrier to be identified at sample site 1.</p>			

4 Conclusion

- 4.1.1 Seventeen fish species were identified during the desk study. Based on desk study records, the following fish species of conservation importance have the potential to be within the scheme:
- Brown trout; NERC Act - Species of Principal Importance, 2006. UK BAP - JNCC, 2007.
 - European eel; IUCN – Critically Endangered, 2001. NERC Act - Species of Principal Importance, 2006. UK BAP - JNCC, 2007.
 - Brook lamprey; Habitat directive – Annex ii, 2003.
 - Lamprey sp. ammocoetes; Habitats Directive – Annex ii species, 2003.
 - European bullhead; Habitats Directive - Annex II species, 2003.
- 4.1.2 Fish habitat within the survey sites is fragmented by significant weirs and culverts, many of which are considered to be impassable to all fish species (with the potential exception of European eel). Nevertheless, diverse and varied habitats with the potential to support all life stages of salmonids, and potentially coarse fish were recorded, should isolated populations exist.
- 4.1.3 If development proposals will impact watercourses that support notable fish species, then mitigation will be required to protect the integrity of the fish communities present.
- 4.1.4 Detailed impact assessment and mitigation measures will be addressed in the Biodiversity chapter of the Environmental Statement.

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Appendix A River habitat survey results

Table A.1 Site 1

Survey parameters	Results
Upstream grid reference	SO9285615723
Downstream grid reference	SO9238215706
Date	29/10/2019
Predominant valley form	Deep vee
Number of riffles, pools and point bars	6 riffles, 3 pools and 1 unvegetated point bar
Realigned channel	No
Over-deepened channel	No
Impoundments	Yes, <33%
Banktop land use and vegetation structure	Broadleaved woodland with continuous trees on both banks
Channel dimensions	Left bank top height 0.4m Right bank top height 0.45m Channel bank full width 2.25m Channel water depth 0.04m Channel water width 1.75m
Locations of channel measurements	Riffle
Embankments	None present
Trashline	None present
Bed material	Consolidated
Invasive species	None present
Habitat Modification Score	4055
Habitat Modification Class	5 – Severely Modified
Habitat Quality Assessment Score	65
HQA Class	2 – High habitat quality

Table A.2 Site 2

Survey parameters	Results
Upstream grid reference	SO9134216295
Downstream grid reference	SO9111316693
Date	16/01/2020
Predominant valley form	No obvious valley side
Number of riffles, pools and point bars	2 pools, no riffles or point bars
Realigned channel	Yes, <33%
Over-deepened channel	Yes, <33%
Impoundments	No
Banktop land use and vegetation structure	Tall herbs/scrubs with semi-continuous trees on both banks
Channel dimensions	Left bank top height 0.25m Right bank top height 0.25m Channel bank full width 1.00m Channel water depth 0.20m Channel water width 0.50m
Locations of channel measurements	Riffle
Embankments	None present
Trashline	None present
Bed material	Unconsolidated
Invasive species	None present
Habitat Modification Score	2170
Habitat Modification Class	5 – Severely Modified
Habitat Quality Assessment Score	39
HQA Class	4 – Low habitat quality

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Table A.3 Site 3

Survey parameters	Results
Upstream grid reference	SO9136715494
Downstream grid reference	SO9099215545
Date	16/01/2020
Predominant valley form	No obvious valley side
Number of riffles, pools and point bars	9 riffles, 3 pools, 1 unvegetated point bar
Realigned channel	Yes, >33%
Over-deepened channel	No
Impoundments	No
Banktop land use and vegetation structure	Irrigated land with semi-continuous trees on both banks
Channel dimensions	Left bank top height 1.00m Right bank top height 0.75m Channel bank full width 0.50m Channel water depth 0.05m Channel water width 0.50m
Locations of channel measurements	Riffle
Embankments	None
Trashline	None
Bed material	Unconsolidated
Invasive species	None present
Habitat Modification Score	2000
Habitat Modification Class	5 – Severely Modified
Habitat Quality Assessment Score	44
HQA Class	4 – Low habitat quality

Appendix B Photos



Site 1 – Potential lamprey habitat



Site 1 – Natural broad crested weir which is impassable for migratory species



Site 2 - Natural weir with an inclined crest



Site 2 - Habitat suitable for mixed juveniles



Site 3 - Suitable mixed juvenile habitat with some spawning potential



Site 3 - Habitat identified as unsuitable for fish



Site 4 – Pipe culvert



Site 4 – Habitat surrounded by deciduous woodland



Site 5 – Mixed juvenile habitat with margins providing potential lamprey habitat



Site 5 – Man made concrete and metal barrier made impassable to migratory fish; except eel



Site 6 – Large, man-made concrete weir with a vertical drop.



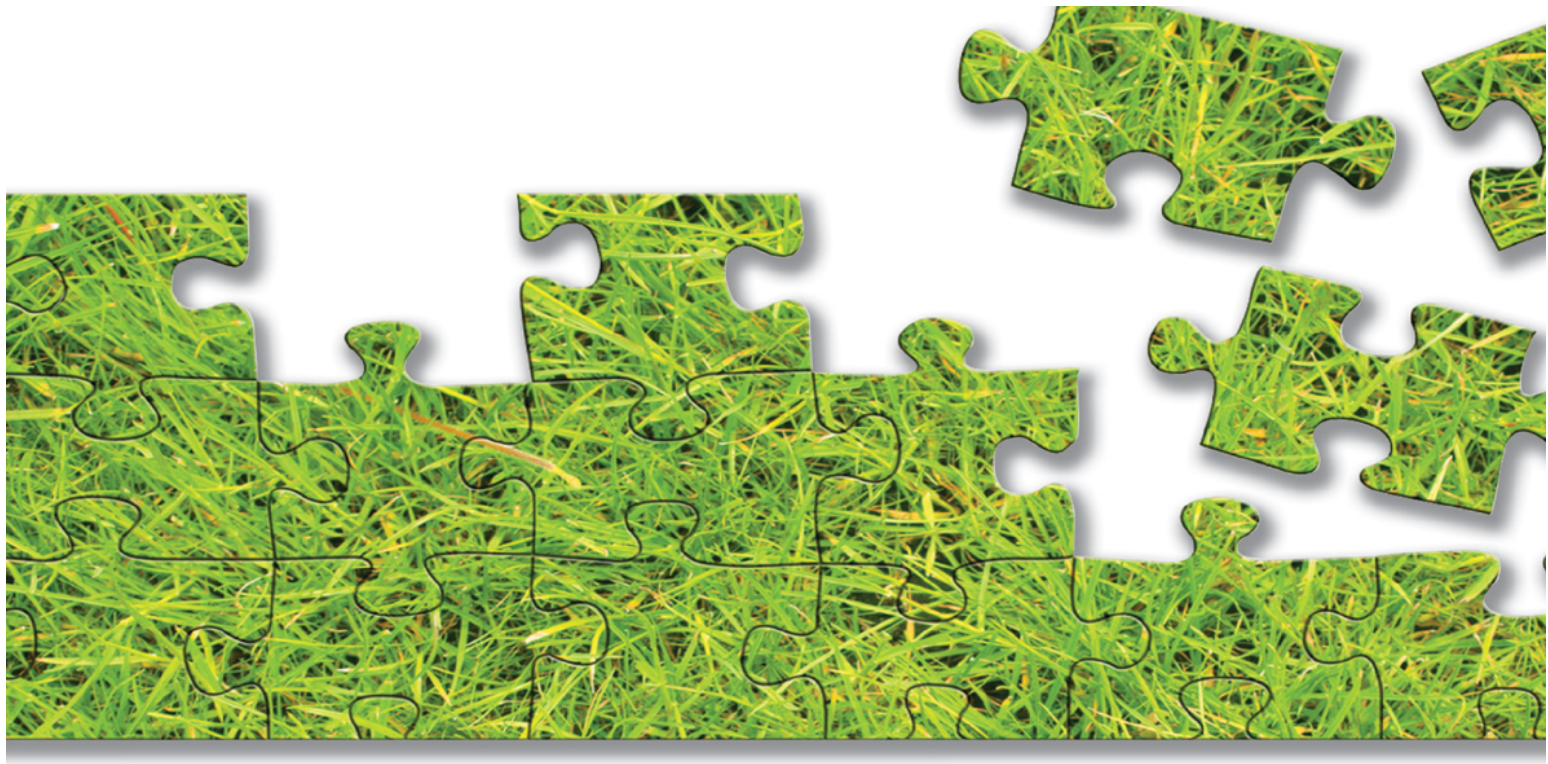
Site 6 – Mixed juvenile habitat with marginal, emergent and submerged macrophytes.

A417 Missing Link

Preliminary Environmental Information Report

Appendix 8.24
Assessment of tufaceous vegetation

28 September 2020



VEGETATION SURVEY & ASSESSMENT

A417 MISSING LINK SCHEME

ASSESSMENT OF TUFACEOUS VEGETATION

Revised July 2020



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I. INTRODUCTION

I.1 Scope of Work and Objectives

This report is the product of a contract to botanically assess and characterise a number of hydrological features near Birdlip in Gloucestershire and determine whether they should be regarded as the Annex I habitat H7220 Petrifying springs with tufa formation (Cratoneurion).

The majority of features were identified during previous ecological assessments of land likely to be directly or indirectly affected by construction of the proposed A417 Missing Link Scheme.

I.2 Conservation Context

Under the EC Habitats Directive (92/43/EEC), tufaceous deposits which qualify as the Annex I habitat H7220 Petrifying springs with tufa formation (Cratoneurion) are defined as 'hard water springs with active formation of tufa'. These formations are found in such diverse environments as woodlands or open countryside. They are generally small (point or linear formations) and dominated by the pleurocarpous moss *Palustriella commutata* (referred to hereafter in this report as *Palustriella*).

In the UK, the vegetation of such springs conforms to the National Vegetation Classification (NVC) types M37 *Palustriella commutata* - *Festuca rubra* spring community and M38 *Palustriella commutata* - *Carex nigra* spring community. As the M38 *Palustriella commutata* - *Carex nigra* spring community is confined to the uplands and is characteristic of montane springs in the northern Pennines and the central Scottish Highlands (Rodwell 1991), it is not considered relevant to the current assessment.

The most extensive and/or best developed examples of the M37 *Palustriella commutata* - *Festuca rubra* spring community also tend to be found in upland districts. The majority of sites which have been selected as Special Areas of Conservation because of the presence of the Annex I habitat H7220 Petrifying springs with tufa formation (Cratoneurion) are in upland, lime-rich parts of northern England, Wales and Scotland. Tufaceous springs represented by the M37 *Palustriella commutata* - *Festuca rubra* spring community also occur locally in southern England and other lowland areas, but such examples are poorly represented in the literature and further study is needed to characterise these properly.

In the lowlands, the M37 *Palustriella commutata* - *Festuca rubra* spring community is also usually dominated by *Palustriella*, although locally *Cratoneuron filicinum* may wholly or partially replace it. Other associates vary greatly but often include *Festuca rubra* (Red Fescue), *Agrostis stolonifera* (Creeping Bent) and the bryophytes *Bryum pseudotriquetrum*, *Didymodon tophaceus* and *Pellia endiviifolia*.

Tufa formation is usually, but not exclusively, associated with hard-water springs, where lime-rich groundwater comes to the surface. On contact with the air, carbon dioxide is lost from the water and a hard deposit of calcium carbonate is formed. These conditions occur most often in areas underlain by limestone or other calcareous rocks, and particularly in the uplands of northern England and the Scottish Highlands.

There is no standard classification for the freshwater carbonate deposits known as tufa. Pentecost (1981) describes tufa as a soft, porous, calcareous rock formed in springs, waterfalls and lakes in limestone regions and Pedley (1990) describes it as a highly porous or "spongy" freshwater carbonate rich in microphytic and macrophytic growths, leaves and woody tissue. A number of different kinds of tufa deposit have been described (Table 1). An alternative term, travertine, is generally used to describe older, well lithified and often laminated deposits and is not considered applicable to the features assessed in the current work.

Table 1. Geomorphological classification of tufa formation types (from Lyons and Kelly, 2016)

<u>Category</u>	<u>Description</u>
Cascade	Developing on steep slopes at varying distances from the water source; characterised by massive, frequently complex build-ups
Dam	Similar to cascades but forming along streams and rivers and causing the impoundment of water behind a tufa crest
Stream crust	Sheet-like deposits forming in streams of intermediate to low gradient; these may merge with cascades
Paludal	Formed in low gradient mires where tufa accumulates around the bases of plants, often surrounded by carbonate muds
Cemented rudites	Gravels etc. cemented by tufa; often found on coasts where spring water seeps onto shingle banks
Oncoids/ooids	Unattached, coated grains (<1mm up to 30cm); the cortex may consist of biotic or abiotic particles, such as stones or plant fragments

As well as being a rare kind of habitat, H7220 Petrifying springs with tufa formation (Cratoneurion) are vulnerable to loss and change because they are:

- often small - many examples are only a few square metres in extent;
- isolated and vulnerable to changes in management;
- sensitive to abstraction or interruption of groundwater – this can cause dewatering and loss of characteristic and rare species;
- low nutrient habitats - nutrient enrichment from surface water, groundwater and/or atmospheric pollution is associated with a decrease in species richness and loss of rare species.

2. METHODOLOGY

Four hydrological features where tufaceous vegetation might be present were assessed. Two of these were along a tributary of Norman's Brook south of the A417 near Crickley Hill (G231 and G81, at Ordnance Survey National Grid Reference SO 9281 1573 and SO 9240 1570 respectively). The other two were near Watercombe Farm, Brimpsfield (G111 and an un-named spring and rivulet rising nearby in Bushley Muzzard, Brimpsfield Site of Special Scientific Interest at SO 9439 1318 and SO 9434 1342 respectively). The latter site was highlighted in the course of a botanical survey of the SSSI (Pilkington 2019) whereas the other three had been identified in earlier ecological/hydrological surveys associated with the road scheme assessment.

All four sites were surveyed in good weather conditions on 19th March 2020 by Sharon Pilkington, a professional botanist, bryologist and vegetation ecologist with 20 years' experience of botanical assessment.

There is no standard methodology applicable to ecological assessment of tufaceous vegetation. In 2014, Natural Resources Wales (NRW) let a contract to investigate the hydrology, topography and vegetation of certain Welsh examples of this feature (Farr, Graham and Stratford, 2014). The current methodology is based loosely on the approach taken to the ecological aspects of that work.

A visual assessment of each feature was undertaken to determine the ecological boundary of the tufa formation (where present) and its associated vegetation. This focussed on homogenous vegetation dominated by *Palustriella* and/or *C. filicinum*.

Where tufaceous vegetation was found, a detailed field map was drawn, noting locations of individual spring heads, runnels and tufa and *Palustriella* / *C. filicinum*-dominated vegetation. Photographs were also taken to highlight particular details. Each feature was also sketched to produce an overview map placing it in the context of other physical features nearby.

Within the constraints imposed by the season, a complete list of vascular plants, bryophytes (mosses, liverworts and hornworts) and macroalgae was recorded for each feature with the occurrence of each species recorded using the DAFOR scale¹. Where a feature was in woodland, woody species were noted only where they were rooted within the feature.

Although formal NVC sampling was not undertaken, the species present in each hydrological feature meant that it was mostly straightforward to visually assign vegetation to NVC communities as described by Rodwell (1991). Where the M37 *Palustriella commutata* - *Festuca rubra* spring community was found to be present, a condition assessment was undertaken against attributes and targets indicated by Common Standards Monitoring (CSM) guidance (JNCC 2004).

¹ DAFOR: Dominant, Abundant, Frequent, Occasional, Rare (relative to the survey area)

3. RESULTS

Botanical nomenclature used in this report follows Stace (2019) for vascular plants and Hill *et al* (2008 as amended) for bryophytes. Appendix I shows tabulated data collected from all sites where sampling was undertaken. A record of CSM attributes and targets used for the condition assessment (adapted from JNCC 2004) is provided as Appendix II.

3.1 Feature G23 I

A tufaceous stream crust 1-3 metres wide occupies the channel of a small rivulet entering the Norman's Brook tributary in mature W8 *Fraxinus excelsior* – *Acer campestre* – *Mercurialis perennis* woodland (Figure 1). At the time of survey, it was fed by a single spring rising in pasture, flowing into a grassy runnel and in turn a shallow, silt-bottomed pool used by drinking livestock and heavily poached around its margins. Like the runnel and spring, the pool lacks tufa deposits and is dominated by *Glyceria* (a sweet-grass) and *Juncus inflexus* (Hard Rush).

The stream crust (Figure 2) is intact and undisturbed, extending from the outfall of the pool (where there is a fence) approximately 12 m downhill at an estimated gradient of 20° to the brook, where it ends in a prominent tufaceous step covered in *Palustriella* (Plate 1). Oncoidal/oidal tufa is also present on twigs and stones lying on top of the stream crust.

The stream crust supports sparse bryophyte-dominated vegetation that is consistent with a relatively poorly developed example of the M37 *Palustriella commutata* - *Festuca rubra* spring community. *Palustriella* is frequent but forms less than 5% cover. Also frequent are *C. filicinum*, *Pellia endiviifolia* and *Chrysosplenium oppositifolium* (Opposite-leaved Golden-saxifrage), none of which exceed 2% cover.

Figure 1

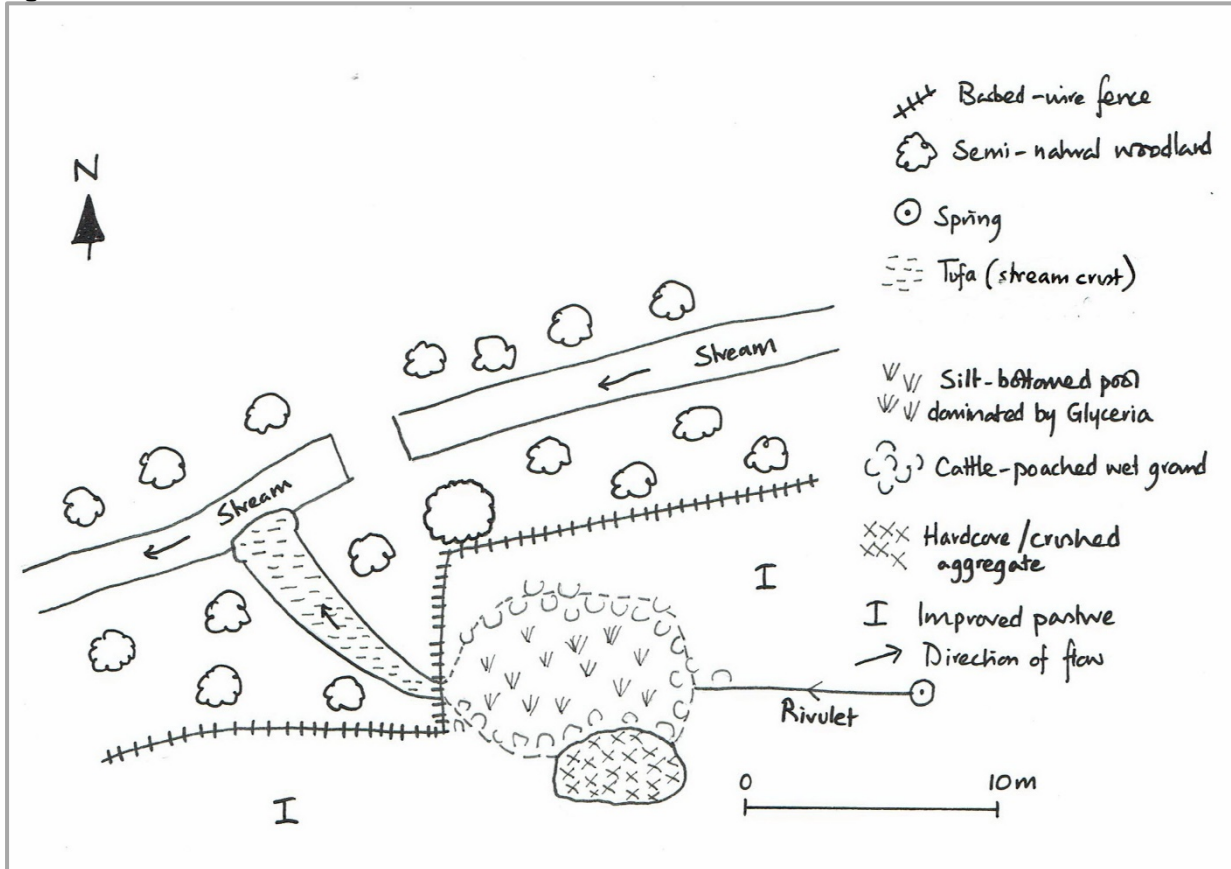
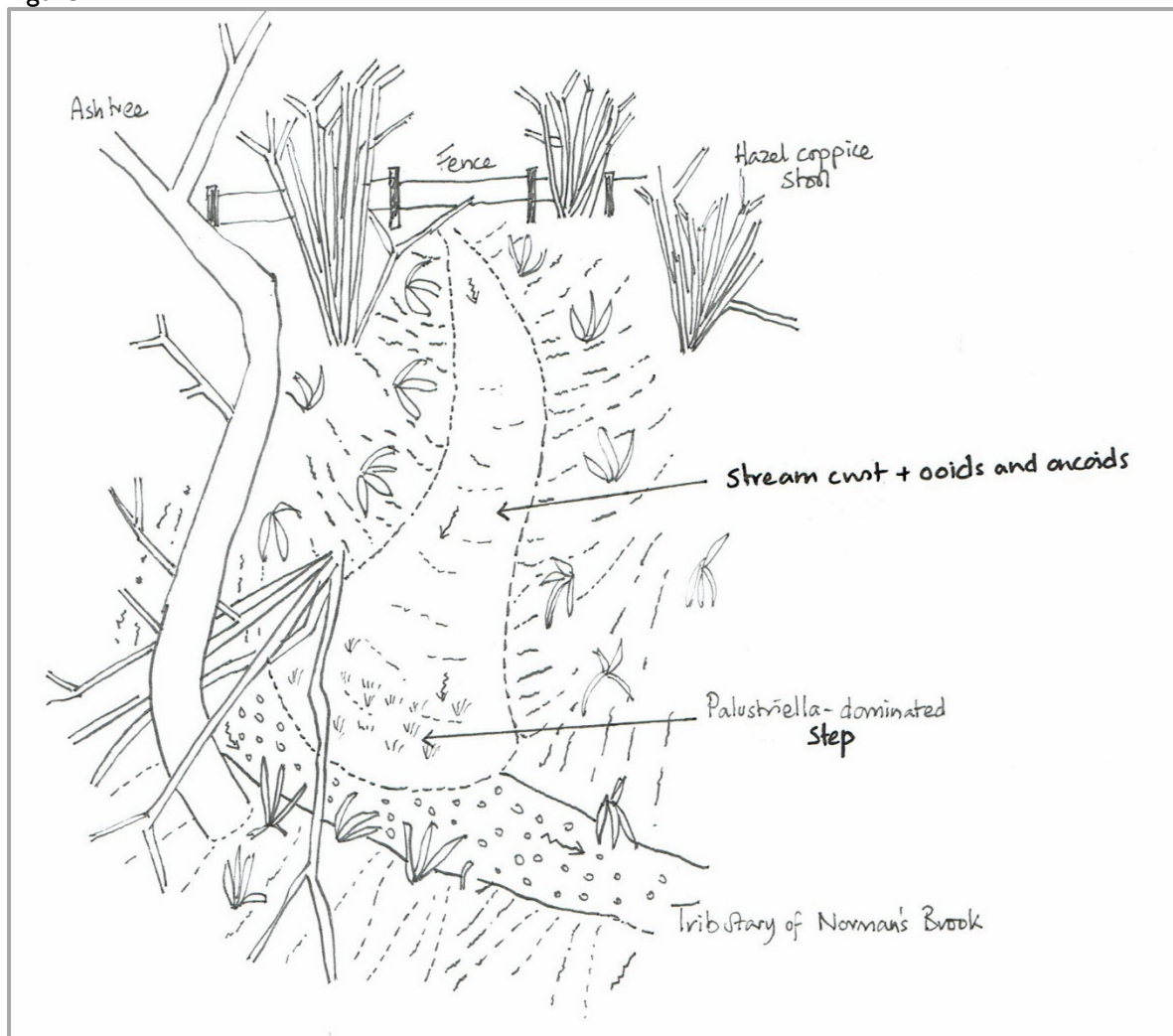


Figure 2



A condition assessment of this feature (Table 2) indicates that it is in Unfavourable Condition, largely because the stream crust is not vegetated sufficiently.

Table 2. Condition Assessment of Feature G231

Mandatory attribute	Result	Favourable/unfavourable
Habitat structure: exposed substrate	80%	Unfavourable (M37)
Habitat structure: litter	Negligible	Favourable
Vegetation composition: positive indicators	3 positive indicators present, combined cover of <i>Palustriella</i> and <i>C. filicinum</i> <10%	Favourable - indicates poorly developed M37
Vegetation composition: indicators of negative change – undesirable non-woody species	No invasive non-native species present; <i>Kindbergia praelonga</i> O	Favourable
Vegetation composition: indicators of negative change – woody species	None	Favourable

Plate 1



3.2 Feature G81

Feature G81 lies within the same stream catchment as G231 and is approximately 500 metres from that feature. However, it has quite different physical character and vegetation. It comprises a springline flush in gently dipping wet woodland below the A417. The whole flush is approximately 30 metres wide and extends 20–25 m from the stream to the springs (Figure 3).

Each of the three springs flows into a small silty runnel which meanders southwards through the flush to the brook. There is a very small amount of oncoidal/ooidal tufa on small stones and twigs in two of the runnels (Plate 2) but no other tufa deposits, nor bryophytes characteristic of tufaceous vegetation are present.

Between runnels the flush is characterised by wet silt with high cover of *C. oppositifolium* (Plate 3). Frequent to abundant associates include the moss *Brachythecium rivulare*, *Equisetum telmateia* (Great Horsetail), *Carex pendula* (Pendulous Sedge), *Poa trivialis* (Rough Meadow-grass) and more locally, *Urtica dioica* (Common Nettle). Sprawling mature *Salix cinerea* (Grey Willow) forms a semi-open canopy of sorts and nearby *Alnus glutinosa* (Alder) over *U. dioica* indicates a transition to W6 *Alnus glutinosa* – *Urtica dioica* woodland, a common and widespread form of lowland wet woodland.

In NVC terms, this springline flush can be classified as M36 *Lowland springs and streambanks of shaded situations*, a community of the field and ground layers of various kinds of wet woodland where seepage lines and damp stream banks occur (Rodwell 1991). The prominence of *C. oppositifolium* and several other associates is highly characteristic. M36 *Lowland springs and streambanks of shaded situations* is not associated with tufaceous vegetation and is not regarded as a qualifying NVC community of the Annex I habitat H7220 Petrifying springs with tufa formation (Cratoneurion). No condition assessment of the feature was therefore undertaken.

Figure 3

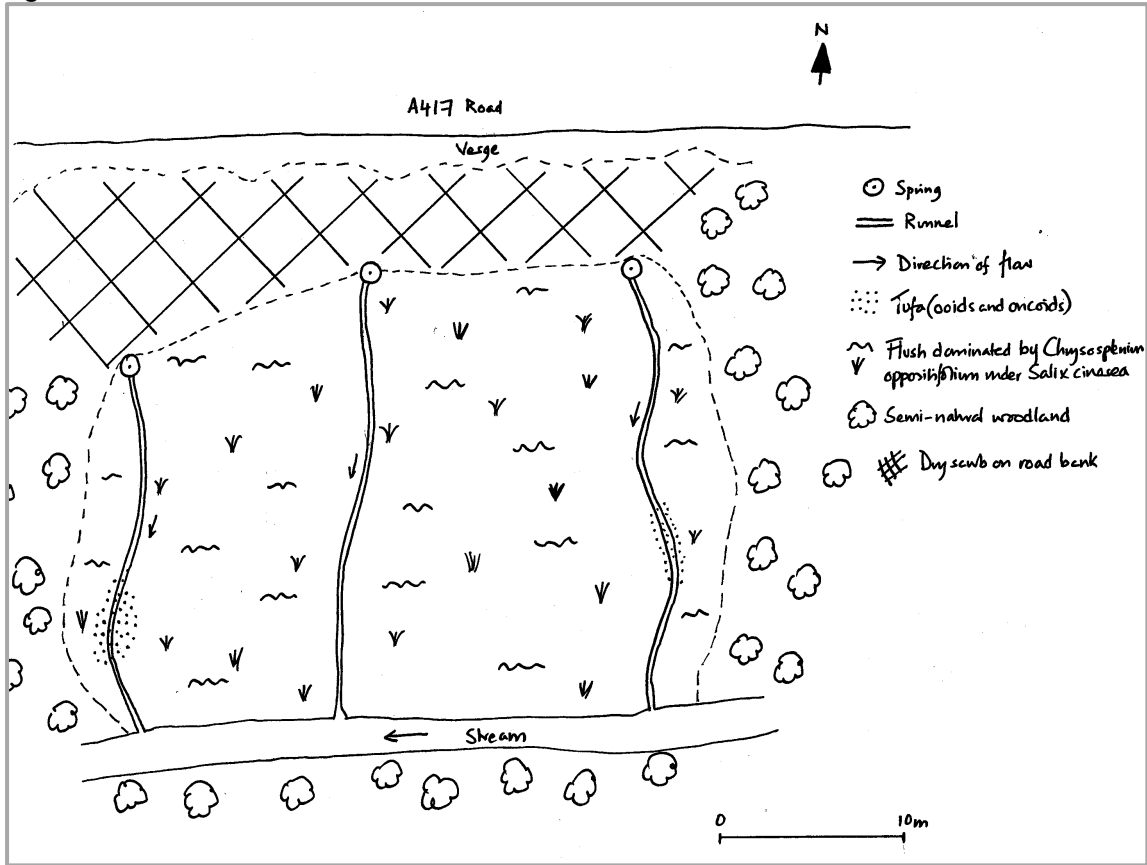


Plate 2



Plate 3



3.3 Feature GIII

A potential tufa-forming deposit was highlighted at the outfall of a pond in open secondary woodland and scrub (Figure 4). Inspection of this feature showed that no tufaceous vegetation is present, although there is some local deposition of hard calcium carbonate crusts on man-made weir structures and on rocks in the stream immediately below the weir.

Vegetation in the stream is dominated by common riparian mosses growing on rocks and concrete and in particular *Platyhypnidium riparioides* and *B. rivulare*. A species of *Vaucheria*, a green pelt-like filamentous alga, is also frequent in the flowing water. A single mound of *Palustriella* is growing on one side of the concrete weir (Plate 4) but this species is absent from the rest of the feature.

Feature GIII's vegetation is not referable to M37 *Palustriella commutata* - *Festuca rubra* spring community and it is not possible to classify it confidently as any other NVC community. No condition assessment was therefore undertaken.

Figure 4

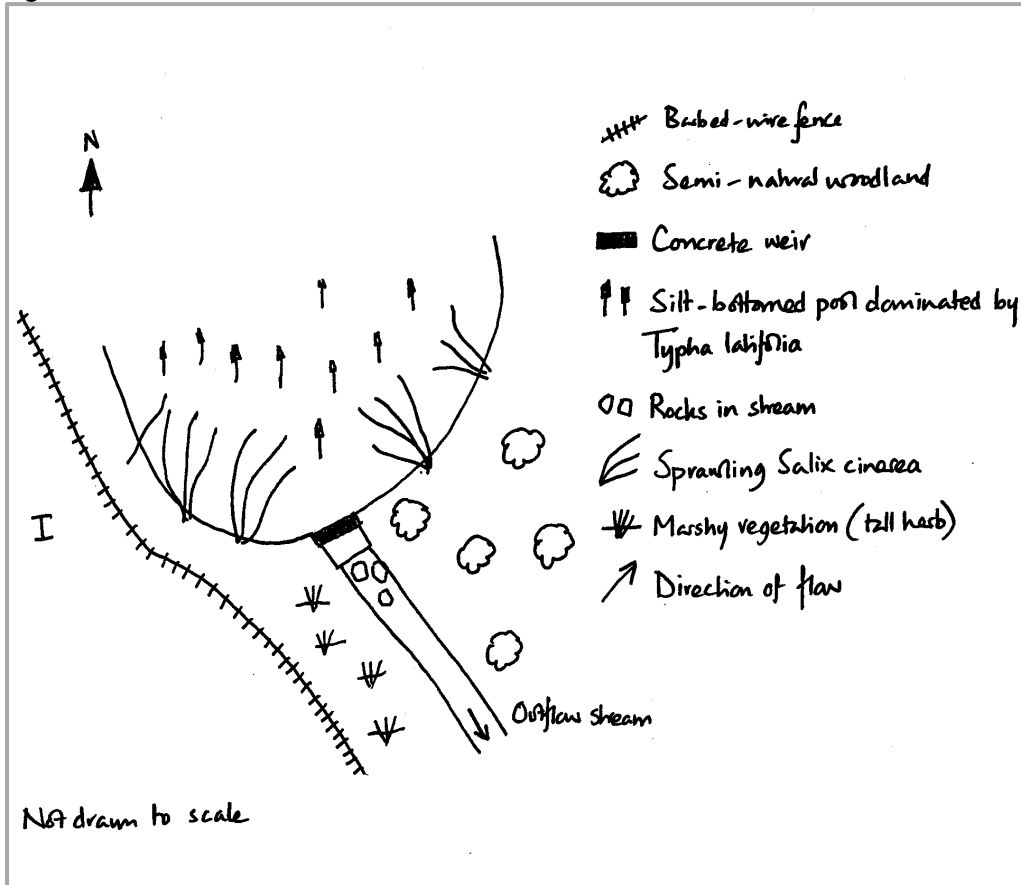


Plate 4. Red arrow shows single mound of *Palustriella*



3.4 Feature in Bushley Muzzard, Brimpsfield SSSI

A single, lime-rich spring rising on an east-facing slope in Bushley Muzzard, Brimpsfield SSSI feeds a small but active rivulet that eventually enters the pond above Feature G111. It supports rich vegetation, including many mounds of *Palustriella* and *C. filicinum*. Oncoids and ooids are frequent among silt in the channel but it is difficult to estimate their extent because of heavy poaching of the rivulet by cattle and possibly other livestock (Figure 5, Plate 5).

The hummocks created by the poaching support certain uncommon plants including *Carex lepidocarpa* (Long-stalked Yellow-sedge) and *Valeriana dioica* (Marsh Valerian). Common plants also characteristic of the hummocks include *F. rubra*, *Carex flacca* (Glaucous Sedge) and the pleurocarpous moss *Calliergonella cuspidata*. In the water itself, which has a predominantly silty substrate, *Apium nodiflorum* (Fool's Water-cress), *Nasturtium officinale* agg. (water-cress), *J. inflexus* and a *Glyceria* (sweet-grass) are all common.

A survey of the SSSI's terrestrial vegetation in 2019 indicated that this supports vegetation intermediate between M37 *Palustriella commutata* - *Festuca rubra* spring community and the M22 *Juncus subnodulosus* - *Cirsium palustre* fen-meadow. When undertaking condition assessment, it is important to choose well-defined examples of the vegetation feature being assessed. As the vegetation in the feature appears to be transitional, it was not possible to undertake a condition assessment of it.

Figure 5

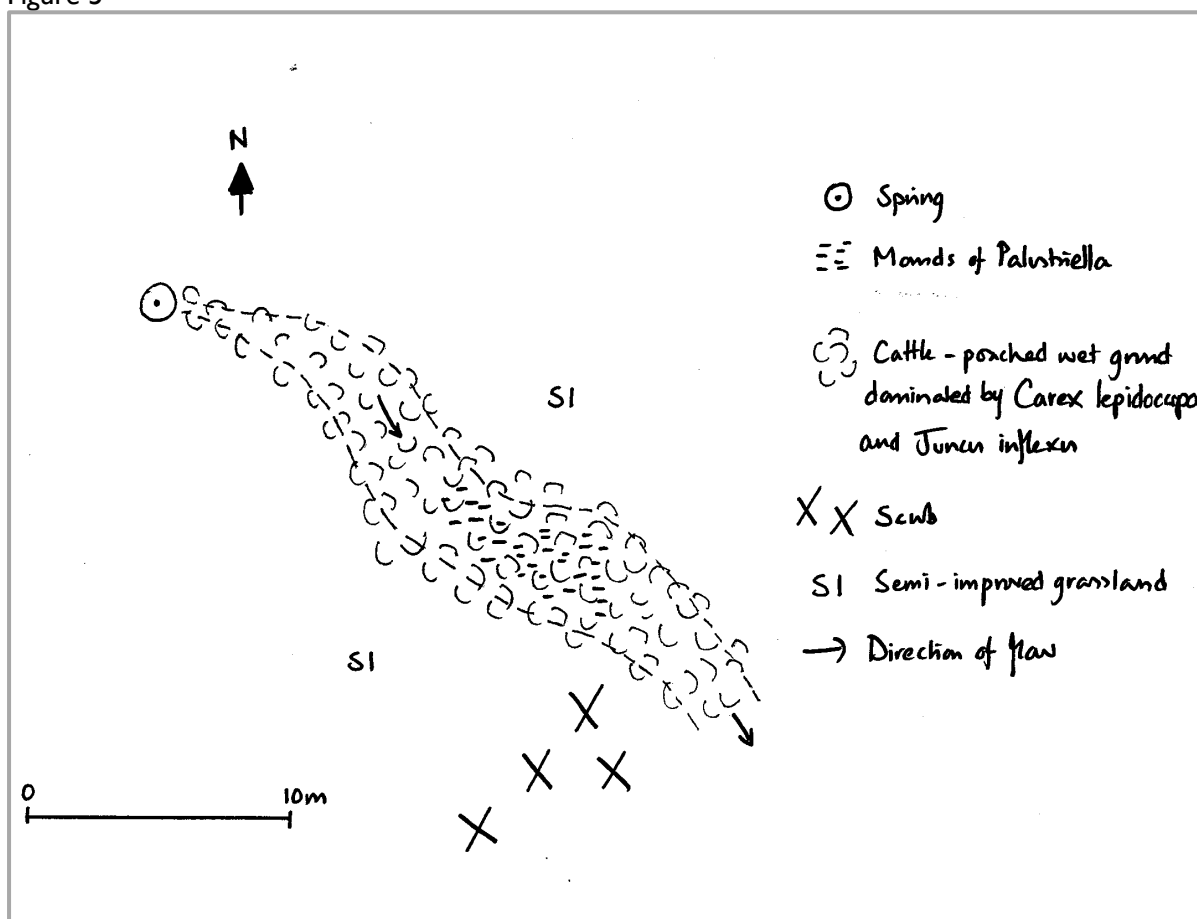


Plate 5



3.5 Other Features

One feature was not previously identified but was noticed during the current assessment. A small tufa-depositing spring rises close to the edge of mature *Fraxinus excelsior* (Ash) woodland (Birtlands Grove) at SO 9425 1339 and appears to also be within the boundary of Bushley Muzzard, Brimpsfield SSSI. The wood is fenced off from the adjacent pasture and no survey was undertaken because of uncertainty over its ownership. Large mounds of *Palustriella* are visible in the trickle of water coming from the spring but without access to the woodland interior no further botanical assessment was made.

4. CONCLUSIONS

Of the four features that were assessed and characterised, only G23 I would be considered to support qualifying vegetation of the Annex I habitat H7220 Petrifying springs with tufa formation (Cratoneurion). The undisturbed nature of this feature appears to have contributed to the accumulation of a substantial stream crust with loose overlying oncoids and ooids, but its vegetation is quite a poorly developed example of the M37 *Palustriella commutata* - *Festuca rubra* spring community. The reasons for this are unclear but may be linked to the tufaceous deposits being under closed semi-natural woodland canopy and hence heavily shaded, as well as a possibly variable or intermittent flow from the single spring feeding it.

Nearby, G81 represents an interesting springline flush in wet woodland but has very little tufa and its vegetation does not qualify as the Annex I habitat H7220 Petrifying springs with tufa formation (Cratoneurion).

The species-rich streamlet fed by the spring rising in Bushley Muzzard, Brimpsfield SSSI is clearly very lime-rich and it is likely that if it were not so heavily poached, it would have substantial tufaceous deposits. Whilst *Palustriella* is more frequent in this feature than any of the others and its vegetation has some affinities to the M37 *Palustriella commutata* - *Festuca rubra* spring community, it is not a straightforward example and therefore cannot be unequivocally regarded as the Annex I habitat H7220 Petrifying springs with tufa formation (Cratoneurion). Potentially, an intact example of this habitat type lies in woodland elsewhere in the SSSI and it is recommended that an assessment is undertaken to confirm its status.

G111, located at a man-made weir controlling the outfall of a pond, does not support tufa-forming vegetation.

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APPENDIX I. FIELD DATA

Species name	English name	G23I	G8I	G11I	SSSI
<i>Agrostis stolonifera</i>	Creeping Bent				O
<i>Ajuga reptans</i>	Bugle		O		
<i>Allium ursinum</i>	Ramsons		R		
<i>Alnus glutinosa</i>	Alder		R		
<i>Amblystegium serpens</i>	Creeping Feather-moss		R		
<i>Angelica sylvestris</i>	Wild Angelica		R	R	
<i>Anthriscus sylvestris</i>	Cow Parsley			R	
<i>Apium nodiflorum</i>	Fool's-water-cress				A
<i>Arum maculatum</i>	Lords-and-Ladies		R		
<i>Asplenium scolopendrium</i>	Hart's-tongue	F	R		
<i>Brachypodium pinnatum</i>	Heath False-brome				F
<i>Brachythecium rivulare</i>	River Feather-moss	R	F	F	
<i>Brachythecium rutabulum</i>	Rough-stalked Feather-moss		F		O
<i>Calliergonella cuspidata</i>	Pointed Spear-moss				F
<i>Cardamine flexuosa</i>	Wavy Bitter-cress		R	R	
<i>Cardamine pratensis</i>	Cuckooflower		R	R	
<i>Carex flacca</i>	Glaucous Sedge				F
<i>Carex lepidocarpa</i>	Long-stalked Yellow-sedge				A
<i>Carex pendula</i>	Pendulous Sedge	R	A		
<i>Chrysosplenium oppositifolium</i>	Opposite-leaved Golden-saxifrage	F	D	O	
<i>Cirsium palustre</i>	Marsh Thistle		R		F
<i>Conocephalum conicum</i>	Great Scented Liverwort	R			
<i>Cratoneuron filicinum</i>	Fern-leaved Hook-moss	R	O	F	
<i>Didymodon sinuosus</i>	Wavy Beard-moss			R	
<i>Dryopteris dilatata</i>	Broad Buckler-fern	R			
<i>Equisetum telmateia</i>	Great Horsetail		A		
<i>Epilobium</i> sp.	a willowherb				O
<i>Festuca rubra</i>	Red Fescue				O
<i>Ficaria verna</i>	Lesser Celandine		R		O
<i>Filipendula ulmaria</i>	Meadowsweet				O
<i>Fissidens adianthoides</i>	Maidenhair Pocket-moss		R		
<i>Fissidens pusillus</i>	Petty Pocket-moss	R			
<i>Fissidens taxifolius</i> var. <i>taxifolius</i>	Common Pocket-moss			R	R
<i>Galium aparine</i>	Cleavers		R		
<i>Geranium robertianum</i>	Herb-Robert		R	R	
<i>Glechoma hederacea</i>	Ground-ivy		R		
<i>Glyceria</i> sp.	a sweet-grass				F
<i>Hedera helix</i>	Common Ivy	R		R	
<i>Holcus lanatus</i>	Yorkshire-fog		R		O
<i>Juncus acutiflorus/articulatus</i>	Sharp-flowered Rush/Jointed Rush				R
<i>Juncus inflexus</i>	Hard Rush				F

Species name	English name	G23I	G8I	G11I	SSSI
<i>Kindbergia praelonga</i>	Common Feather-moss	O	O		
<i>Lunularia cruciata</i>	Crescent-cup Liverwort			R	
<i>Mentha aquatica</i>	Water Mint				O
<i>Mercurialis perennis</i>	Dog's Mercury		O		
<i>Nasturtium officinale</i> agg.	Water-cress			R	F
<i>Oxyrrhynchium hians</i>	Swartz's Feather-moss	O	R		O
<i>Palustriella commutata</i>	Curled Hook-moss	F		R	F
<i>Pellia endiviifolia</i>	Endive Pellia	F	R	R	F
<i>Plagiomnium undulatum</i>	Hart's-tongue Thyme-moss		R	O	R
<i>Platyhypnidium riparioides</i>	Long-beaked Water Feather-moss	F	O	A	
<i>Poa trivialis</i>	Rough Meadow-grass		A		
<i>Pohlia melanodon</i>	Pink-fruited Thread-moss				O
<i>Polystichum setiferum</i>	Soft Shield-fern	R			
<i>Ranunculus repens</i>	Creeping Buttercup		R		O
<i>Rhizomnium punctatum</i>	Dotted Thyme-moss	R	O		
<i>Ribes uva-crispa</i>	Gooseberry	O			
<i>Rubus fruticosus</i> agg.	Bramble		R		
<i>Rumex sanguineus</i>	Wood Dock		R		
<i>Salix cinerea</i>	Grey Willow		F		
<i>Sambucus nigra</i>	Elder		R		
<i>Schedonorus giganteus</i>	Giant Fescue		R		
<i>Scrophularia auriculata</i>	Water Figwort		R		
<i>Thamnobryum alopecurum</i>	Fox-tail Feather-moss	R		O	
<i>Urtica dioica</i>	Common Nettle		F		
<i>Vaucheria</i> sp.	an alga		O	F	
<i>Valeriana dioica</i>	Marsh Valerian				O
<i>Veronica beccabunga</i>	Brooklime				O

APPENDIX II: COMMON STANDARDS MONITORING GUIDANCE ATTRIBUTES AND TARGETS - M37 PALUSTRIELLA COMMUTATA - FESTUCA RUBRA SPRING COMMUNITY

Modified from standard CSM guidance for monitoring designated sites (JNCC 2004). All attributes are mandatory.

Attribute	Targets	Method of Assessment	Comments
Habitat structure	<p>The total extent of exposed substrate across the area assessed should be no more than 25%.</p> <p>The total extent of litter cover across the area assessed should be no more than 25%.</p>	Visual estimate of % cover	<p>A high frequency and cover of exposed substrate will usually be undesirable and may indicate, <i>inter alia</i>, over-grazing, and water scour.</p> <p>More than 25% litter cover indicates insufficient removal of biomass by grazing.</p>
Vegetation composition: positive indicator species	The frequencies of positive indicators should at the very least confirm the presence of M37.	Visual assessment of frequency and cover	See table below
Vegetation composition: indicators of negative change – undesirable non-woody species	<p>Invasive non-native species should be absent, or no more than rare if present</p> <p>No more than 2 other undesirable species to be more than frequent with combined cover of all such species no more than 15%.</p>	Visual assessment of frequency and cover	See table below
Vegetation composition: indicators of negative change – undesirable woody species	No woody species (including <i>Betula</i> , <i>Salix</i> , <i>Rhododendron</i> , <i>Pinus</i> , other gymnosperms) species should be present on flushes & springs, although <i>Salix</i> is acceptable at least 5m from petrifying springs.	Visual assessment of the whole feature	

Positive Indicator species

NVC type	Relevant wetland type	Positive indicators (major, desirable and associated vascular plants and bryophytes)
M37	Petrifying springs with tufa formation (Cratoneurion)	<i>Festuca rubra</i> , <i>Carex nigra</i> , <i>C. panicea</i> , <i>Cardamine pratensis</i> , <i>Scorzoneroides autumnalis</i> , <i>Carex viridula</i> , <i>C. dioica</i> , <i>Agrostis stolonifera</i> , <i>A. canina</i> , <i>Deschampsia cespitosa</i> , <i>Equisetum palustre</i> , <i>Chrysosplenium oppositifolium</i> , <i>Poa trivialis</i> , <i>Trifolium repens</i> , <i>Bryum pseudotriquetrum</i> , <i>Palustriella commutata</i> , <i>Cratoneuron filicinum</i> , <i>Philonotis fontana</i>

Negative indicator species

Type	Negative indicators
Invasive non-natives	<i>Crassula helmsii</i> , <i>Acorus calamus</i> , <i>Mimulus</i> spp., <i>Impatiens glandulifera</i> , <i>Fallopia japonica</i> , <i>Heracleum mantegazzianum</i>
Undesirable non-woody species	Graminoids: <i>Phragmites australis</i> , <i>Phalaris arundinacea</i> , <i>Glyceria maxima</i> , <i>Typha latifolia</i> , <i>Juncus</i> spp., <i>Molinia caerulea</i> , <i>Holcus lanatus</i> Tall herbs: <i>Epilobium hirsutum</i> , <i>Urtica dioica</i> , <i>Pteridium aquilinum</i> . <i>Rubus fruticosus</i> agg. Bryophytes: <i>Brachythecium rutabulum</i> , <i>Kindbergia praelonga</i> and <i>Sphagnum fallax</i> .