Highways England

BAT ACTIVITY INTERIM BASELINE SURVEY REPORT

A27 Arundel Bypass

70038257
JANUARY 2019

PUBLIC

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TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. 70038257

OUR REF. NO. 70038257

DATE: JANUARY 2019

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A27 Arundel Bypass

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QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	N/A			
Date	15/01/2019			
Prepared by	[redacted]			
Signature	[redacted]			
Checked by	[redacted]			
Signature	[redacted]			
Authorised by	[redacted]			
Signature	[redacted]			
Project number	70038257			
Report number	001			
File reference	A27_ECO_04.1_Batactivity_Interim_Baseline_ISSUE01			

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This report has been prepared by WSP on behalf of Highways England in relation to the A27 Arundel Bypass project ('the Scheme').

The contents of this report represent interim baseline survey findings collected at Project Control Framework Stage 2 (option selection) between spring 2017 and spring 2018 inclusive prior to the Preferred Route Announcement. The Scheme Options under consideration in 2017/early-2018 were Options 1, 3 and Option 5A.

It is intended that the baseline data presented in this report will be updated following further consultation at Stage 2 (2018/2019) and again for Project Control Framework Stage 3 (in 2020).

EXECUTIVE SUMMARY

The purpose of this report is to document the bat species present and the relative levels of bat activity within the survey area of the A27 Arundel bypass (the Scheme).

This report has been prepared considering three potential Scheme Options; Options 1, 3 and 5a. Option 1 comprises predominantly online upgrades to the A27 in the vicinity of Arundel town. Options 3 and 5a comprise offline bypass options passing to the south of Arundel.

The information compiled in this report will be used to determine the importance of the survey area for bats and identify key areas of bat activity, and if possible, any temporal or spatial patterns in bat activity.

The landscape surrounding the Scheme Options contains habitat considered to be of high suitability for bats[1]. The area is well connected to the wider landscape by features such as river floodplains, tree-lined watercourses, extensive hedgerows and large areas of ancient woodland.

Survey methods applied for this study include; transect and static activity surveys, and two Defra methods for monitoring the effectiveness of mitigation for bats crossing linear infrastructure.

The data from the activity surveys suggests that a broad assemblage of bat species is present within the survey area, with all three ecological communities (clutter, edge and open habitat adapted bats) represented at all locations, throughout the bat activity season.

Three Annex II species and one very rare bat species[2] were confirmed to be present within the survey area during activity surveys: barbastelle, Bechstein's bat, greater horseshoe bat and Alcathoe bat, respectively.

The bat transect and static data obtained display a lack of obvious pattern in behaviour of the animals recorded. These data indicate that bat activity within the study area follows no obvious

[1] Collins, J. (ed) (2016) Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edn.). The Bat Conservation Trust, London.
[2] Table 5

seasonal, temporal or habitat dependant association with any one location which may be explained by the variables measured.

It may be inferred that these animals are moving across the survey area to perhaps manipulate resources (such as roosting and foraging resources) when available or preferred, and that no one location is more important than any other to these animals.

The interpretation is based on preliminary findings, and this report will be updated with an additional full bat active season of activity data (2018) to enhance the overall understanding of the baseline conditions for bats in relation to the study area.

The Defra methods findings will be used as a baseline for monitoring the effectiveness of mitigation for bats crossing the scheme both during and post-construction to provide a measure of the magnitude of impact on bats.

1 INTRODUCTION

1.1 PROJECT BACKGROUND

The scope of the A27 Arundel Bypass scheme as described in the Road Investment Strategy[3] is:

1.1.1 "The replacement of the existing single carriageway road with a dual carriageway bypass, linking together the two existing dual carriageway sections of the road".

1.1.2 This corresponds to the 6km section of the a27 from the a284 crossbush junction (east of arundel) to the west of yapton lane (west of arundel). the a27 currently goes through the south downs national park and the town of arundel passing over the river arun and crossing the railway line.

1.1.3 The scheme options taken forward to the 2017 non-statutory public consultation were options 1, option 3 and option 5a. these are briefly described individually below.

- **Option 1** consists of new dual carriageway from Crossbush junction south of the current A27 to the south-west of Arundel railway station, joining the A27 east of Ford Road, with a new bridge over the River Arun alongside the existing bridge. From Ford Road roundabout, which will be signalised, the existing A27 would be widened to dual carriageway.
- **Option 3** is an off-line route from the existing A27 alignment. Option 3 would consist of a new dual carriageway corridor along its entire length. The proposed alignment will then be joined to the existing A27 via an extension of the existing infrastructure at Crossbush Junction. The alignment that runs westwards across the floodplain south of Tortington Priory and requires two new overbridges, firstly over the Arun Valley Railway Line and secondly over the River Arun. Its alignment diverges north through the Binsted Woods, Tortington Common and South Downs National Park, re-joining the existing A27 at Havenwood Park. It requires four new underbridges at Old Scotland Lane, Binsted Lane, Tortington Lane and at Ford Road.
- **Option 5A** is a new dual carriageway from Crossbush junction south of the current A27. The alignment crosses the Arun Valley Railway, continuing west across the floodplain, over Ford Road, running south of Tortington Priory Scheduled Monument before going north through the Binsted Wood Complex and the South Downs National Park, re-joining the existing A27 at a new junction near Yapton Lane.

[3] Road Investment Strategy: for the 2015/2016 – 2019/2020 Road Period, Department for Transport, March 2015

1.1.4 When referring to the combined footprint of the scheme (all options), the term 'scheme options' is used in this report. When discussing the footprint of any single option, it is referred to as its number i.e. Option 1, option 3 or option 5a.

1.1.5 When referring to the Arun floodplain in this report, this is the area east and south of Binsted wood complex LWS, toward the river Arun- and eastward, up to, and including, where the scheme options merge at the Yapton lane junction.

1.2 ECOLOGICAL BACKGROUND

1.2.1 The landscape surrounding the Scheme Options contains habitat considered to be of high suitability for bats[4] which is well connected to the wider landscape by features such as river floodplains, tree-lined watercourses, extensive hedgerows and large areas of ancient woodland. These habitats have the potential to support a wide range of UK bat species, including rare woodland bats that do not occur where habitat diversity is lower.

Comprehensive survey data for bat species and habitats is required to understand the biodiversity baseline conditions for the area of the Scheme Options.

To achieve this objective, WSP undertook the following further bat surveys in addition to those included in this report:

- Radio-tracking surveys[5] carried out in July, August and September 2017/18 to locate roosts, colonies and foraging ranges of bats within the Survey Area.
- Preliminary Bat Roost Assessments, aerial inspections, dusk emergence and dawn re-entry surveys on trees and structures within the Survey Area[6]; and,
- Hibernation roost surveys[7].

[4] Collins, J. (ed) (2016) Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edn.). The Bat Conservation Trust, London.
[5] WSP (2017) A27_ECO_BAT_BAT RADIO-TRACKING INTERIM-BASELINE REPORT
[6] WSP (2017) A27_ECO_BAT_BAT HABITAT AND TREE ROOST INTERIM-BASELINE REPORT
[7] WSP (2017) A27_ECO_BAT_BAT HABITAT AND TREE ROOST INTERIM-BASELINE REPORT

1.2.2 The surveys identified the species of bat present, confirming the presence of the roosting Annex II bat species: Bechstein's bat Myotis bechsteinii and barbastelle Barbastellus barbastellus, and Alcathoe bat Myotis alcathoe, the conservation status of which in the UK is poorly understood[8], but which is likely to be a rare species.

1.2.3 The presence of grey long-eared bat Plecotus austriacus has not been excluded, and further radio-tracking work in 2018 may confirm this species to be present.

1.2.4 Radio-tracking surveys have revealed several breeding colonies of woodland Myotis species, which are also travelling to, and foraging in, the floodplain area crossing over the River Arun.

1.2.5 Ongoing surveys in 2018 will provide comprehensive information of known roosts within 100m of the Scheme Options.

1.2.6 Highways England is undertaking an Environmental Impact Assessment of the Scheme Options to inform scheme development. Comprehensive survey data for bats is required to inform Scheme Option selection and ultimately inform an Environmental Impact Assessment of the preferred Scheme Option selected.

1.3 BAT COMMUNITIES

1.3.1 As a result of the differences in flight behaviour and willingness to cross gaps, the level of risk posed by a new road will differ significantly between species. However, many bat species have similar hunting behaviour and flight characteristics since they occupy similar ecological niches. These similarities mean that the risks and mitigation required for species with similar ecological niches are broadly the same.

1.3.2 For the purposes of interpreting the static data[9], bats recorded were classified as cluttered habitat; edge habitat or open habitat species in accordance with the flight characteristic assumptions shown in Table 1.1.

[8] As stated in Desk Study Results, taken from the Sussex bat group local distribution information on this species. Also listed nationally as 'data deficient'.

[9] Insufficient sample size from the BCT walked transect data to apply this method

Table 1.1 - Ecology of the bat species recorded or likely to be present within the Survey Area

Ecological niche	Species	Abbreviation/ label	Flight speed	Willingness to cross gaps and open habitat [10]	Flight height[11]	Light tolerance [12], [13]
Cluttered habitat adapted species	Myotis species ▪ Daubenton's bat *(Myotis daubentonii)* ▪ Whiskered bat *(Myotis mystacinus)* ▪ Brandt's bat (*Myotis brandtii)* ▪ Alcathoe bat ▪ (*Myotis alcathoe)* ▪ Natterer's bat (*Myotis nattereri)* ▪ Bechstein's bat (*Myotis bechsteini*	Myotis species	Slow	Least Willing to cross gaps and open ground	Generally fly close to linear features, when crossing open habitat will usually fly close to the ground.	Least tolerant of light. Artificial lighting may present a barrier to these species[14]
	Plecotus species Brown long-eared bat (*Plecotus auritus*) and grey long-eared bat (*Plecotus austriacus*)	Plecotus species				
	Lesser horseshoe bat (*Rhinolophus hipposideros*)	Rhip				
	Greater horseshoe bat (*Rhinolophus ferrumequinum*)	Rref				
Edge habitat adapted species	Common pipistrelle *(Pipistrellus pipistrellus)*	Ppip	Medium	Will regularly cross small and medium sized gaps	Typically tend to fly 10 meters off the ground /	Light tolerant, will often predate insects
	Soprano pipistrelle *Pipistrellus pygmaus)*	Ppyg				

[10] Frey-Ehrenbold A., Bontadina F., Arlettaz R., Orbist M. K. (2013) Landscape connectivity, habitat structure and activity on bat guilds in farmland-dominated matrices. *Journal of applied Ecology,* **50**, 252-261.

[11] Russ J (2012) British Bat Calls: A Guide to Species Identification. Pelagic Publishing, UK

[12] Stone, E.L. (2013) Bats and lighting: Overview of current evidence and mitigation guidance

[13] Stone, E.L. (2013) Bats and lighting: Overview of current evidence and mitigation guidance

[14] Stone, E. L., Jones, G. & Harris, S. (2012) Conserving energy at a cost to biodiversity? Impacts of LED lighting on bats. Global Change Biology, 18, 2458-2465

Ecological niche	Species	Abbreviation/ label	Flight speed	Willingness to cross gaps and open habitat [10]	Flight height[11]	Light tolerance [12], [13]
	Nathusius' pipistrelle *(Pipistrellus nathusii)*	Pnat			linear features	drawn to light
	Serotine *(Eptesicus serotinus)*	Eser				
	Barbastelle *(Barbastella barbastellus)*	Bbar				
Open habitat adapted species	Noctule *(Nyctalus noctula)*	Nnoc	Fast	Open habitat does not present a problem for these species	Usually fly high > 10 meters above open habitat	Light tolerant, will often predate insects drawn to light.
	Leisler's bat *(Nyctalus leisleri)*	Nlei				

1.4 AIMS AND OBJECTIVES

1.4.1 The aim of the surveys was to obtain a baseline activity dataset for the Scheme. This was achieved by undertaking the following:

- A detailed desk study;
- Field surveys to establish the presence of bats and determine species;
- Locate and characterise roosts within the Survey Area; and
- Locate and characterise commuting and foraging habitats within the Survey Area.

1.4.2 The objectives of the study were to:

- Use the baseline dataset to determine the importance of the Survey Area for bats and identify key areas of bat activity; and,
- Outline requirements for further survey work to inform detailed mitigation design and for a European Protected Species licence application (should this be required).

1.4.3 Bat activity surveys detailed in this report and undertaken in 2017 were designed to capture the following information:

- Bat activity transect surveys undertaken with reference to current guidance[15] to identify the bat species assemblage and relative distribution of bat activity within the Survey Area;
- Bat static automated surveys undertaken with reference to current guidance[16] to supplement the transect surveys by providing data on the temporal changes in bat activity, and provide a baseline for longer-term quantitative monitoring;
- Department for Environment, Food and Rural Affairs (Defra) Local Effects (or Crossing Point) surveys to identify bat flight paths along linear features that will be directly severed by the proposed Scheme Options. This information will be used to inform the design of appropriate mitigation, and will provide a baseline of information on which the effectiveness of the mitigation/compensation will be measured against; and
- Defra Landscape Scale Effects surveys to provide a baseline of information on species diversity and activity levels at a landscape scale, against which the effectiveness of the mitigation/compensation will be measured.

1.4.4 The results of this survey and its subsequent recommendations, are presented within this report. The contents of this report represent interim baseline survey findings collected at Project Control Framework Stage 2 (option selection).

1.4.5 The bat mitigation measures and pre-licence application information will be presented within the subsequent Environmental Impact Assessment for the Development Consent Order Application.

[15] Bat Conservation Trust recommended survey requirements, taken from *Collins, J. (ed) (2016) Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edn.). The Bat Conservation Trust, London.*

[16] Bat Conservation Trust recommended survey requirements, taken from *Collins, J. (ed) (2016) Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edn.). The Bat Conservation Trust, London.*

2 METHODS

2.1 STUDY AREA

2.1.1 The following study areas were used for desk study and field survey work (Figure 1):

- Desk Study Area – a distance of 6km from the outer boundary of the Scheme Options footprint was selected, within which bat records were obtained from the Sussex Biological Records Centre. This distance was selected based on the furthest bat core sustenance zone.
- Survey Area – land within 0.25km of the outer boundary of the Scheme Options footprint was selected for field survey work (hereafter the 'Survey Area'). This distance is considered an appropriate and proportionate approach to capture activity information to determine both direct and indirect effects on bats in relation to each Scheme Option. Other studies have been undertaken (such as radio tracking and the Defra studies) alongside the activity surveys to determine effects on bats at a landscape scale.
- Study Area – land within 1km of the outer boundary of the Scheme Options footprint (hereafter the 'Study Area'). This term is used when describing and interpreting landscape scale effects on bats (such as relative levels of activity), and specifically for the radio tracking and Defra Landscape Scale Effects surveys.

2.2 DESK STUDY

2.2.1 A desk study was undertaken to collate all records of bats within 6km of the Scheme Options over the past 10 years. Verified records were obtained from the Sussex Biological Records Centre[17]. This information was supplemented by a review of radio tracking work undertaken for Mid-Arun Environmental Survey (MAVES); both the May 2016[18] and June 2017[19] (interim) reports.

2.2.2 A review of the conservation status of bats present within the Study Area, both within the UK, and Sussex, was also undertaken to provide context to the discussion section of the report.

2.2.3 The record centre also provided information on non-statutory designated sites within 6km of the existing A27 that have been designated for bats / contains bats within the citation. The Multi-Agency Geographic Information for the Countryside (MAGIC)[20] website was consulted for National statutory designated sites within 10km of the Survey Area, and 30km for Special Areas of Conservation, where bats are the qualifying interest, in accordance with the Design Manual for Roads and Bridges[21].

2.2.4 The Joint Nature Conservation Committee website[22] was consulted to identify any candidate Special Areas of Conservation where bats are the qualifying interest, within 30km of the Study Area.

2.3 FIELD SURVEYS

2.3.1 The Survey Area was assessed in May 2017 by senior, licensed bat ecologists for its suitability to support bats. Features likely to be of importance for bats, such as roosting and foraging opportunities, potential commuting features and connectivity to the wider landscape, were recorded.

2.3.2 The Survey Area is of high suitability for bats; the distribution and extent of habitats used by bats informed the design of surveys, and the subsequent level of effort required, in accordance with the recommendations in the BCT guidelines for surveying high suitability habitat.

2.3.3 The locations, dates, times and weather data for each survey type is shown in Appendix A.

2.3.4 All surveys and repetitions were undertaken by a senior, licensed bat ecologist, with previous experience of these studies, supported by assistants.

2.3.5 Data from the transect and static activity surveys was used to produce indices of bat activity. Activity indices provide an indication of how bats make use of an area, by quantifying relative levels of bat activity and comparing data spatially and temporally. They cannot be related to, or used to infer bat abundance and population density.

[17] This includes records submitted by the Sussex Bat Group.
[18] Whitby, D. (2016) Bat Survey and Trapping Survey, Binsted Woods AEWC Ltd. Private publication.
[19] Whitby, D. (2017) Bat Survey, Trapping Survey Interim report of results Binsted Woods. AEWC Ltd. Private publication
[20] http://www.magic.gov.uk/MagicMap.aspx: Accessed 14/3/2018
[21] DMRB volume 11 section 4 (2009) Assessment of Implications (of highways and/or roads projects).
[22] http://jncc.defra.gov.uk/page-1458- Accessed 2017

2.4 TRANSECT SURVEY

2.4.1 Bat activity transect survey work required ecologists to walk predetermined transect routes to observe, listen for and record bats in flight away from the roosts. Four transects were designed to capture bat activity in representative habitats across the Survey Area. Transects were predominantly along public rights of way or minor roads, to allow surveys to be easily replicated. The exception was Transect 4 which was predominantly within private land, and the difficulties in surveying this consistently are discussed further in the Limitations section of this report. Each transect was approximately 5km long, and incorporated 10, five-minute Listening Points (Appendix A, Figure 2).

2.4.2 Each transect was visited twice-monthly between May and October inclusive, in appropriate weather conditions. Visits to all four transects were undertaken during the same night to standardise for temporal and weather variables, and allow for direct comparison of activity levels across all transects. The start and end points of transect walks was alternated between visits to intersperse time and location (i.e. to prevent bias due to certain areas always being surveyed close to dusk).

2.4.3 Dawn surveys were not undertaken. Dawn activity data has been collected during the Defra Local Effects survey and the emergence survey work (Section 2.6). Radio tracking work[23] has also captured pre-dawn bat behaviour within the Study Area.

2.4.4 Each visit began at sunset and continued for up to 200 minutes afterwards, with weather conditions recorded at commencement of each transect walk, along with any significant changes as the survey progressed. Visits were undertaken in dry conditions with temperatures at a minimum of 10ºC or warmer.

2.4.5 During each visit surveyors walked at constant speed between Listening Points, recording a summary of the bat species observed by sound or sight, including behaviour type, species and direction of flight. These data described bat activity qualitatively, providing context to quantitative measurements taken at Listening Points, where the number of bat passes, species, number of bats observed, activity, flight height and direction was recorded.

2.4.6 Surveyors were equipped with Batlogger M full spectrum detectors. These were set on an automatic trigger with threshold values at ‘Crest Advantage’, allowing for high sensitivity detection of bat calls. Equipment settings can be viewed in Appendix A.

DATA ANALYSIS PROCEDURE

2.4.7 Only sound files from the Listening Points were verified using analyst software; between Listening Point information was used as supplementary qualitative information.

2.4.8 For analysis, a ‘bat pass’ was defined as two or more bat calls in a continuous sequence, up to 10 seconds duration. Sound files longer than 10 seconds were split using Kaleidoscope[24] software.

2.4.9 Each bat pass recorded on the survey form was checked against the relevant sound file to verify species. This was done using Bat explorer[25] software by senior grade analysts.

2.4.10 Due to the overlap in call characteristics, and inherent limitations using software for species identification, the following labels were used:

- *Myotis* species identified to genus only: Myotis spp.;
- Long-eared bats identified to genus only: *Plecotus spp*.; and,
- Noctule, serotine and Leisler’s bat grouped to: “NSL”.

2.4.11 For instances when the analyst was more confident in verifying these sound files further than genus level using the software (due to quality of the spectrogram, known call characteristics, location and behaviour), these were labelled to species level, for example, Bechstein's bat passes.

2.4.12 For *Pipistrellus* species the following criteria based on measurements of peak frequency are used to classify calls (alongside other call parameters typical of this genus):

- Nathusius' pipistrelle <39KHz;
- P40 (Nathusius' / common pipistrelle) ≥ 39 and <42KHz;
- Common pipistrelle ≥ 42 and <49KHz;
- P50 (common / soprano pipistrelle) ≥ 49 and <51KHz; and
- Soprano pipistrelle ≥ 51KHz.

2.4.13 The output was subject to a three-tiered quality assurance process; a minimum of 10% of the sound files identified to each species/genus was verified by a principal grade analyst using Batsound[26] software, and then a randomised[27] 10% of the total labelled sound files was checked by an associate grade analyst using Batsound software.

2.4.14 The number of bat passes was subsequently used to provide an index of bat activity across the Survey Area, calculated by the number of bat passes per five-minute sample.

2.5 STATIC DETECTOR SURVEY

2.5.1 Automated bat detectors in static locations were used to supplement transect survey data. Thirteen Batlogger A+ full spectrum detectors were deployed throughout the Survey Area (Appendix A, Figure 3); three detectors per transect (or four per Scheme Option). An additional unit was deployed in the floodplain area to compensate for difficulties completing the walked transect in this area. Static detector locations were chosen to ensure coverage in a range of habitat types present in the Survey Area.

2.5.2 The detectors were calibrated at the beginning of the survey, and deployed with the omnidirectional microphones at an upward angle and at a height of approximately 2m, recording for a minimum of 5 consecutive nights per month from May to October. Due to access restrictions, these units were operational from June-October only within the floodplain area, discussed further in the Limitations section of this report.

2.5.3 Detectors were set to begin recording 30 minutes prior to sunset and until 30 minutes after sunrise on an automatic trigger with threshold values at 'Crest Advantage', allowing for high sensitivity detection of bat calls. Settings can be viewed in Appendix A.

[23] WSP (2017) A27_ECO_BAT_BAT RADIO-TRACKING INTERIM-BASELINE REPORT

[24] https://www.wildlifeacoustics.com/products/kaleidoscopesoftware-ultrasonic/download version 4.3.2 (Released 2017-06-01)

[25] http://www.batlogger.com/en/support/download.html version 1.11.4.0 (Released 2016-07-04)

[26] http://www.batlogger.com/en/support/download.html version 1.11.4.0 (Released 2016-07-04)

[27] Generated using an excel function to randomise the order of data

DATA ANALYSIS PROCEDURE

2.5.4 For analysis, a 'bat pass' was defined as in paragraph 2.4.8. Each sound file was analysed using Kaleidoscope Pro**.** software to verify species. Due to the overlap in call characteristics, and inherent limitations using software for species identification, the following labels were used:

- *Myotis* species identified to genus only: Myotis spp.;
- Long-eared bats identified to genus only: *Plecotus* spp.; and,
- Noctule, serotine and Leisler's bat grouped to: NSL.

2.5.5 For instances when the analyst was more confident in verifying these sound files further than genus level using the software (due to quality of the spectrogram, known call characteristics, behaviour and location), these were labelled to species level, for example, barbastelle passes.

2.5.6 For Pipistrellus species the following criteria based on measurements of peak frequency are used to classify calls (alongside other call parameters typical of this genus):

- Common pipistrelle ≥ 42 and <49KHz;
- P50 (common / soprano pipistrelle) ≥ 49 and <51KHz;
- Soprano pipistrelle ≥ 51KHz;
- P40 (Nathusius' / common pipistrelle) ≥ 39 and <42KHz; and,
- Nathusius' pipistrelle <39KHz.

2.5.7 The output was subject to a three-tiered quality assurance process; a minimum of 10% of the sound files identified to each species/genus was verified by a principal grade analyst using Batsound**.** software, and then a randomised[28] 10% of the total labelled sound files was checked by an associate grade analyst using Batsound software.

2.5.8 To allow comparison of static location, the data was transformed to 'number of bat passes per hour' (PPH), as per current best practice and as detailed below:

$$bat\ PPH = \frac{Total\ bat\ passes\ recorded\ at\ a\ location}{Total\ number\ of\ hours\ unit\ operational}$$

[28] Generated using an excel function to randomise the order of data

2.5.9 Conversion to PPH normalised the data for changes in seasonal night length, and as such, available bat foraging time, and varying survey length due to unit battery life, occasional equipment malfunction and other external factors. The transformed data were used as an index of bat activity.

2.6 DEFRA LOCAL EFFECTS SURVEY

2.6.1 This survey uses sightings of bats by surveyors to determine levels of activity, and assess long-term effectiveness of crossing structures as mitigation for bats. Data collected by survey work in 2017 is analysed in this report and provides baseline (pre-construction) information.

2.6.2 The survey was undertaken as per specifications of the 2015 Defra research report WC1060 between June and September inclusive in appropriate weather conditions, with a total of 31 locations selected for survey (Appendix A, Figure 4). Locations represented points where the Scheme Options bisect habitat or boundary features and significant bat commuting routes were likely to be found, and are hereafter referred to as ‘crossing points’.

2.6.3 Access could not be arranged for 8 of the crossing points, therefore they could not be included within the survey, leaving 23 crossing points within its scope.

2.6.4 Initial visits to each crossing point comprised observing bats both at dusk and dawn, with observations at dusk commencing at sunset and continuing for 120 minutes after, and dawn surveys commenced 120 minutes prior to sunrise before ceasing. Two surveyors monitored each crossing point, one at either side of the Scheme Option, and where possible on opposite sides of the habitat feature used by commuting bats.

2.6.5 Each surveyor recorded direct observations (i.e. those they had seen) of bats, their species (where this could be accurately determined) and their flight behaviour; ground-level distance from the feature and height above the ground when observed. The closest distance the bat came to the feature was recorded, and for flight height during crossing, the lowest height was recorded. Incidental records of bat activity near the surveyor locations were also collected. Each passing bat was recorded as a separate observation, regardless of whether the same bat has clearly passed the surveyor more than once.

2.6.6 Surveyors used Batlogger M full spectrum detectors. These were set on an automatic trigger with threshold values at ‘Crest Advantage’, allowing for high sensitivity detection of bat calls (detector settings can be seen in Appendix A).

2.6.7 Crossing points where more than 10 bats were recorded using habitat features per survey (5 bats for rare species) were considered ‘flight paths’ (regularly used bat commuting routes) and subject to 4 further dusk surveys. Nine crossing points did not meet this threshold and were scoped out of the survey and not visited further. A further 3 only received only one dusk or dawn survey before access was declined and they could not be visited further.

2.6.8 Eleven crossing points therefore received the full complement of six repeat visits between June-September, as per the specification in WC1060 (Table 3.3).

DATA ANALYSIS PROCEDURE

2.6.9 Post-survey data handling involved the removal of duplicate survey results, whereby both surveyors recorded bats traversing the feature at the same time, height, distance and direction. If bats are heard but not seen (from both surveyors), the time on the visit's proforma was used to identify a match; direction, height and distance were left unknown. The behaviour of the bat was taken from the visual description on the proforma and verified during the sound analysis.

2.6.10 Processing the data revealed a substantial amount of partial and non-target information, such as foraging activity along the habitat feature, and bats heard but not seen. Data on the number of passes which were heard but not seen were retained and analysed, but assessed separately from the target 'commuting' behaviour required for the statistical analysis.

2.6.11 Foraging data was transformed from descriptions of bat behaviour to number of passes as surveyors often recorded narratives of their observations, rather than counts of bat passes. This allowed these data to be analysed along with the rest of those collected.

2.6.12 When determining the number of passes for each observed activity behaviour, the minimum amount of information was inferred and a conservative approach taken (Table 2.1 for survey proforma examples). This method was applied because the data collected is not quantifiable; the number of bats and amount of time the bats were present for was not recorded. This will be re-examined for the 2018/2019 surveys to provide a more accurate representation of these foraging data.

Table 2.1 - Transforming activity information- worked examples

Example comment from the survey proforma	Decision
No comment on type of activity provided	One commuting pass
'Constant activity' within a range of time	One pass, unless stated 'passing back and forth', then two passes
'Constant foraging'	One pass
'Constant activity' with 'multiple bats'	Four passes; two passes (one for each direction) for two bats (more than 1 from multiple)
'Multiple bats' within a range of time, e.g. Ppip x 3	Three passes
'Distant bats'	One commuting pass
'Multiple passes'	If the same bat (seen) then two passes
'Quiet calls'	One commuting pass
'Signal calls'	Not a pass
'Foraging and commuting'	One pass
'Foraging back and forth'	If no direction information then two passes
'Foraging briefly'	One pass

2.6.13 Each pass was assigned a species either by the surveyor in the field, or by matching recordings of the passing bat by either the file name on the proforma, or the time the bat was observed. Recordings were analysed automatically to determine the bat species they represent using BatClassify[29], with a probability of 90% set as the threshold for acceptance of identification of a recording. BatClassify output was checked against the surveyor's identification, and changes made where necessary, favouring the identification made automatically.

2.6.14 Where the threshold was not met by the automatic classification, or there were discrepancies within recorded species identification, recordings were checked by an analyst using Analook W[30] software. To provide quality assurance, all instances where the analyst changed the species from the initial identification on the proforma, a principal grade analyst verified this using Batsound software.

2.6.15 For instances where recordings revealed more than one bat species was present (e.g. a Myotis sp. and a Pipistrelle sp.) passes were included for each, but flight behaviour data was left as unknown for those which were not observed by surveyors. In addition, recordings which were exclusively comprised of bat social calls were excluded from the data set.

2.6.16 The output was subject to a three-tiered quality assurance process; a minimum of 10% of the sound files which were identified to each species/genus was verified by a principal grade analyst using Batsound software, and then a randomised[31] 10% of the total labelled sound files was checked by a principle grade analyst using Batsound software.

2.6.17 Data for each crossing point was categorised and presented the following information:

- Total number of passing bats observed;
- Number of passing bats using (passing within 5m distance of the feature) and not using (passing further than 5m distance);
- Number of bats using the structure at a 'safe' height and therefore not at risk of collision, defined as passing at a height higher than 5m from the ground;
- Number of bats using the structure at a 'unsafe' height and therefore at risk of collision, defined as passing at a height lower than 5m from the ground; and
- Total number of bats heard but not seen.

2.6.18 Safe and unsafe height are defined with reference to the maximum height for a heavy goods vehicle on UK roads, 4.95m. It has been rounded to 5m for the analysis. Bats passing above this threshold would not be at risk of collision.

[29] https://bitbucket.org/chrisscott/batclassify/downloads/ Accessed September 2017 (Version 2014-07-15)

[30] https://www.titley-scientific.com/uk/downloads-support/firmware-software Accessed September 2017 (Version 4.2)

[31] Generated using an excel function to randomise the order of data

2.6.19 Flight heights of bats using crossing points are presented as box plots, which summarise data for the total number of bats observed, those observed at 'safe' height and those at 'unsafe' and thus flying within the collision zone. Quartiles illustrate the median, upper and lower quartiles of the heights at which bats were recorded flying to identify the likely risk of collision. Where no median or upper quartile is present, this is due to the limited range of the results; either single bats being recorded, or all bats being recorded at the same height (the median can also be the upper quartile). Outliers are also displayed as points.

2.6.20 Data from the current year of survey will be compared to construction and post construction monitoring surveys to measure the effectiveness of the mitigation structures.

2.7 DEFRA LANDSCAPE EFFECTS SURVEY

2.7.1 The aim of this work was to assess the effect of linear infrastructure on bats at a landscape and population scale. This is done by identifying changes in the level of bat activity, and species diversity, in relation to proximity to a road scheme. The survey provided baseline (pre-construction) information.

2.7.2 The survey was undertaken as per specifications of the WC1060, and visits to collect data were undertaken between June and September inclusive in appropriate weather conditions. Surveyors walked 10 transects per Scheme Option, each covering 1km of the landscape on either side of the Scheme Options (Appendix A, Figure 5), with transect arrangements being perpendicular to the Scheme Option crossed. Some transects were shared where the route of Scheme Options overlapped.

2.7.3 Transects were located ~300m apart to avoid pseudo-replication of data. They were predominantly along public rights of way or minor roads to allow these surveys to be replicated each active season without access to private land preventing transects being visited, and for during and post construction monitoring purposes.

2.7.4 Each transect was visited twice[32], with walking direction reversed on the second visit to intersperse the effect of time on bat activity. Eleven spot checks were made along each transect, located at 0m, and then consecutively every 100m up to 1km. Surveyors stood for 10 minutes at each spot check, and recorded habitat (Table 2.2 for criteria) and weather information, and the calls of passing bats using Batlogger M full spectrum detectors. These were set on an automatic trigger with threshold values at 'Crest Advantage', allowing for high sensitivity detection of bat calls (detector settings can be seen in Appendix A). Bat detectors were held at approximately waist height pointing upwards and away from the surveyor at all times

[32] To detect changes in activity of less common species.

Table 2.2 - Habitat criteria

Grade	Habitat Type
1	Fence or wall lining road/path and open fields beyond.
2	Hedges/shrubby verges lining road/path and open fields beyond.
3	Intermittent medium trees/bushes lining road/path and open fields beyond.
4	Intermittent tall trees lining road/path and open fields beyond.
5	Continuous tall tree cover lining road/path with woodland and/or open fields beyond.

2.7.5 Visits commenced approximately 30 minutes after sunset and were completed within approximately two hours.

DATA ANALYSIS PROCEDURE

2.7.6 Recorded data was analysed to determine the bat species present and numbers of passes. For analysis, a 'bat pass' was defined as in paragraph 2.4.8, and recordings were analysed using BatClassify**.** using the procedure described in paragraph 2.6.13. Resulting data was analysed using Generalised Estimating Equations (GEE) model in the R program[33] following the method in WC1060 to determine a baseline of data to measure the effect of the Scheme Option on bats during and post construction. The Wald statistic (a parametric statistical test that tests the true value of a model parameter based on a sample estimate) and significance level are reported individually for each variable within the text, as requested in WC1060. The variables tested in the Wald test are as follows: distance from the Scheme Option, habitat type and time.

2.7.7 The Generalised Estimating Equations model tests for significant difference between the variables recorded within the data set. If no significance is found, then the null hypothesis is accepted; in which there is no relationship.

2.7.8 NSL, serotine and noctule calls were removed from the data set for total bat activity models, as per the Defra report guidance.

2.7.9 The results of the analyses detail the significance value and standard error of 'distance from the Scheme Option', and other variables within the model found to significantly affect bat activity. The results are displayed as tables along with the scale and correlation parameters.

2.7.10 Graphs display predicted percentage changes in bat activity between 0m and 1000m from each Scheme Option using the following formula:

$$\%\ change = \frac{(predicted\ number\ of\ bat\ passes\ at\ 100\ m - predicted\ number\ of\ bat\ passes\ at\ 0\ m) \times 100}{predicted\ number\ of\ bat\ passes\ at\ 0m}$$

[33] https://www.r-project.org/

2.7.11 Total bat activity has been used as the measure for activity for this study, as modelling the data revealed that the sample size for individual species (other than common pipistrelle and soprano pipistrelle) across the transects was not large enough for to be tested statistically

2.8 LIMITATIONS AND CONSTRAINTS

2.8.1 The following limitations and constraints were identified.

2.9 DATA ANALYSIS

2.9.1 Observations of bats can be restricted by low light levels, meaning flight patterns cannot be determined or animals simply cannot be seen by surveyors; this limitation affects walked transect and crossing point surveys where observational data is needed. As a result, bats heard but not seen were separated from those both seen and heard, as flight behaviour information was not recorded for the former. Bats heard but not seen comprises a significant amount of the total number of bat observations data. For upcoming 2018 bat surveys, visual aids such as infrared cameras will be used to overcome this limitation and reduce the amount of partial information collected.

2.9.2 Each bat species differs in its likelihood of detection (if they are echolocating), the frequency of the call (lower frequencies travel further than higher frequencies) and the overlap in call characteristics (which may inflate or under-record certain species). Therefore, results of the analysis are only compared intra-specifically (within species) and not inter-specifically (between species), due to detectability, repetition rate and call intensity variation between species. For example, a single pulse from a noctule would not equate to the same level of activity, or frequency of an encounter, as a single pulse from a Myotis[34].

2.9.3 The majority of Myotis recordings have not been identified to species and most observations remain grouped to the level of genus. Identification has only been undertaken where call parameters allow a high degree of confidence in the assigned species.

2.9.4 The relative index of activity used in this report has been used to determine how bats are using the Study Area both temporally and spatially.

2.10 DESK STUDY

2.10.1 It should be noted that a lack of desk study records does not infer species absence, but is often a result of a lack of data. Desk study information has been used to provide an indication of species likely to be encountered within the Survey Area to determine survey requirements and to aid in the design of the surveys.

2.10.2 Desk study data was acquired in March 2017; however it will be updated in March 2018 and new information will be incorporated when this interim-baseline report is updated to include the 2018 field season data.

[34] Sowler, S. Middleton, N. (March 2013) CIEEM In Practice. Issue 79. Feature Article: 'Bat Passes'- Redundant or Still Useful?

2.11 TRANSECT SURVEY

2.11.1 Transect 1, Listening point 1.10 could only be completed during the first monthly visit in June, August and October, due to problems with cattle, and health and safety concerns.

2.11.2 Transect 4 was also affected by access and health and safety concerns. As a result, this transect's route varied (Appendix A, Figure 2) and an additional static detector deployed (and analysed as part of static surveys). This transect will be repeated in 2018 to obtain another year of baseline data, to capture any missing information from the 2017 surveys.

STATIC SURVEY

2.11.3 Data was transformed to bat passes per hour (see paragraph 2.5.8) to control for seasonal variation in night length. This does not take into account state-dependant behaviours of bats[35], but allows for a standardisation data to provide an index of activity across the Survey Area. This has been considered further in the discussion section.

2.11.4 There were instances where static detectors failed to operate, access issues prevented their installation at the required location and/or health and safety concerns prevented locations being accessed, leading to incomplete or missing data. These instances were omitted from the analysis to avoid false negative counts. For instances when the unit was operational, but did not record any bat information, a count of zero was included in the analysis. Missing data for the static monitoring surveys can be viewed in Appendix A. Static detector surveys will be repeated in 2018 to obtain another year of baseline data, to capture missing information from the 2017 surveys.

2.12 DEFRA LOCAL EFFECTS SURVEY

2.12.1 These surveys were affected by access and health and safety problems in a similar way to those outlined in 2.12.2. The missing data for these surveys can be viewed in Appendix A.

2.12.2 Surveys will be repeated in 2018 for locations where bat activity did not indicate a bat flight path existed and they were scoped out of the survey, to provide another opportunity to account for natural behavioural variation of the bats within the Study Area and for those locations with access prohibiting the surveys in 2017.

2.12.3 When transforming the non-target activity information, the minimum amount of information was inferred from the recording, due to lack of visual or contextual information. This may have under-represented the actual number of passes by an individual bat. This limitation will be managed in the 2018 surveys by providing a time estimate the bat was present for, so that the number of passes can be multiplied accordingly, and provide a more accurate evaluation of the use of the feature.

2.12.4 The number of bats heard, but not seen was substantial. A total of 1,569 visual observations of bats passing were made compared to 2,500 passes not visually observed (audio only), accounting for 61.4% of the total data recorded. This resulted in only 38.5% of the data suitable for use in statistical analyses. It is unknown if bats represented by the 61.4% of observations are using the feature, and if so if they are within the collision zone of traffic. This limitation will be managed in the 2018 surveys by equipping the surveyors with infrared equipment, which should increase the amount of complete data which can be included in the statistical analyses.

2.12.5 Eleven spot checks out of the total of 484 planned were not undertaken. Transect 8 was also not completed during either visit due to access and health and safety issues (paragraph 2.13.1). For instances when no data was collected, spot checks were omitted from the analysis to avoid a false count of zero. The missing data for these surveys can be viewed in Appendix A.

2.12.6 Transects were designed where possible to avoid known maternity roosts, or habitats of particularly high or low bat suitability which may bias the results. However, due to habitats throughout the Study Area assessed to be of high suitability, and the abundance of known roosts across the Study Area, which was difficult to achieve.

[35] Bat behaviour can vary with the lifecycle and seasonal status of the bat. An example of a bat state is the breeding status of the bat, behaviours which could depend on the breeding status include the territoriality of males and the length of foraging period through the night.

3 RESULTS

3.1 DESK STUDY

DESIGNATED SITES

3.1.1 Three Special Areas of Conservation (SACs) designated for bats were identified within 30km of the Survey Area. These are: Ebernoe Common SAC, which is located approximately 19km north of the nearest of the three Scheme Options; The Mens SAC, which is located approximately 15km north of the nearest of the three Scheme Options; and Singleton and Cocking Tunnels SAC, which is located approximately 14 km north-west of the nearest of the three Scheme Options. Table 3.1 provides details of these sites.

3.1.2 Two bat species, barbastelle and Bechstein's bat, were identified as primary or secondary reasons for the selection of these SACs. They are of international importance

Table 3.1 - SACs designated for bats

Site Name	Associated Sites of Special Scientific Interest	Approximate Distance (kilometres) and Direction from Scheme Options			Key Habitat Type	Species
		1	3	5A		
Singleton and Cocking Tunnels	Singleton and Cocking Tunnels	14.1 km north-west	13 km north-west	12.4 km north-west	Man-made structure	Barbastelle, Bechstein's bat
The Mens	The Mens	14.5 km north	14.5 km north	15.4 km north	Woodland / wood pasture	Barbastelle,
Ebernoe Common	Bognor Common Quarry	18.1 km north	18 km north	18.3 km north	Woodland / wood pasture	Barbastelle, Bechstein's bat

3.2 SPECIES RECORDS

3.2.1 The desk study identified 35 confirmed or likely bat roosts within the Desk Study Area. The most recent records were from 2015. Sussex Biodiversity Records Centre identified confirmed or likely bat roosts for five bat species: common pipistrelle, soprano pipistrelle, brown long-eared bat Plecotus auritus, serotine and barbastelle.

3.2.2 Records confirmed bat roosts to be widely distributed within the Desk Study Area. The majority of bat roost records were from the area around Slindon Common and Slindon Wood approximately 1km north west of the Survey Area, and 1km to the north east within Arundel Wetland Centre. Common pipistrelle roosts were also present around Arundel Castle approximately 0.4km north of the Survey Area. Barbastelle roosts were recorded within Poling Copse and Slindon Common / Wood, approximately 1km east and west of the Survey Area respectively. All bat records can be seen in Appendix A and viewed in Appendix A, Figure 6.

3.2.3 The MAVES commissioned ecological consultants Animal Ecology and Wildlife Consultants to complete bat surveys in 2016 and 2017[36]. These surveys identified the following list of species, predominantly from the Binsted Wood Complex LWS. Those with an asterisk (*) are identified by the MAVES to be breeding within the Desk Study Area:

- Barbastelle;
- Alcathoe bat *(Myotis alcathoe)* (*);
- Bechstein's bat *(Myotis bechsteinii)* (*);
- Brandt's bat *(Myotis brandtii)* (*);
- Daubenton's bat *(Myotis daubentonii)*;
- Natterer's bat *(Myotis nattereri)* (*);
- Whiskered bat *(Myotis mystacinus)* (*);
- Brown long-eared bat (*);
- Nathusius' pipistrelle *(Pipistrellus nathusii)*;
- Common pipistrelle;
- Soprano pipistrelle;
- Noctule *(Nyctalus noctula)* (*); and
- Serotine

3.2.4 The status[37] of each species both locally and nationally are detailed within Table 3.2

[36] Whitby, D (2016 and 2017 – two reports). *Bat Survey Trapping Survey Binsted Woods*. A report by Animal Ecology and Wildlife Consultants for MAVES

[37] The distribution and status data was obtained from a national source and a local source, as such terminology may vary

Table 3.2 - Status of the bat species recorded or assumed to be present within the survey area

Flight strategy	Species	Relative UK Distribution and Status[38]	Local Distribution and Status [39]
Cluttered Habitat Adapted Species	Brown long-eared bat	Widespread, relatively common	Widespread, relatively abundant
	Whiskered bat	Widespread, uncommon	Widespread, scarce
	Brandt's bat	Widespread, uncommon (slightly less common and widespread than Whiskered bat)	Widespread, scarce
	Natterer's bat	Locally common	Widespread, scarce
	Daubenton's bat	Relatively common, widespread	Widespread, fairly abundant
	Greater horseshoe bat	Rare (restricted to the south west England and south Wales)	Very rare
	Bechstein's bat	Very rare, (restricted to southern Wales and parts of southern England)	Very rare
	Alcathoe bat	Data deficient	Very rare- hardly known
Edge Habitat Adapted Species	Serotine	Uncommon, (largely restricted to the south)	Widespread, uncommon
	Common pipistrelle	Widespread, common	Widespread, abundant
	Nathusius' pipistrelle	Rare, but widespread, may be under recorded	Widespread, scarce
	Soprano pipistrelle	Widespread, common (England)	Widespread, fairly common
	Barbastelle	Very rare, widespread	Widespread, very rare

[38] Bat Conservation trust (2010) Species Factsheets http://www.bats.org.uk/pages/uk_bats.html Accessed 13 September 2017

[39] http://www.sussexbatgroup.org.uk/batsinsussex Accessed 13 September 2017

Flight strategy	Species	Relative UK Distribution and Status[38]	Local Distribution and Status [39]
Open Habitat Adapted Species	Leisler's bat	Widespread, uncommon (England, although it may be under recorded)	Rarely recorded
	Noctule	Widespread, relatively common	Widespread, uncommon

3.2.5 A review of MAGIC maps[40] identified a total of eleven Granted Natural England European Protected Species Licences relating to bats within 6km. The licences included the damage and destruction for both breeding sites and resting places. Species covered by these licences were: common pipistrelle; soprano pipistrelle; brown long-eared bat; whiskered/Brandt's bat; serotine; Natterer's bat and barbastelle. The closest licence recorded was within 200m of the Scheme Options and was for the destruction of a resting place for common pipistrelle and brown long-eared bat (EPSM2013-5700) in 2013.

3.3 TRANSECT SURVEY

3.3.1 Data revealed 978 bat passes at listening points along the four transects across all months, from a minimum of ten bat species; data are shown in Figure 3.1, transect routes and listening points can be viewed in Appendix A, Figure 2.

3.3.2 The peak month for bat activity occurred during September with 276 passes, and the lowest level of activity occurred in June and October (104 passes each). Overall activity levels rose from June to September, then dropped to October. May activity levels were relatively high for common pipistrelle, soprano pipistrelle and noctule. Low activity levels of were recorded throughout the surveys for the following species: barbastelle (high count of 6), serotine (high count of 3), Nathusius' pipistrelle (high count of 1) and *Plecotus* spp.[41] (High count of 15).

3.3.3 Transect 3 showed the highest level of activity with 369 bat passes recorded across all months, dominated by common and soprano pipistrelle, and *Myotis* spp., and activity by other species relatively rare. Activity levels associated with transects 1, 2 and 4 were similar, comprising 195, 217 and 197 passes respectively; however, species composition of the bat community varied between transects and survey month.

3.3.4 Activity at transect 1 was dominated by soprano pipistrelle which was most active during May, August and September, followed by common pipistrelle where activity was high in May, but lower in other survey months. Passes by noctule were common in May and August, low in July, and absent in other survey months, with Leisler's bat common in September, represented by a single pass in October, and absent from other survey months. The following were represented by single passes in the given months: Myotis spp. (August and October), *Plecotus* spp. (August and September) and Nathusius' pipistrelle (June).

3.3.5 At transect 2, activity was dominated by common pipistrelle, present in all survey months with total passes ranging from 11 in September/October to 33 in August. *Myotis* spp. passes indicated a higher level of activity for these bat species compared to transect 1 and 4, and were present in all survey months with 15 passes recorded in May but only a single pass in September. Barbastelle, serotine, Leisler's bat and *Plecotus* spp. were represented but by low numbers of passes.

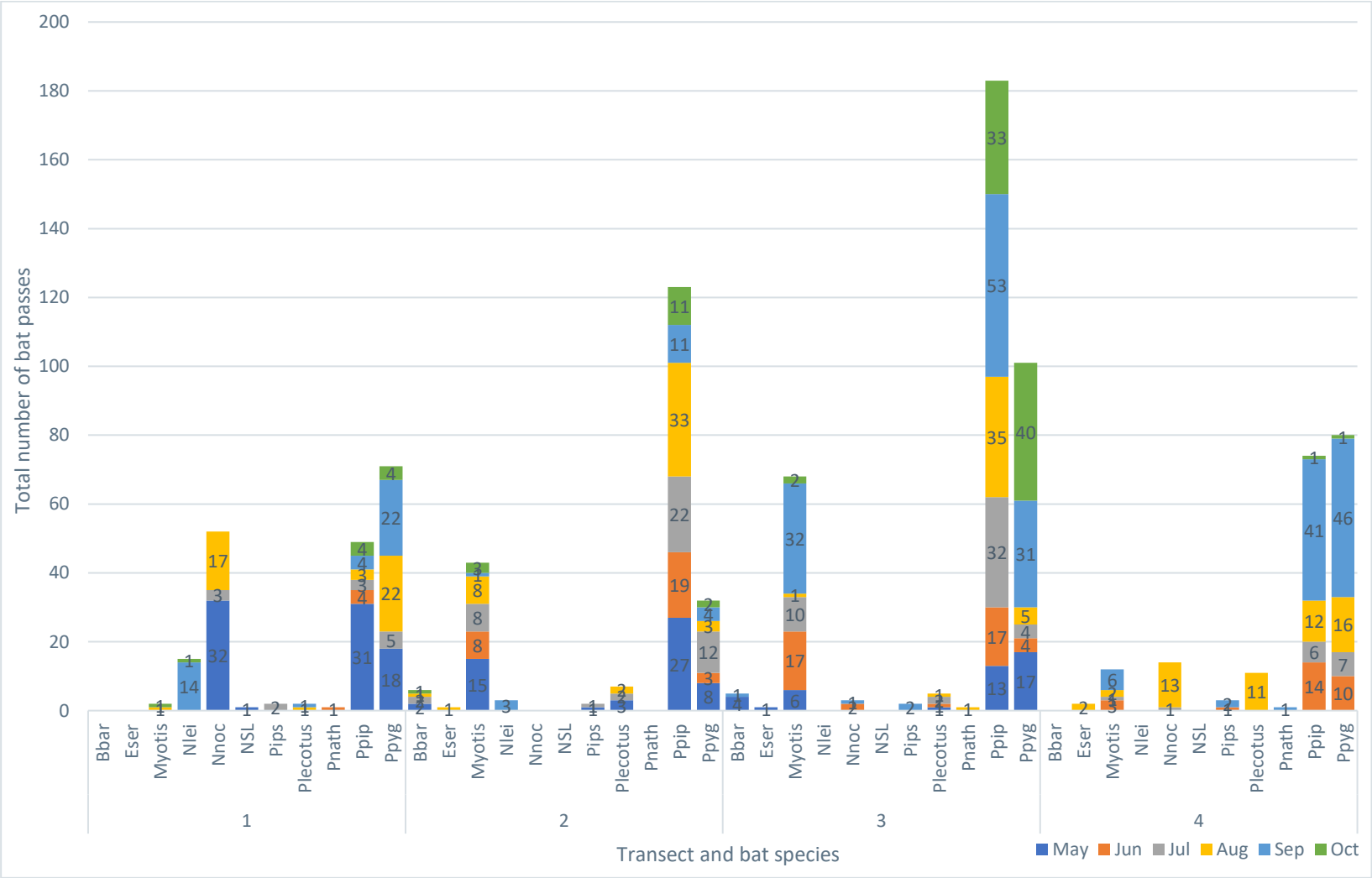
3.3.6 Common pipistrelle was the dominant species at transect 3 where this species was present in all survey months, and particularly active between July and October. Relatively high numbers of passes were recorded for soprano pipistrelle also during September and October, with lower numbers in May, and relatively few in remaining survey months. *Myotis* spp. were also present with highest numbers of passes in June and September compared to other transects. Barbastelle, serotine, noctule, *Plecotus* spp. and Nathusius' pipistrelle were also present but represented by low numbers of passes.

3.3.7 Total numbers of passes at transect 4 were affected by the fact that not all visits could be completed during 2017, and thus the data presented likely under-represents the actual level of activity in this area. Common and soprano pipistrelle were dominant with similar levels of activity between June and October. Passes by *Myotis* spp., noctule and *Plecotus* spp. indicated their repeated use of the area, but activity was relatively low compared to other transects and mostly confined to August. Serotine and Nathusius' pipistrelle were present but represented only by 1 or 2 passes.

[40] DEFRA, MAGIC mapping https://magic.defra.gov.uk/ [Accessed September 2017]

[41] This may be due to inherent difficulties in detecting this quiet echolocating species.

Figure 3.1 - Bat activity, measured as total number of bat passes, by species, transect and month.



3.4 STATIC DETECTOR SURVEY

3.4.1 The data in Figure 3.2 shows bat activity measured as PPH by static detectors, by transect/location and split by month. Activity varied widely between static locations and survey months, but the data indicate higher overall levels of activity at certain static detector locations when compared to others. Locations 1.1, 2.3 and 3.3 showed PPH approximately double that of other locations, although this was strongly dependent on survey month. Location 1.1 is adjacent to Binsted Wood Complex LWS (known to be important for bats), within 10 m of the current A27 bypass. Locations 2.3 and 3.3 are both along Tortington Lane 600m apart, and within 800m of the Binsted Wood Complex, indicating this is an important bat activity corridor.

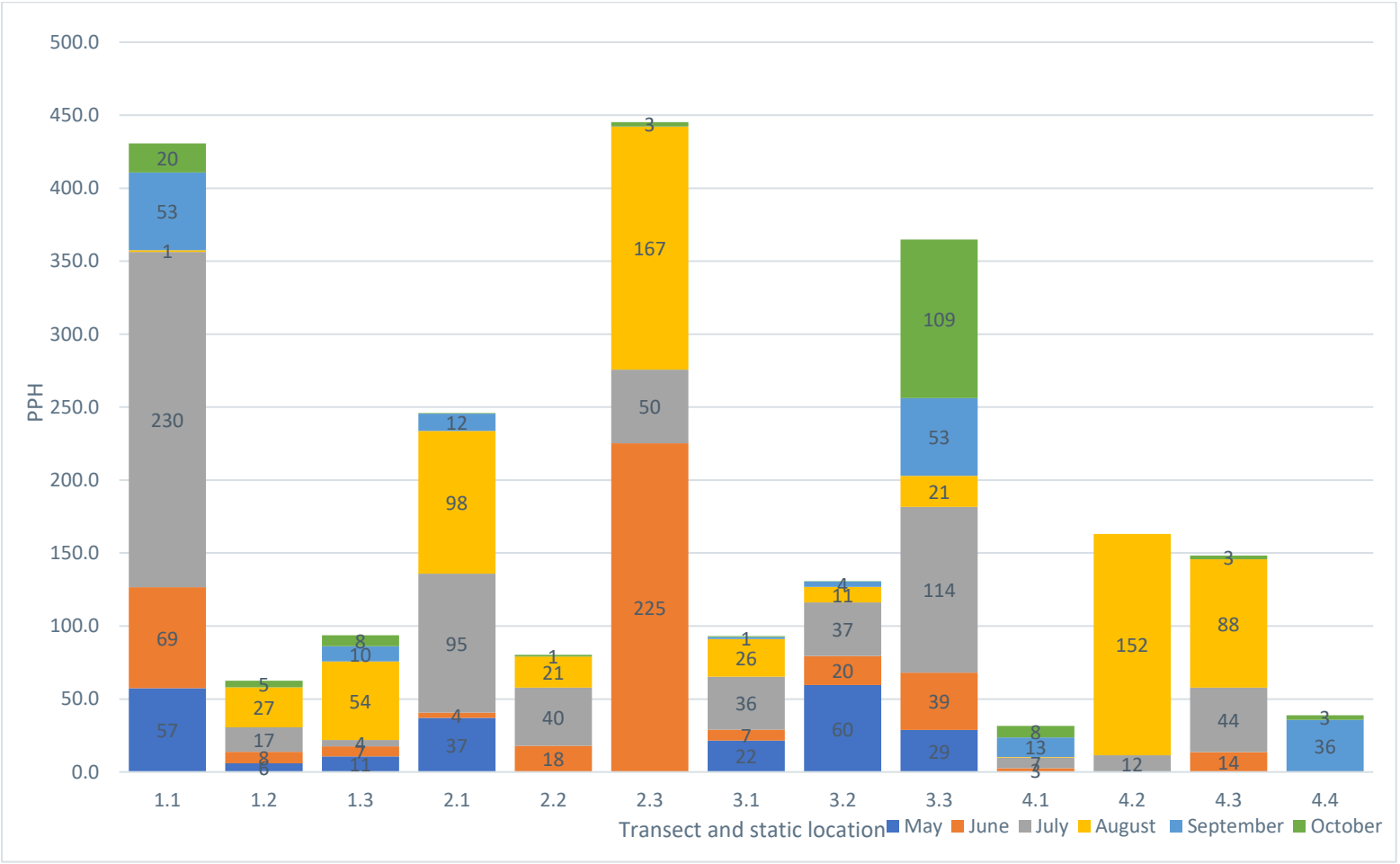
3.4.2 For static detectors associated with transect 1, activity levels were relatively high (20254 passes across all months) at location 1.1 but low at locations 1.2 (3565 passes across all months) and 1.3. (6015 passes across all months) At location 1.1 PPH increased in May and June (57 and 69 respectively) to a peak in July (230 PPH), at which point activity dropped through August (1 PPH), September (53 PPH) and October (20 PPH). At location 1.2, activity was low through May, June and July (6, 8 and 17 PPH respectively) and peaking in August (27 PPH), before dropping to minimal levels in October (5 PPH). No data was recorded for September due to failure of the detector. Location 1.3 showed similarly low levels of activity through May, June and July (11, 7 and 4 PPH respectively), peaking again in August (54 PPH), then dropping through September and October (10 and 8 PPH).

3.4.3 Aggregated PPH indicated levels of bat activity were highest at static detectors associated with transect 2. Location 2.3 attracted high levels of bat activity in June (225 PPH) and August (167 PPH), but was relatively low in July (50 PPH), and minimal in September (0.2 PPH) and October (3 PPH); no bat passes were recorded at this location for May (0 PPH). Activity at location 2.1 was roughly half that at 2.3; July and August saw the highest rate of passes (95 and 98 PPH respectively), followed by May (37 PPH), with June, September and October showing relatively low levels of activity (4, 12 and 0.4 PPH respectively). Location 2.2 supported low levels of bat activity, with July recording the highest number of passes (40 PPH), followed by June and August (18 and 21 PPH respectively), October (1 PPH) and no passes in May and September.

3.4.4 For locations associated with transect 3 aggregated PPH was only 0.5 passes lower than transect 2, with highest activity associated with location 3.3 and relatively low levels of activity at locations 3.1 and 3.2. Activity at location 3.1 fluctuated as time progressed, starting at in May with activity at 22 PPH, then dropping sharply in June (7 PPH), and rising to peak levels in July and August (26 and 36 PPH respectively) before falling minimal levels in September and October (both with 1 PPH). Location 3.2 showed similar but slightly higher levels of activity, peaking early in May (60 PPH) and fluctuating through June, July and August (20, 37 and 11 PPH respectively) before dropping to 4 PPH in September, and with no passes in October. Activity at location 3.3 however was relatively high with passes increasing through May, June and July (29, 39 and 114 PPH respectively), then fluctuating at a lower level through August and September (21 and 53 PPH) before, uniquely, peaking in October (103 PPH).

3.4.5 Detector locations along transect 4 were in the floodplain area, and were under-recorded due to limited access; of the 24 monitoring periods planned (4 locations by 6 months) only 13 could be completed. Location 4.1 provided the most complete data set with only May not being recorded. However, activity at this location, which was next to the River Arun, was the lowest from any studied through-out the survey period, fluctuating between June (2.5 PPH), July (7 PPH) and August (1 PPH) to a peak in September (13 PPH), before dropping again through October (8 PPH). At locations 4.2 and 4.4 only two months were monitored; July (12 PPH) and August (152 PPH) for location 4.2, and September (36 PPH) and October (3 PPH) at location 4.4. It is unclear from these measurements how activity changes through the year, but the high PPH value in August at location 4.2 is in line with summer peaks seen at other locations. Location 4.3 was represented by 4 months of data, June (14 PPH), July (44 PPH), August (88 PPH) and October (2.5 PPH), also indicating a rising pattern of bat activity peaking in summer, then dropping towards autumn

Figure 3.2 - Bat PPH by static detector location and survey month



3.5 BAT COMMUNITIES

3.5.1 These graphs provide a visual representation of the data, which displays the lack of obvious pattern in behaviour of the animals represented by the data obtained within this study.

3.5.2 Figure 3.3 displays the data for open habitat adapted bats. These are species considered to be least susceptible to road collisions, typically flying above 10m over open habitat. These species were present at all static locations. Static location 1.2 captured the peak in activity during July, of 4.0 PPH throughout the night. Noctule was recorded more consistently throughout the survey period at location 1.3 with a range between 0.5-2.5 PPH.

3.5.3 Figure 3.4 displays the data for cluttered habitat adapted bats. These are species considered to be most susceptible to road collisions. These species were present at all static locations. Static location 1.1 captured the highest level of activity in May of ~30 PPH throughout the night. Activity at this location remained relatively high through June and July, dropping to almost 0 PPH in August and September, and back up to 11 PPH in October. It is non-typical to record woodland specialists in open habitat, such as locations 4.1, 2.3 and 4.3.

3.5.4 Figure 3.5 displays the data for edge habitat adapted bats. These species were present at all static locations. Static locations 1.1 and 2.3 captured the highest level of activity for these species, ~215 PPH. This can be interpreted as approximately 4 bat passes per minute throughout the night, and could be considered to be at a level of 'constant' activity for this species group during these periods. At location 2.3 the peak level of activity was 225 PPH in June, dropped to under 50 PPH in July, then rose again to 160 PPH in August. In comparison, location 3.3 had a lower level of activity, but this community had a more consistent presence throughout the study period.

3.5.5 A single greater horseshoe bat pass was recorded at location 2.3 in August. The only record for this species in all four types of activity surveys discussed within this report.

Figure 3.3 - Bat PPH at all static locations over the survey period for open habitat adapted bats

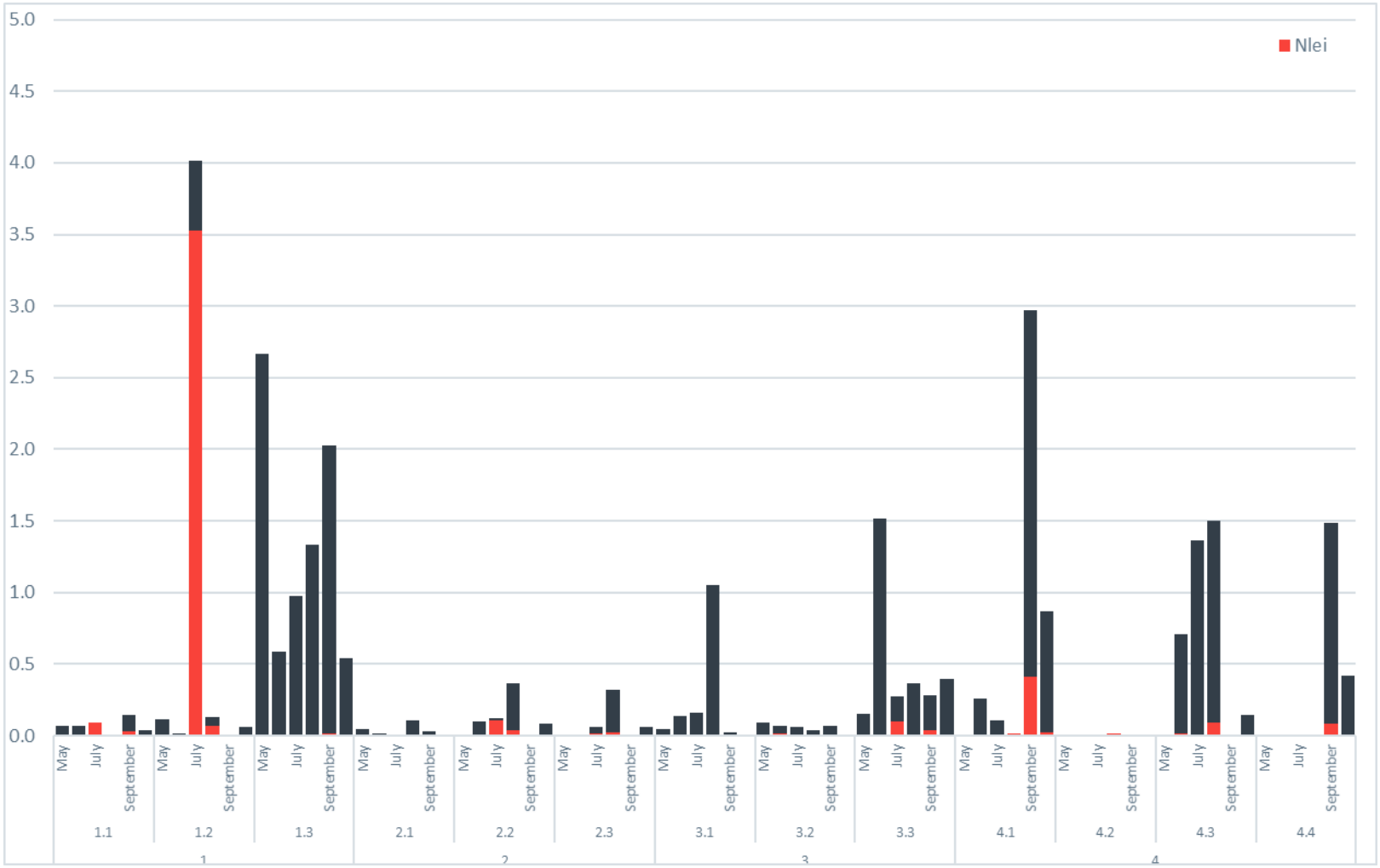


Figure 3.4 - Bat PPH at all static locations over the survey period for clutter adapted bats

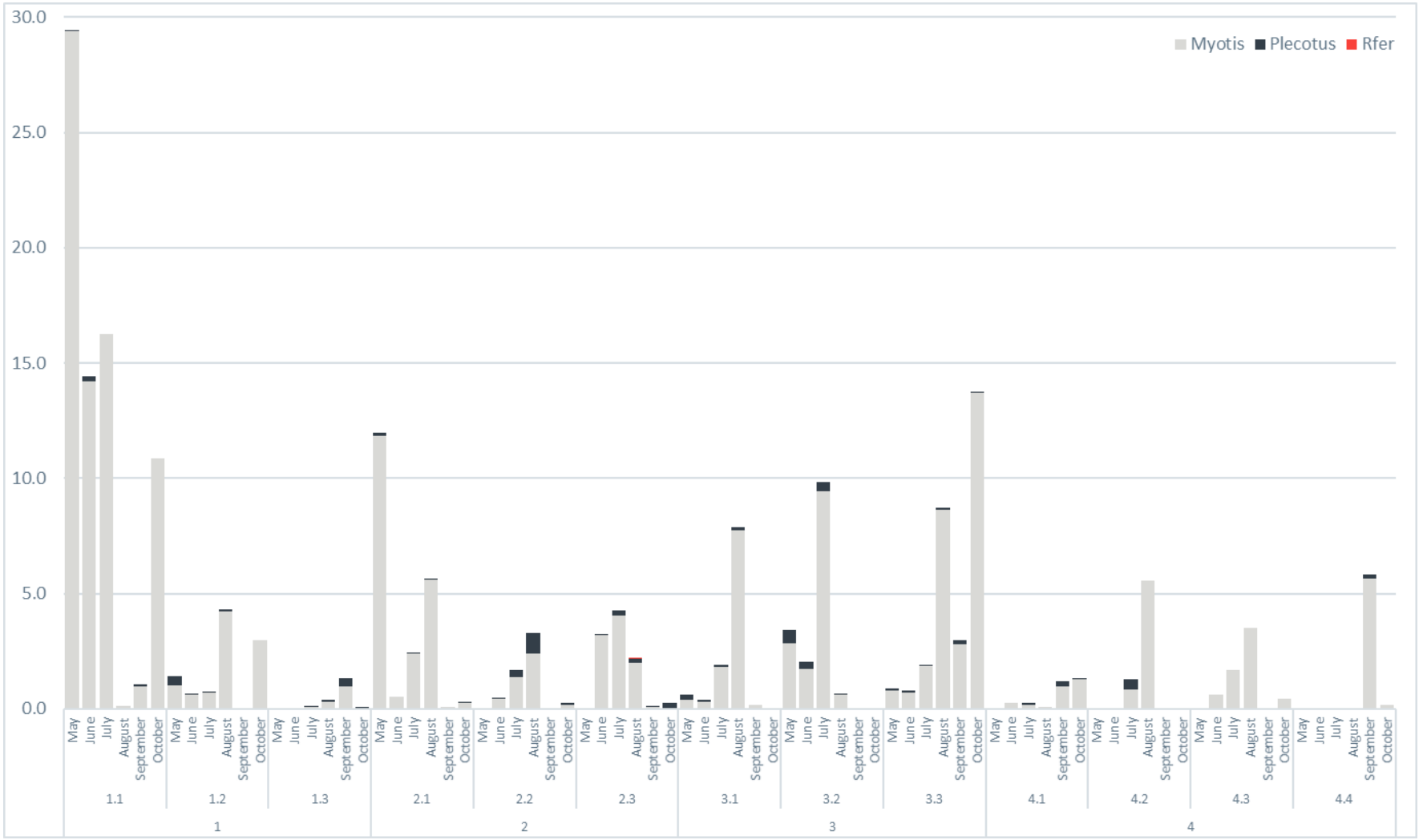
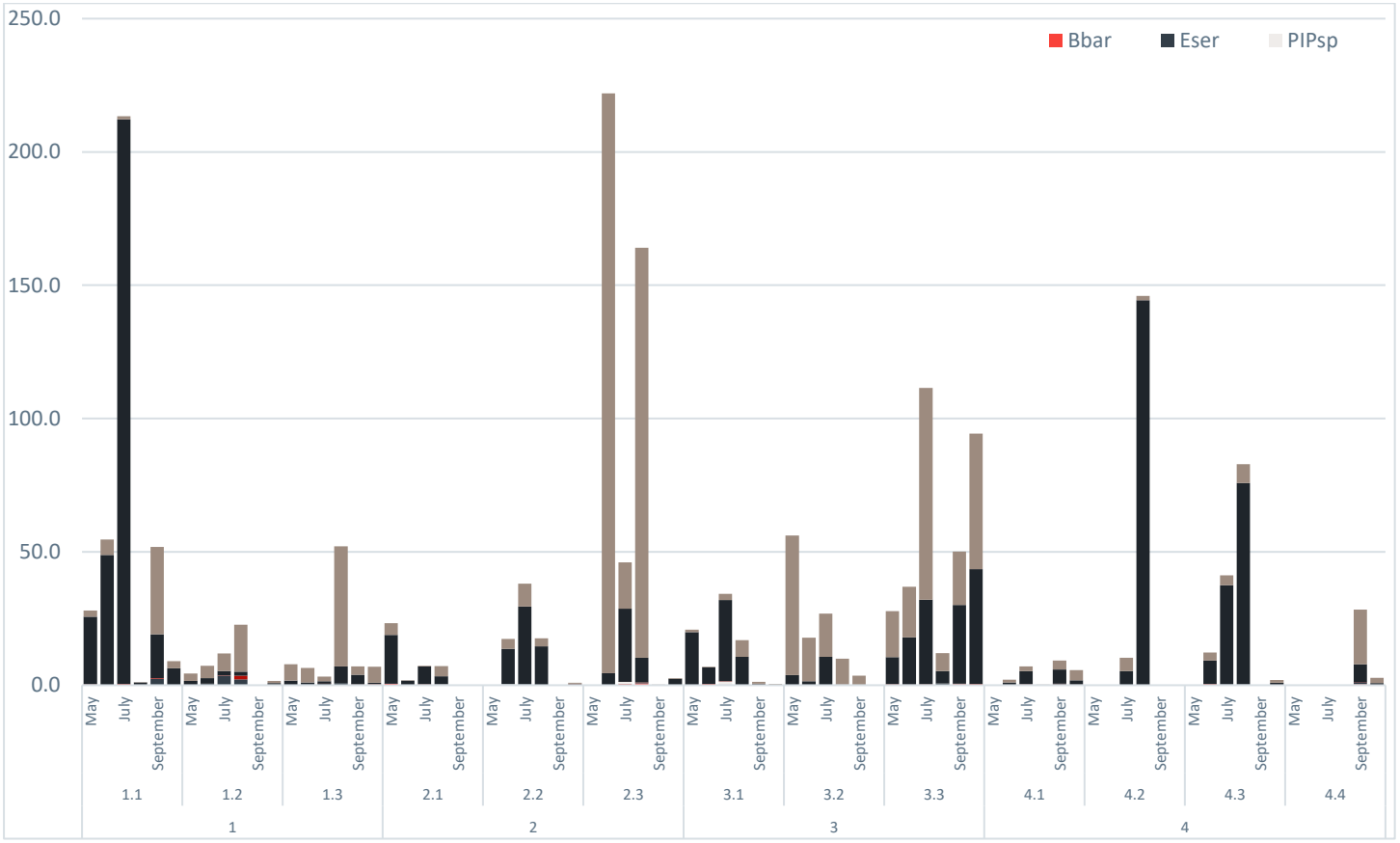


Figure 3.5 - Bat PPH at all static locations over the survey period for edge habitat adapted bats



3.6 DEFRA LOCAL EFFECTS SURVEY

3.6.1 A total of 4,069 bat passes were recorded across all locations, a breakdown of which can be viewed in Table 3.3.

3.6.2 The peak number of passes was recorded at crossing point 14, within the Binsted Wood Complex, along Binsted Lane, with 648 passes over the six survey visits; with 309 of those passes confirmed as using the feature as commuting feature or a foraging resource.

3.6.3 The fewest number of passes was recorded at crossing point 13, again within Binsted Wood Complex, but along a narrow walking path between woodland blocks, with 126 passes recorded over the six survey visits; with 51 of those passes confirmed as using the feature as using the feature as commuting feature or a foraging resource.

Table 3.3 - Survey results for locations confirmed as flight paths

Scheme Option	Crossing point	Number of passes heard but not seen crossing	Number of passes observed crossing	Total number of bats crossing over all surveys
5A	1	166	158	324
	3	223	143	366
	5	233	127	360
	6	198	125	323
	8	342	187	529
	9	230	130	360
	10	348	108	456
3	12	180	83	263
	13	75	51	126
	14	339	309	648
	15	166	148	314
	Total	**2500**	**1569**	**4069**

3.6.4 A total of 1,569 visual observations of bats passing were made compared to 2,500 passes which were recorded by the detector but not visually observed, accounting for 61.4% of the total data recorded. This resulted in only 38.5% of the total data recorded used in the statistical analysis. It is unknown if this 61.4% are in fact using the feature, and if so, if they are within the collision zone of traffic. However, Table 3.4 breaks down the 61.4% to the species level. A total of 690 of these passes are by clutter adapted species, which are most likely to be using the feature at an unsafe height and within the collision zone of traffic. This accounts for 27.6% of the total number of passes heard but not seen.

Table 3.4 - Number of passes by species or species group

Community	Species	Number of passes heard but not seen crossing
Cluttered habitat adapted bats	Plecotus species	69
	Whiskered bat/Brandt's bat	2
	Daubenton's bat	60
	Myotis species	559
Edge habitat adapted bats	Serotine	38
	Common pipistrelle	1183
	Soprano pipistrelle	440
	Nathusius' pipistrelle	2
Open habitat adapted bats	Noctule-Leisler's bat-Serotine (NSL)	19
	Leisler's bat	17
	Noctule	29

3.6.5 A summary of the results is presented in Table 3.5. A detailed breakdown of the data for each crossing point (CP1, CP3, CP5, CP6, CP8, CP9, CP10, CP12, CP13, CP14 and CP15) are presented in the subsequent sections of this report. Survey data can be found in Appendix A.

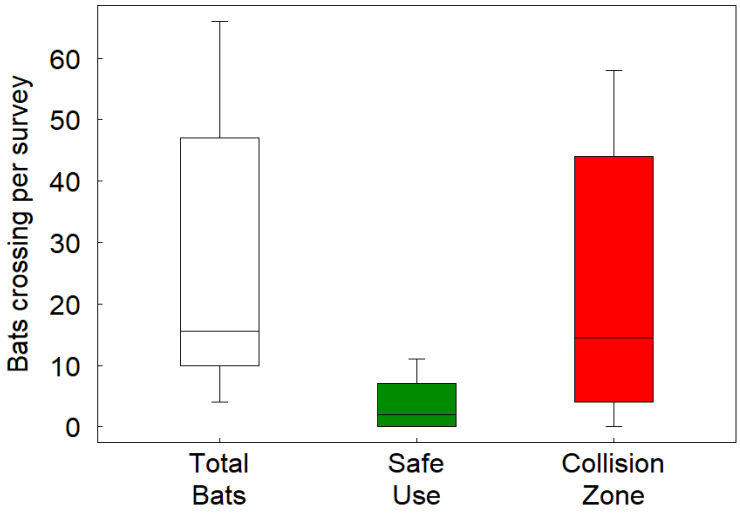
Table 3.5 - Summary of results

Scheme Option		Crossing point	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
		Total	1569	543	34.6	1004	64.0
5A		1	158	22	13.9	135	85.4
		3	143	3	2.1	140	97.9
		5	127	19	14.9	108	85.0
		6	125	16	12.8	108	86.4
		8	187	20	10.7	167	89.3
		9	130	11	8.5	117	90.0
		10	108	9	8.3	94	87.0
3		12	83	58	69.8	24	28.9
		13	51	2	3.9	46	90.2
		14	309	259	83.8	43	13.9
		15	148	124	83.7	22	14.8

Crossing Point 1

3.6.6 A total of 158 bat passes were observed, of which; 22 (13.9%) were considered to be using the feature at a safe crossing height, with 135 (85.4%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic.

Boxplot 1 - Number of bats crossing per survey for all bat species at crossing point 1



3.6.7 These data are presented per species/species group in Table 3.6. These bats were observed using this woodland edge for foraging or commuting over the course of the six survey visits. One pass was unaccounted for within Table 4.6. This bat did not use the feature (within 5m distance) and also flew above 5m from ground level.

3.6.8 No known tree roosts were located within immediate proximity, although known maternity roosts of Alcathoe bat and brown long-eared bats were identified within the woodland within 500m of this location (reported separately[42]).

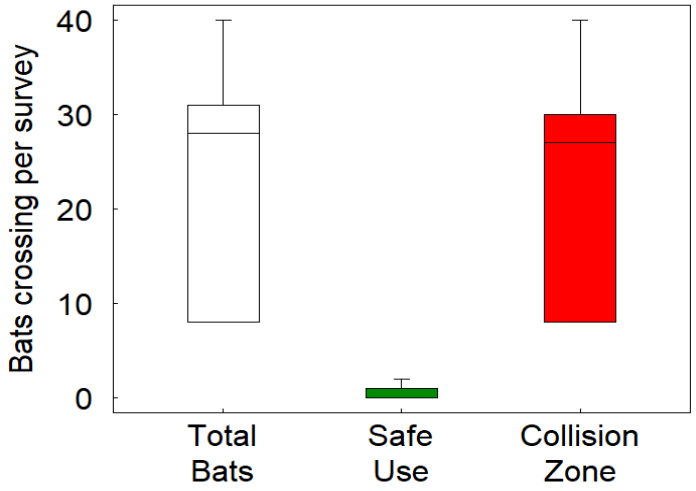
Table 3.6 - Survey results for Crossing Point 1

Species	Number of passes observed	Number of passes observed usin[g] the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	158	22	13.9	135	85.4
Common pipistrelle	102	16	15.6	85	83.3
Soprano pipistrelle	21	4	19.0	17	80.9
Myotis species	34	2	5.8	32	94.1
Noctule-Leisler's-Serotine (NSL)	1	0	0	1	100.0

[42] WSP (2017) A27_ECO_BAT_BAT RADIO-TRACKING INTERIM-BASELINE REPORT

Boxplot 2 - Number of bats crossing per survey for all bat species at crossing point 3

3.6.9 A total of 143 bat passes were observed, of which; 3 (2.1%) were considered to be using the feature at a safe crossing height, with 140 (97.9%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic



3.6.10 These data are presented per species/species group in Table 3.7. These bats were observed using this hedgerow for foraging or commuting over the course of the six survey visits.

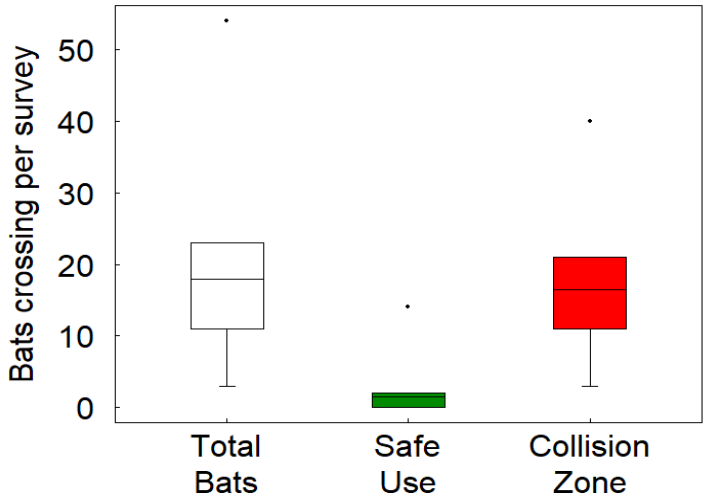
3.6.11 No known tree roosts were located within immediate proximity, although known roosts of barbastelle and Alcathoe bat were identified within the woodland connected to this feature within 500m of this location.

Table 3.7 - Survey results for Crossing Point 3

Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	143	3	2.1	140	97.9
Common pipistrelle	88	3	3.4	85	96.5
Soprano pipistrelle	44	0	0	44	100
Myotis species	6	0	0	6	100
Barbastelle	5	0	0	5	100

3.6.12 A total of 127 bat passes were observed, of which; 19 (14.9%) were considered to be using the feature at a safe crossing height, with 108 (85%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic.

Boxplot 3 - Number of bats crossing per survey for all bat species at crossing point 5



3.6.13 These data are presented per species/species group in Table 3.8. These bats were observed using this woodland edge for foraging or commuting over the course of the six survey visits.

3.6.14 No known tree roosts were located within immediate proximity, although known roosts of barbastelle and Alcathoe bat were identified within the woodland connected to this feature within 500m of this location.

Table 3.8 - Survey results for Crossing Point 5

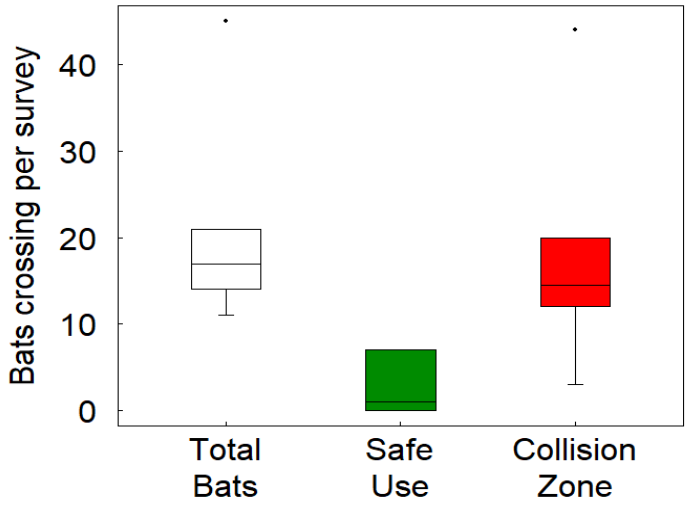
Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	127	19	14.9	108	85.0
Common pipistrelle	52	8	15.4	44	84.6
Soprano pipistrelle	38	6	15.8	32	84.2
Myotis species	20	5	25	15	75
Barbastelle	3	0	0	3	100
Whiskered bat/Brandt's bat	2	0	0	2	100

Daubenton's bat	10	0	0	10	100
Plecotus species	2	0	0	2	100

Crossing Point 6

3.6.15 A total of 125 bat passes were observed, of which; 16 (12.8%) were considered to be using the feature at a safe crossing height, with 108 (86.4%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic.

Boxplot 4 - Number of bats crossing per survey for all bat species at crossing point 6



3.6.16 These data are presented per species/species group in Table 3.9. These bats were observed using this single-track lane for foraging or commuting over the course of the six survey visits. One pass was unaccounted for within Table 4.9. This bat did not use the feature (within 5m distance) and also flew above 5m from ground level.

3.6.17 No known tree roosts were located within immediate proximity.

Table 3.9 - Survey results for Crossing Point 6

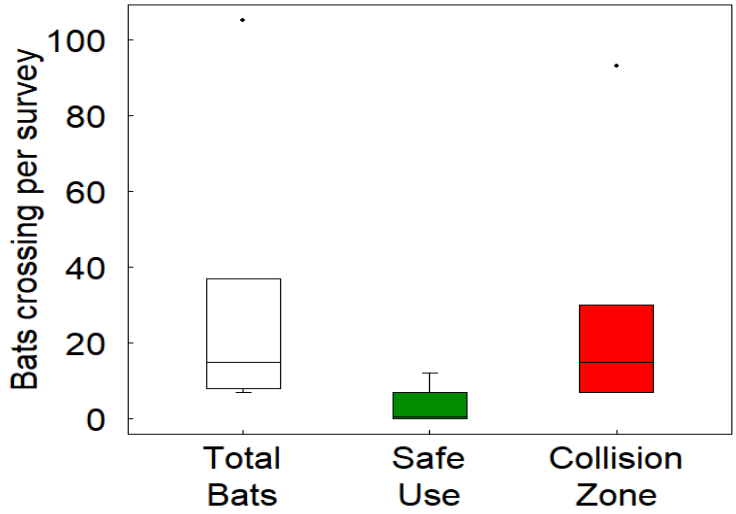
Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	125	16	12.8	108	86.4
Common pipistrelle	37	4	10.8	33	89.2
Soprano pipistrelle	55	8	14.5	47	85.4
Myotis species	24	4	16.6	20	83.3

Noctule-Leisler's-Serotine (NSL)	1	0	0	0	0
Plecotus species	7	0	0	7	100

Crossing Point 8

3.6.18 A total of 187 bat passes were observed, of which; 20 (10.7%) were considered to be using the feature at a safe crossing height, with 167 (89.3%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic.

Boxplot 5 - Number of bats crossing per survey for all bat species at crossing point 8



3.6.19 These data are presented per species/species group in Table 3.10. These bats were observed using this hedgerow for foraging or commuting over the course of the six survey visits.

3.6.20 No known tree roosts were located within immediate proximity, although known roosts of barbastelle and Alcathoe bat were identified within the woodland connected to this feature within 500m of this location (reported separately).

Table 3.10 - Survey results for Crossing Point 8

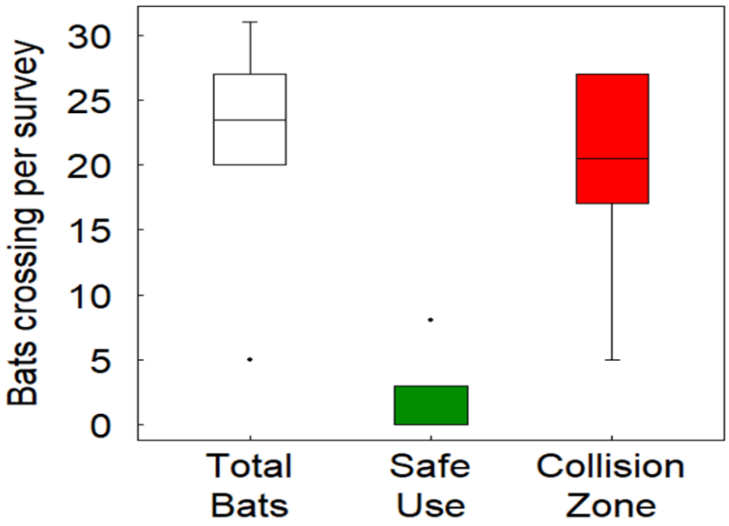
Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	**187**	**20**	**10.7**	**167**	**89.3**
Common pipistrelle	118	12	10.2	106	89.8
Soprano pipistrelle	33	2	6.1	31	93.9
Myotis species	24	3	12.5	21	87.5

Daubenton's bat	6	1	16.7	5	83.3
Barbastelle	2	0	0	2	100
Noctule-Leisler's bat-Serotine (NSL)	3	2	66.7	1	33.3

Crossing point 9

3.6.21 A total of 130 bat passes were observed, of which; 11 (8.5%) were considered to be using the feature at a safe crossing height, with 117 (90%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic.

Boxplot 6- Number of bats crossing per survey for all bat species at crossing point 9



3.6.22 These data are presented per species/species group in Table 3.11. These bats were observed using this hedgerow for foraging or commuting over the course of the six survey visits. Two passes are unaccounted for within Table 3.11. These bats did not use the feature (within 5m distance) and also flew above 5m from ground level.

3.6.23 No known tree roosts were located within immediate proximity, although known maternity roosts of Bechstein's bat were identified within the woodland connected to this feature within 500m of this location (reported separately[43]).

[43] WSP (2017) A27_ECO_BAT_BAT RADIO-TRACKING INTERIM-BASELINE REPORT

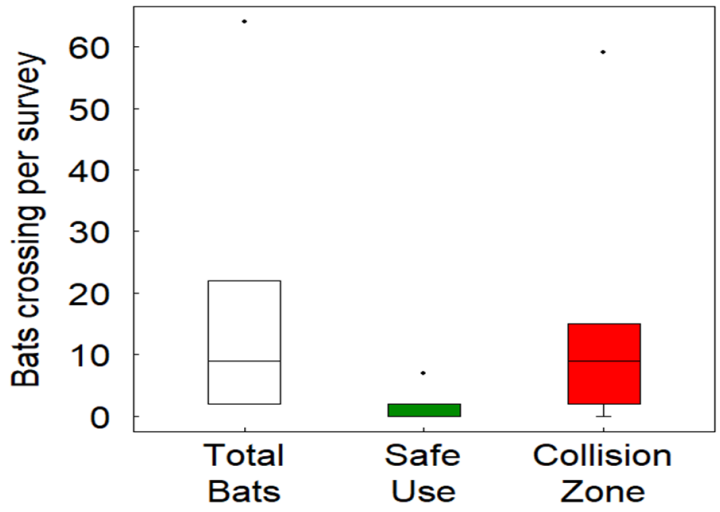
Table 3.11 - Survey results for Crossing Point 9

Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed [c]rossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	**130**	**11**	**8.5**	**117**	**90**
Common pipistrelle	59	5	8.5	54	91.5
Soprano pipistrelle	49	2	4.1	46	93.9
Myotis species	12	2	16.7	10	83.3
Daubenton's bat	2	0	0	2	100
Serotine	4	[1]	25	2	50
Noctule-Leisler's-Serotine (NSL)	1	1	100	0	0
Plecotus species	3	0	0	3	100

Crossing point 10

3.6.24 A total of 108 bat passes were observed, of which; 9 (8.3%) were considered to be using the feature at a safe crossing height, with 94 (87%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic.

Boxplot 7 - Number of bats crossing per survey for all bat species at crossing point 10



3.6.25 These data are presented per species/species group in Table 3.12. These bats were observed using this hedgerow for foraging or commuting over the course of the six survey visits. Five passes are unaccounted for within Table 3.12. These bats did not use the feature (within 5m distance) and also flew above 5m from ground level.

3.6.26 No known tree roosts were located within immediate proximity, although known maternity roosts of Bechstein's bat were identified within the woodland connected to this feature within 500m of this location.

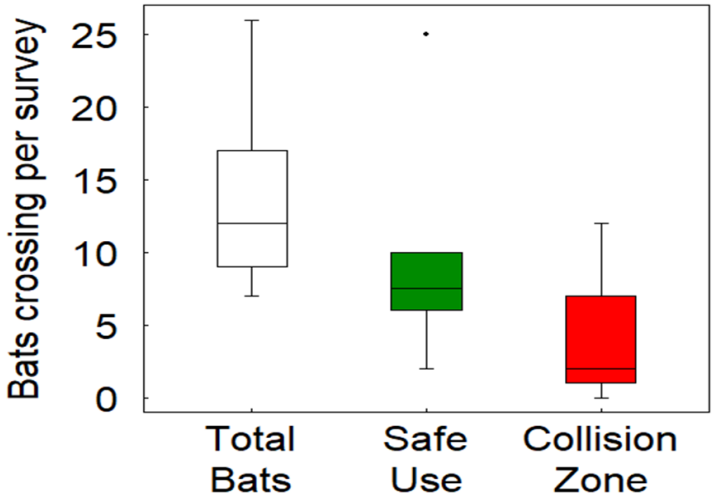
Table 3.12 - Survey results for Crossing Point 10

Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	**108**	**9**	**8.3**	**94**	**87.0**
Common pipistrelle	73	5	6.8	64	87.6
Soprano pipistrelle	22	4	18.2	18	81.8
Myotis species	7	0	0	7	100
Daubenton's bat	2	0	0	2	100
Noctule	2	0	0	1	50
Serotine	1	0	0	1	100

Crossing point 12

3.6.27 A total of 83 bat passes were observed, of which; 58 (69.8%) were considered to be using the feature at a safe crossing height, with 24 (28.9%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic.

Boxplot 8 - Number of bats crossing per survey for all bat species at crossing point 12



3.6.28 These data are presented per species/species group in Table 3.13. These bats were observed using the woodland edge for foraging or commuting over the course of the six survey visits. One pass was unaccounted for within Table 3.13. This bat did not use the feature (within 5m distance) and also flew above 5m from ground level.

3.6.29 No known tree roosts were located within immediate proximity, although known maternity roosts of Bechstein's bat were identified within 500m of this location.

Table 3.13 - Survey results for Crossing Point 12

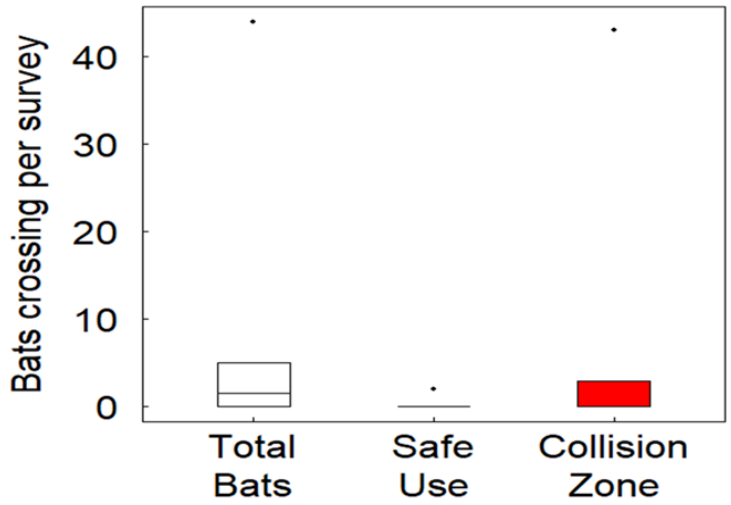
Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	**83**	**58**	**69.8**	**24**	**28.9**
Common pipistrelle	61	45	73.7	15	24.5
Soprano pipistrelle	14	8	57.1	6	42.8
Myotis species	4	1	25	3	75
Barbastelle	1	1	100	0	0
Daubenton's bat	1	1	100	0	0

Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
Serotine	1	1	100	0	0
Plecotus species	1	1	100	0	0

Crossing point 13

3.6.30 A total of 51 bat passes were observed, of which; 2 (3.9%) were considered to be using the feature at a safe crossing height, with 46 (90.2%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic.

Boxplot 9 - Number of bats crossing per survey for all bat species at crossing point 13



3.6.31 These data are presented per species/species group in Table 3.14. These bats were observed using this footpath within the woodland for foraging or commuting over the course of the six survey visits. Three passes are unaccounted for within Table 3.14. These bats did not use the feature (within 5m distance) and also flew above 5m from ground level.

3.6.32 No known tree roosts were located within immediate proximity, although known maternity roosts of Bechstein's bat were identified within 500m of this location.

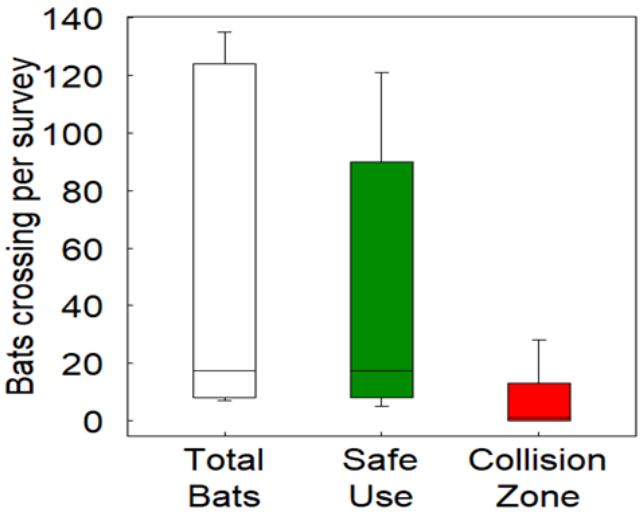
Table 3.14 - Survey results for Crossing Point 13

Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	**51**	**2**	**3.9**	**46**	**90.2**
Common pipistrelle	26	2	7.69	21	80.76
Soprano pipistrelle	1	0	0	1	100
Myotis species	18	0	0	18	100
Daubenton's bat	6	0	0	6	100

Crossing point 14

3.6.33 A total of 309 bat passes were observed, of which; 259 (83.8%) were considered to be using the feature at a safe crossing height, with 43 (13.9%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic.

Boxplot 10 - Number of bats crossing per survey for all bat species at crossing point 14



3.6.34 These data are presented per species/species group in Table 3.15. These bats were observed using this lane within the woodland for foraging or commuting over the course of the six survey visits. Three passes are unaccounted for within Table 3.15. These bats did not use the feature (within 5m distance) and also flew above 5m from ground level.

3.6.35 No known tree roosts were located within immediate proximity, although known maternity roosts of Bechstein's bat were identified within 500m of this location.

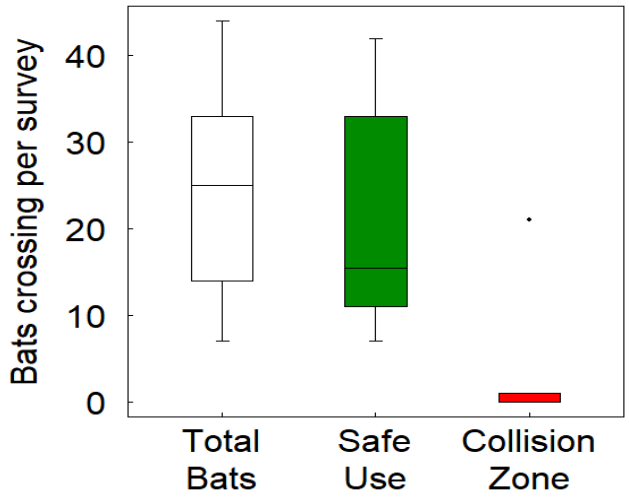
Table 3.15 -Survey results for Crossing Point 14

Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	**309**	**259**	**83.8**	**43**	**13.9**
Common pipistrelle	205	174	84.9	27	13.2
Soprano pipistrelle	57	50	87.7	6	10.5
Myotis species	15	11	73.3	3	20
Daubenton's bat	3	0	0	2	66.6
Serotine	29	24	82.8	5	17.2

Crossing point 15

3.6.36 A total of 148 bat passes were observed, of which; 124 (83.7%) were considered to be using the feature at a safe crossing height, with 22 (14.8%) observed to be crossing at an unsafe height- and within the collision zone of potential traffic.

Boxplot 11 - Number of bats crossing per survey for all bat species at crossing point 15



3.6.37 These data are presented per species/species group in Table 3.16. These bats were observed using this track within the woodland for foraging or commuting over the course of the six survey visits. Four passes are unaccounted for within Table 3.16. These bats did not use the feature (within 5m distance) and also flew above 5m from ground level.

3.6.38 No known tree roosts were located within immediate proximity, although known maternity roosts of Bechstein's bat were identified within 500m of this location.

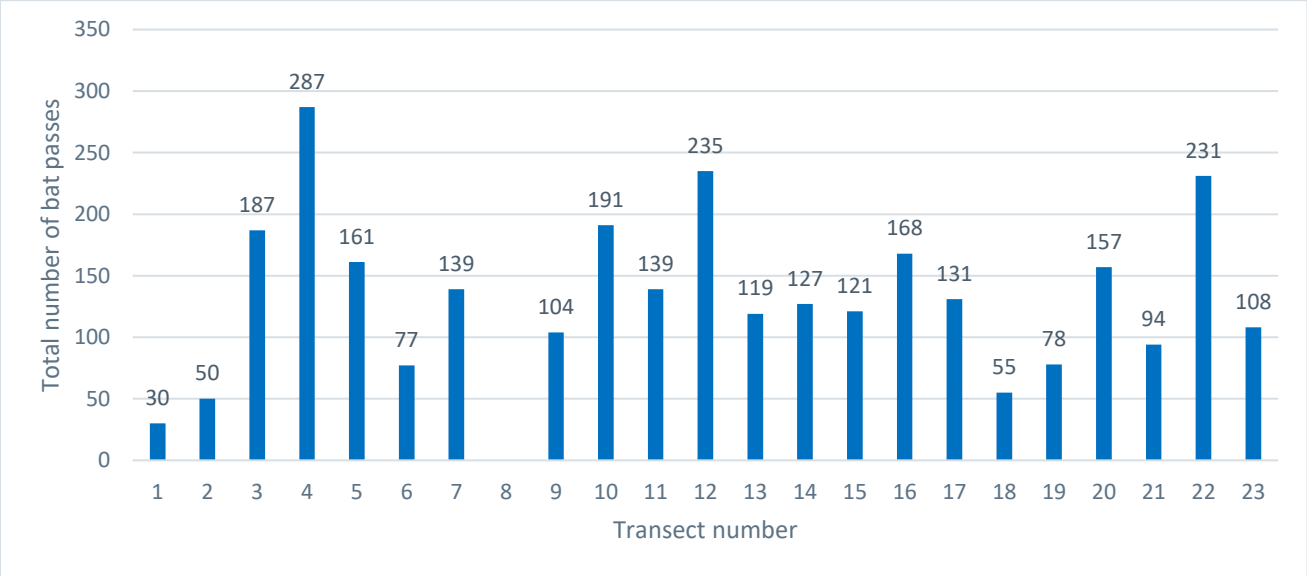
Table 3.16 - Survey results for Crossing Point 15

Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	**148**	**124**	**83.7**	**22**	**14.8**
Common pipistrelle	113	93	82.3	18	15.9
Soprano pipistrelle	13	10	76.9	3	14.8
Myotis species	10	10	100	0	0
Barbastelle	4	4	100	0	0
Serotine	7	6	85.7	1	14.28
Plecotus species	1	1	100	0	0

3.7 DEFRA LANDSCAPE EFFECTS SURVEY

3.7.1 A total of 2,989 bat passes of a minimum of ten species were recorded during the survey. Figure 3.6 displays the total number of passes per transect, with peak level of activity occurring across transect 4.

Figure 3.6 - Total number of bat passes per transect



3.7.2 A total of 86 barbastelle passes were recorded over the course of the survey. 25 of these passes are from transect 5 at 300m, and another 3 passes at 400m during the same repetition survey. One Bechstein's bat pass (Annex II species) was also recorded, at 600m, during the same survey. This particular survey was undertaken on 1st August 2017.

SCHEME OPTION 1

3.7.3 Distance from Option 1 did not have a significant effect on bat activity (Figure 3. 7).

3.7.4 Habitat grade 4[44] has a significant positive effect on bat activity (GEE, Wald $x2$=8.912, P <0.001; Table 3.17) with a predicted increase in bat activity compared to habitat grade 1 (Figure 3.8).

Table 3.17 - GEE Results for total bat activity (log (1 + number of bat passes)) species present per spot check)

```
Summary(M1)

Call:
geeglm(formula = LPass ~ Dist + Hab + Time, family = gaussian,
    data = site1, id = RouteNight, corstr = "ar1", std.err = "fij")

 Coefficients:
             Estimate    Std.err  Wald Pr(>|W|)
(Intercept)  1.0641139  0.3387185 9.870  0.00168 **
Dist        -0.0002302  0.0002628 0.767  0.38102
Hab2        -0.0583364  0.2359296 0.061  0.80471
Hab3         0.2185060  0.2525334 0.749  0.38690
Hab4         0.7490903  0.2509274 8.912  0.00283 **
Hab5         0.1596658  0.1815227 0.774  0.37908
Time         0.0026717  0.0023230 1.323  0.25010
---
Signif. codes:
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Estimated Scale Parameters:
            Estimate Std.err
(Intercept)    1.036 0.05661
```

[44] Habitat grades are a standardised category referenced from the DEFRA methods, see section 2.8.5

```
Correlation: Structure = ar1  Link = identity

Estimated Correlation Parameters:
      Estimate Std.err
alpha   0.1902  0.0436
Number of clusters:   18   Maximum cluster size: 11
```

Figure 3.7 - Effect of distance from 0 - 1000 m on total bat activity with the final GEE model

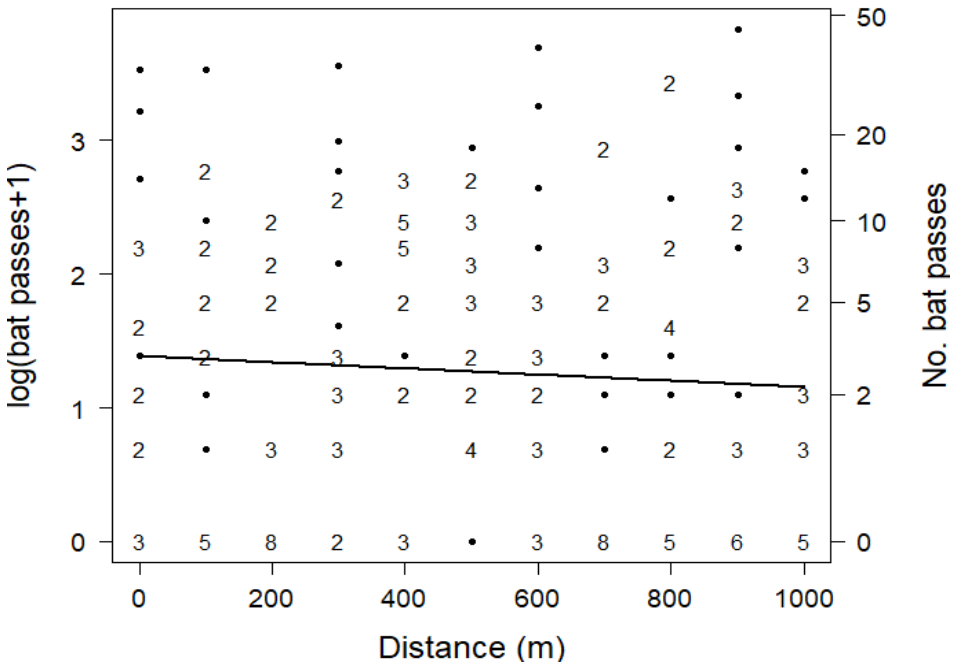
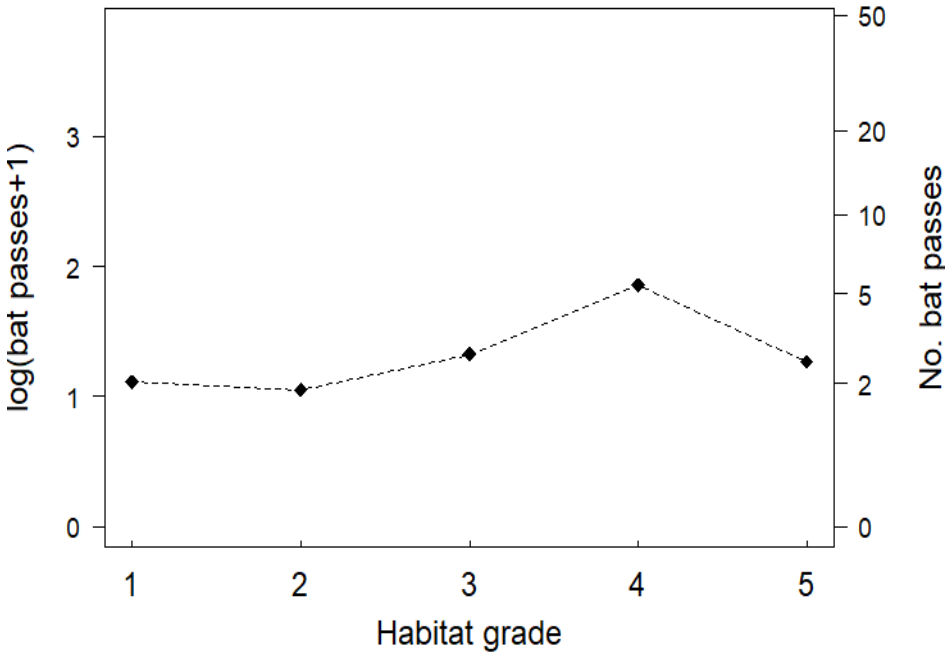


Figure 3-8 - - Effect of habitat grade 1-5 on total bat activity with the final GEE model (1 = Fence or wall lining road/path and open fields beyond, 2 = Hedges/shrubby verges lining road/path and open fields beyond, 3 = Intermittent medium trees/bushed lining road/path and open fields beyond, 4 =Intermittent tall trees lining road/path and open fields beyond, 5 = Continuous tall tree cover lining road/path with woodland and/or open fields beyond)



SCHEME OPTION 3

3.7.5 Distance from Option 3 did not have a significant effect on bat activity (Table 3.18, Figure 3.9). No other variables have a significant effect on bat activity. However, habitat grade 5 is present in over 50% of all habitat grades recorded for these transects, and therefore habitat as a variable is bias toward this grade, meaning there may be too little data to compare the other habitat grades, or because there is no difference.

Table 3.18 - GEE Results for total bat activity (log (1 + number of bat passes)) species present per spot check)

```
Summary(o3M6)

Call:
geeglm(formula = LPass ~ Dist, family = gaussian, data = site3,
    id = RouteNight, corstr = "ar1", std.err = "fij")

 Coefficients:
             Estimate  Std.err  Wald Pr(>|W|)
(Intercept) 1.225004 0.125485 95.30   <2e-16 ***
Dist        0.000397 0.000265  2.26     0.13
---
```

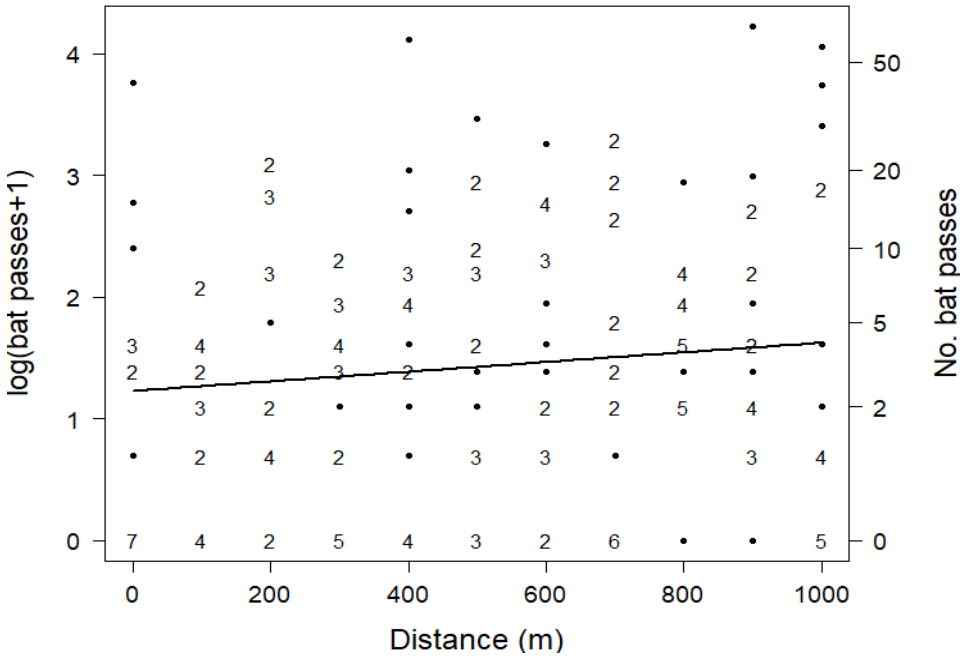
```
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Estimated Scale Parameters:
            Estimate Std.err
(Intercept)      1.1  0.0919

Correlation: Structure = ar1  Link = identity

Estimated Correlation Parameters:
      Estimate Std.err
alpha    0.295  0.0515
Number of clusters:   18   Maximum cluster size: 11
```

Figure 3.9 - Effect of distance from 0 - 1000 m on total bat activity with the final GEE model



SCHEME OPTION 5A

3.7.6 Distance from Option 5A did not have a significant effect on bat activity (Table 3.19, Figure 3.10).

3.7.7 Poly time (a quadratic term for time after sunset) had a significant positive effect on bat activity for both repetitions (GEE, Wald $x2$=17.61 and 14.01, P <0; Table 4.18) with a peak in activity 90 minutes after sunset (Figure 3.11).

Table 3.19 - GEE Results for total bat activity (log (1 + number of bat passes)) species present per spot check)

Summary(o5M2)

```
Call:
geeglm(formula = LPass ~ Dist + Hab + poly(Time, 2, raw = TRUE),
    family = gaussian, data = site5, id = RouteNight, corstr = "ar1",
    std.err = "fij")

 Coefficients:
                      Estimate   Std.err  Wald Pr(>|W|)
(Intercept)          -7.39e-01  6.08e-01  1.48  0.22441
Dist                  3.63e-04  1.88e-04  3.72  0.05375 .
Hab2                  2.30e-01  5.23e-01  0.19  0.65952
Hab3                  3.45e-01  5.75e-01  0.36  0.54855
Hab4                  1.04e+00  5.60e-01  3.46  0.06297 .
Hab5                  4.54e-01  5.83e-01  0.61  0.43571
poly(Time, 2, raw = TRUE)1  4.04e-02  9.62e-03 17.61  2.7e-05 ***
poly(Time, 2, raw = TRUE)2 -2.16e-04  5.78e-05 14.01  0.00018 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Estimated Scale Parameters:
            Estimate Std.err
(Intercept)    0.924  0.0782

Correlation: Structure = ar1  Link = identity

Estimated Correlation Parameters:
      Estimate Std.err
alpha    0.421  0.0869
Number of clusters:   18   Maximum cluster size: 11
```

Figure 3.10 - Effect of distance from 0 - 1000 m on total bat activity with the final GEE model

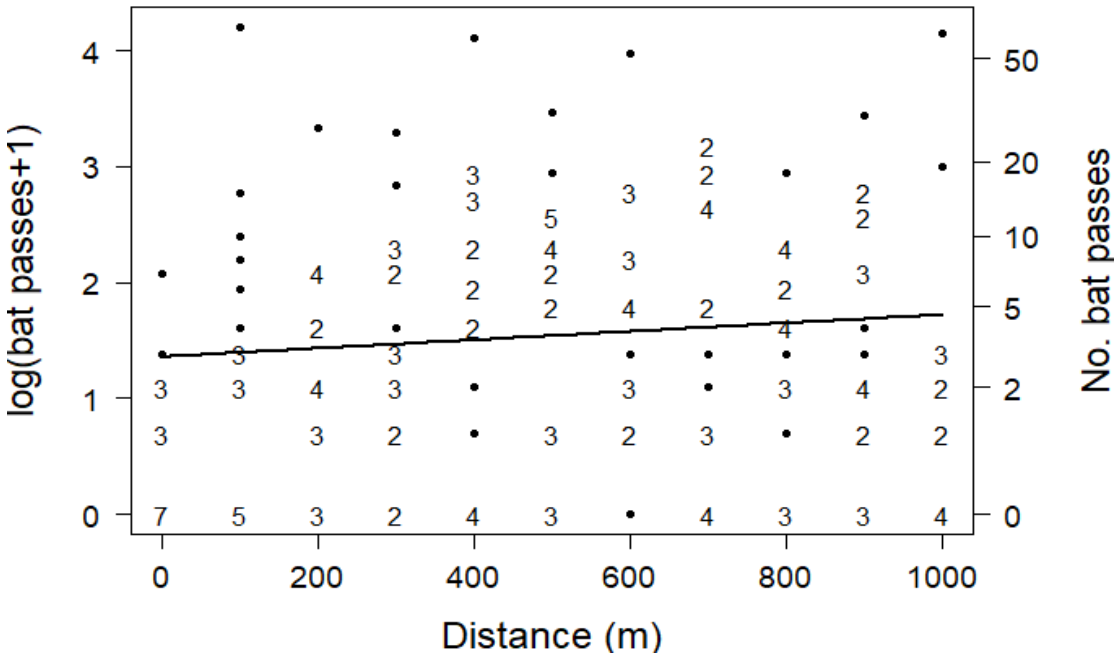
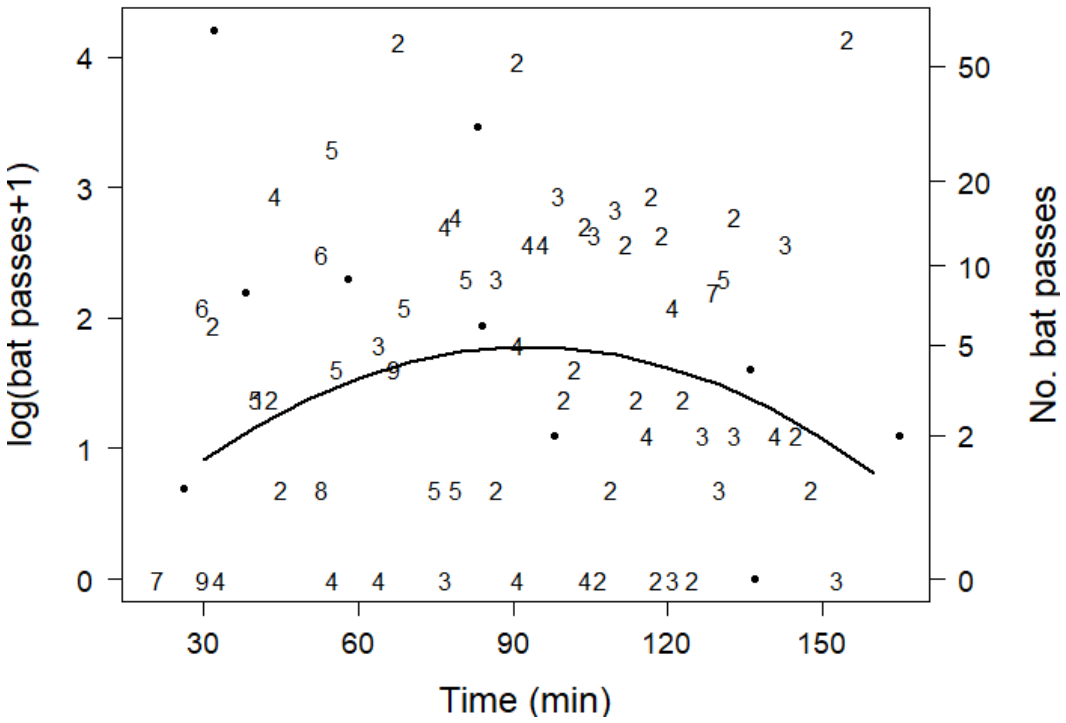


Figure 3.11 - Effect of time from sunset on total bat activity with the final GEE model



4 DISCUSSION

4.1 OVERVIEW

4.1.1 Three Annex II species and one very rare bat species were confirmed to be present within the Survey Area as a result of the activity surveys: barbastelle, Bechstein's bat, greater horseshoe bat and Alcathoe bat. Due to the expected core sustenance zones of these species[45] and the available high quality habitat and roosting opportunities present, it is likely that these species are roosting either within, or a few km away from, the Study Area (Alcathoe bat, barbastelle and Bechstein's bat have been confirmed roosting within the Study Area by the radio-tracking study[46]). These bats are locally and nationally rare.

4.1.2 The data from the activity surveys suggests that a broad assemblage of bat species is present within the Survey Area, with all three ecological communities represented at all static locations, throughout the bat activity season.

4.1.3 Generally, activity levels rose from June to September, then dropped to October; this is fairly typical of the seasonal variation in state-dependant activity of bats[47]. It is likely that the peak in activity in September can be attributed to the maternity colonies disbanding in the woodlands, individuals travelling to swarming/ hibernation sites to mate and foraging further each night to feed in preparation for hibernation.

4.1.4 Within these datasets, the transect and static analyses so far indicate the lack of obvious pattern in behaviour of the animals recorded. These data indicate that bat activity within the Survey Area follows no obvious seasonal, temporal or habitat dependant association with any one location which may be explained by the variables measured. It may be inferred that these animals are moving across the Survey Area to perhaps manipulate resources (such as roosting and foraging resources) when available or preferred, and that no one location is more important to these animals. Interpreting these findings lead us to believe that the ecological system is more complex than these simple measures can detect, and that only with continued work and compilation of data can sound assumptions be drawn.

4.2 DESK STUDY

4.2.1 The MAVES[48] confirmed maternity roosts of Bechstein's bat, Alcathoe bat and occasional roosts for a range of other bat species in Binsted Wood Complex LWS. The maves surveyors recorded barbastelle roosting in the Binsted Wood Complex LWS but considered it unlikely the roost they found was a breeding roost.

4.2.2 Both Bechstein's bat and barbastelle are listed on Annex II of the Habitats Directive (for which SAC are designated as a mechanism for protection of these species) and are also categorised as Near Threatened on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species[49] and are regarded as Very Rare both in Sussex[50] and UK[51]. Alcathoe bat is listed as Data Deficient on the IUCN Red List of Threatened Species[52] and are considered Very Rare, with distribution across the UK unknown, having only recently been recognised in the UK[53].

4.2.3 There are no sites within the Study Area which are being considered or identified as Candidate sites (cSACs) for SAC designation[54].

4.3 TRANSECT SURVEY

4.3.1 Overall activity levels rose from June to September, then dropped in October; this is fairly typical of the seasonal variation in activity of bats[55]. It is likely that the peak in activity in September can be attributed to the maternity colonies disbanding in the woodlands, individuals travelling to swarming/ hibernation sites to mate and foraging further each night to feed in preparation for hibernation.

4.3.2 Generally, however, species composition of the bat community varied between transects and survey month.

4.3.3 The peak activity for noctule and Leisler's bat was across transect 1, at listening point 1.6. This location is adjacent to the bridge over the River Arun, within Arundel town. It is known that open adapted bats such as these use features such as rivers to navigate[56].

4.3.4 A total of 11 barbastelle passes were recorded, on transects 2 and 3, only. Five of these locations are within Binsted Wood complex LWS, the other two locations are along habitat features directly connected to it. As these are woodland roosting bats, these data indicate a likelihood that this species may be roosting within the Binsted Wood complex LWS. The likelihood is strengthened as all passes were recorded within the first hour after sunset and barbastelle are known to emerge from roosts at around 24 minutes after sunset[57].

[45] Collins, J. (ed) (2016) Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edn.). The Bat Conservation Trust, London. Section 3.7.

[46] WSP (2017) A27_ECO_BAT_BAT RADIO-TRACKING INTERIM-BASELINE REPORT

[47] Dietz, C., Kiefer, S. (2014). Bats of Britain and Europe. Bloomsbury

[48] Whitby, D (2016 and 2017 – two reports). *Bat Survey Trapping Survey Binsted Woods*. A report by Animal Ecology and Wildlife Consultants for the Mid-Arun Valley Environmental Survey.

[49] Piraccini, R. (2016). *Barbastella barbastellus*. The IUCN Red List of Threatened Species 2016: e.T2553A22029285. http://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T2553A22029285.en. Downloaded on 13 September 2017 and Paunović, M. 2016. *Myotis bechsteinii*. The IUCN Red List of Threatened Species 2016: e.T14123A22053752.

[50] http://www.sussexbatgroup.org.uk/batsinsussex Accessed 13 September 2017

[51] Bat Conservation trust (2010) Species Factsheet http://www.bats.org.uk/data/files/barbastelle_11.02.13.pdf and http://www.bats.org.uk/data/files/Species_Info_sheets/bechsteins.pdf Downloaded on 13 September 2017

[52] Hutson, A.M. & Paunović, M. 2016. *Myotis alcathoe*. The IUCN Red List of Threatened Species 2016: e.T136680A518740. http://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T136680A518740.en. Downloaded on 13 September 2017.

[53] Bat Conservation trust (2010) http://www.bats.org.uk/pages/uk_bats.html#Alcathoe Accessed 13 September 2017.

[54] http://jncc.defra.gov.uk/page-1458 Accessed 13 September 2017.

[55] Dietz, C., Kiefer, S. (2014). Bats of Britain and Europe. Bloomsbury

[56] Dietz, C., Kiefer, S. (2014). Bats of Britain and Europe. Bloomsbury

[57] Zeale M, Davidson-Watts I & Jones G (2012). Home range use and habitat selection by barbastelle bats (*Barbastella barbastellus*): implications for conservation. *Journal of Mammalogy* 93(4): 1110-1118

4.4 STATIC SURVEY

4.4.1 A total of 114,678 bat passes where recorded from a minimum of 11 bat species, including greater horseshoe bat, an Annex II species, identified from location 2.3 in August. Activity levels, measured as PPH by static detectors, increased through spring to summer, then decreased into late summer and autumn as bats started to mate and approach hibernation. This is shown by the PPH calculated from aggregated monthly data across all static detectors, where it increased 27.6 and 25.2 in May and June respectively, to 48.3 and 49.9 in July and August, then decreasing to 19.3 in September and finally to 12.4 in October. However, there is little evidence for overall differences in activity between transects, as PPH calculated by aggregating data collected by detectors within each transect was 29.0 for transect 1, 32.8 for transect 2, 32.3 for transect 3 and 25.1 for transect 4; a range of 7.7 passes per hour. These aggregated values for PPH, however, hide a wide amount of variation in bat activity at the level of the individual detector location, and for individual months.

4.4.2 It is likely that the static units have also collected regular movements of the same bats, especially when commuting to and from a roost, throughout the bat activity season. The consistently higher levels of activity at static locations 1.1, 2.3 and 3.3 suggest these are located either along a regular commuting route, or close to a roost, or both. Static 1.1 is located close to 6 known Bechstein's bat roosts which were recorded during radiotracking surveys in Steward's Copse. Statics 2.3 and 3.3 are both located along Tortington Lane suggesting this could be a key commuting route.

4.4.3 Cluttered habitat adapted bats are present at all static locations, including 4.1, which is along the River Arun. It is a possibility that Myotis sp. roosting within the survey area are crossing the River Arun to forage within the floodplain meadows to the east. Data from the radio tracking study in 2017[58] also supports this.

4.4.4 Static 1.1 recorded the highest myotis spp. Activity with a peak of 29 pph in May. As stated in section 5.4.2. The static is located near to 6 known bechstein's roosts which likely explain the higher activity by the species group in this area.

The highest barbastelle activity was recorded at statics 2.1 and 2.3 with peak pass counts in a single month of 25 and 29 respectively. Static 2.1 is located within Binsted Woods complex LWS. The high activity at this static supports the idea presented in section 5.3.4 that barbastelle may be roosting within the woodland. Static 2.3 is located on Tortington Lane and suggests as stated in section 5.3.4 that the lane may be used as a commuting route by barbastelle.

[58] WSP (2017) A27_ECO_BAT_BAT RADIO-TRACKING INTERIM-BASELINE REPORT

4.4.5 Static location 1.3 is the only location which recorded noctule with more frequency and consistency over the survey period compared to other static locations. This location is concurrent with the preferred habitat for this species selecting for broadleaved woodland and pasture[59] and also close to the existing railway line, which may be used for navigation purposes by this high-flying species.

4.4.6 Static location 1.2 recorded a peak of 4 PPH in July, twice the aggregated peak of any other month or location for open habitat adapted bats. This location is very close to a series of fishing ponds within the woodland, it may be possible that a particular foraging resource (such as waterborne midges) was exploited during this particular time.

4.4.7 The single greater horseshoe bat record suggests this animal may be outside of its core foraging range at some distance from its roost. Further surveys in 2018 are recommended to provide further evidence on the presence of this species within the study area. These bats are known to roost in Sussex, but are very rare.[60]

4.5 DEFRA LOCAL EFFECTS SURVEY

4.5.1 In total, 1,569 passes were observed over the six survey visits; 64% of which was using this feature at a height below 5m from the ground and within a potential collision zone with traffic.

4.5.2 Figure 4.1 summarises the proportion of observed passes at both safe and unsafe flight heights for all species recorded. Figures 5.2-5.4 provide more detail and the variance within each sample.

Figure 4.1 - Total passes observed

[59] Collins, J. (ed) (2016) Bat Surveys for professional Ecologists: Good Practice Guidelines (3rd edn). The Bat Conservation Trust, London

[60] http://www.sussexbatgroup.org.uk/batsinsussex Accessed 13 September 2017

4.5.3 The peak number of passes was recorded at crossing point 14, located within the Binsted Wood complex LWS. A total of 648 passes were recorded over the six survey visits; 309 of those passes confirmed as using the feature, 83.8% of which was using this feature at a height above 5m from the ground (Figure 4.2 - 4.4). It is likely that this location is an important commuting route for bats travelling to and from the Binsted Wood complex LWS to forage, as this is one of only two lanes which bisects the woodland. This would explain the proportionately high numbers of bats relative to other locations. It is likely that these bats are already habituated to low levels of traffic and light disturbance along Binsted Lane and as open-air hawkers, following the height of the canopy.

Figure 4.2 - The total number of observed bat passes recorded per crossing point

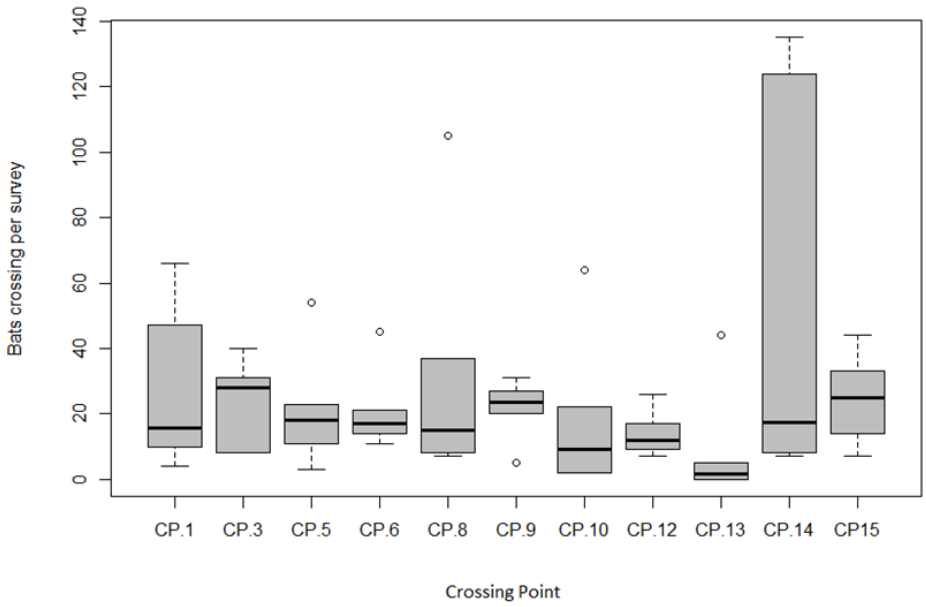


Figure 4.3 - The total number of observed bat passes within the collision zone of traffic per crossing point

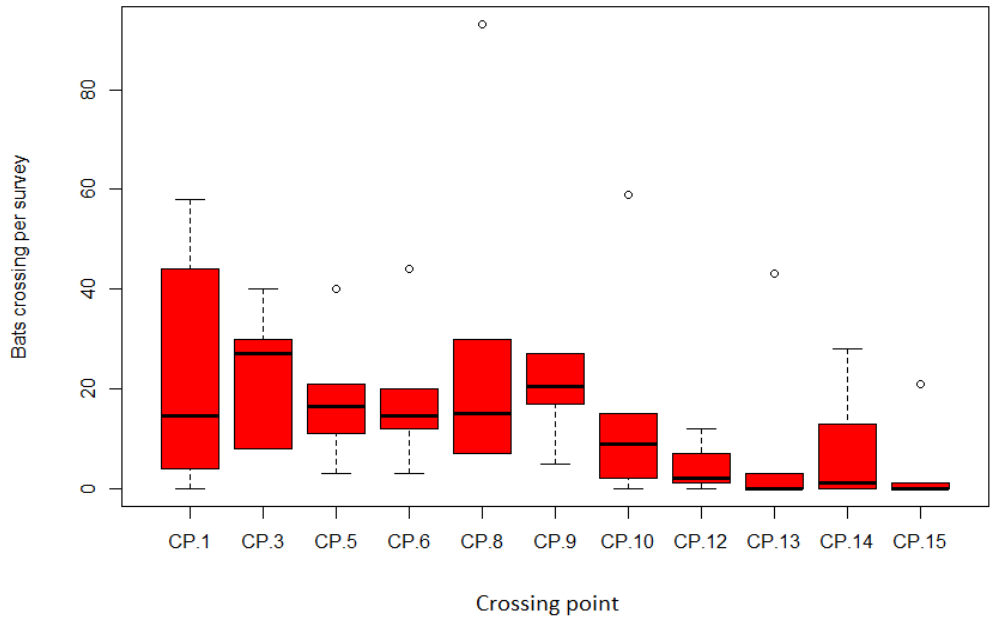
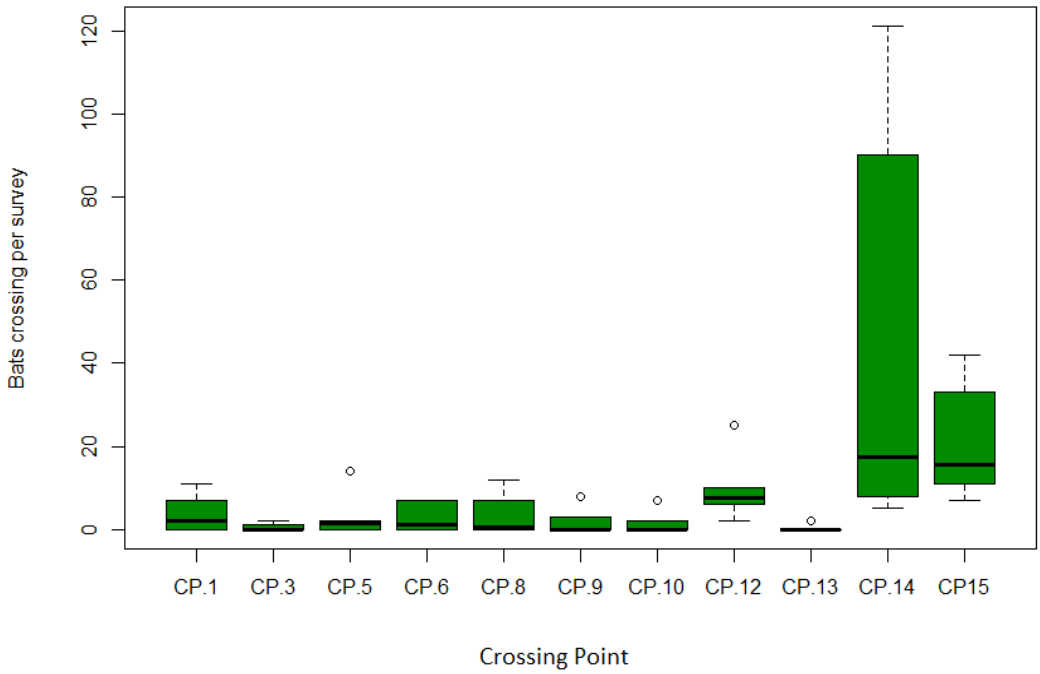


Figure 4.4 - Number of observed bat passes using the feature at a safe height



4.5.4 A total of 1,569 observations of bats passing were made compared to 2,500 passes which were not observed, accounting for 61.4% of the total data recorded. This is a substantial amount of information which was not utilised in the statistical analysis due to lack of flight characteristic data. It is unknown if this 61.4% are in fact using the feature and if so, if they are within the collision zone of traffic.

4.5.5 A total of 690 of these passes are by clutter adapted species, which are more likely to be using the feature at an unsafe height and within the collision zone of traffic. This accounts for 27.6% of the total number of passes heard but not seen. These data also indicate that the open adapted and edge adapted species are also untypically flying within the unsafe zone; this information will need to be taken into consideration as part of the impact assessment for individual species/species groups and when designing suitable mitigation (table 4.1).

Table 4.1 - Summary of height data by species/species group

Species	Number of passes observed	Number of passes observed using the feature safely	Percentage passing at a safe height (%)	Number of passes observed crossing at an unsafe height	Percentage passing at an unsafe height (%)
All bat species	1,569	543	34.61	1,004	63.99
Common pipistrelle	934	367	39.29	552	59.10
Soprano pipistrelle	347	94	27.09	251	72.33
Myotis species	176	38	21.59	137	77.84
Daubenton's bat	30	2	6.67	27	90.00
Whiskered bat/Brandt's bat	2	0	0.00	2	100.00
Barbastelle	15	5	33.33	10	66.67
Serotine	42	32	76.19	9	21.43
Noctule-Leisler's bat-Serotine (NSL)	6	3	50.00	2	33.33
Noctule	2	0	0.00	1	50.00
Plecotus species	14	2	14.29	12	85.71

4.5.6 It is worth commenting for particular locations, such as crossing point 12, 14 and 15 where proportionally more clutter adapted species are travelling at a safe height (above 5m from the ground), rather than the expected unsafe height for these species[61]. It may be that bats are flying higher than expected at these locations due to adaptations to features specific to that location or taking advantage of a foraging resource higher within the canopy of the woodland.

4.5.7 Further information can be derived from this survey on the use of crossing points by species of importance in the Arundel landscape. Barbastelle was recorded in low numbers (between 1 and 5 passes across all surveys) at crossing points 3, 5, 8, 12 and 15, all of which are located within or on the edge of the Binsted Wood complex LWS. This finding aligns with the evidence in section 5.4 which suggested it is likely that these animals are roosting within the woodland.

4.5.8 Myotis spp. were recorded at all crossing points but no trend was seen.

4.6 DEFRA LANDSCAPE SCALE EFFECTS SURVEY

4.6.1 These surveys revealed the presence of two Annex II species; barbastelle and Bechstein's bat. These species are both nationally and locally very rare. These passes were recorded along Binsted Lane, within the Binsted Wood complex LWS. Due to the time of detection, and ecology of these late emerging (Bechstein's bat), tree-roost specialist species it is likely that these animals are roosting within Binsted Wood complex LWS.

4.6.2 For all options distance from the scheme does not have a significant effect on bat activity.

4.6.3 These data will be compared to during and post construction data in order to compare the magnitude of the impact by monitoring the effectiveness of mitigation against this baseline.

4.7 FURTHER SURVEY RECOMMENDATIONS

TRANSECT AND STATIC SURVEY

It is recommended that a second year of data is collected during the 2018 bat activity season to contribute to the baseline data collected in 2017, and to collect information from areas described within the Limitations section of this report, where issues with access and health and safety prevented the surveys from being undertaken. This will also capture natural, annual variation in bat movements throughout the Survey Area and provide a greater understanding of how local bat populations are using the Study Area.

DEFRA LOCAL EFFECTS SURVEY

4.7.1 A total of 9 crossing points were scoped out after the initial surveys, as these locations did not meet threshold value set to determine if the habitat feature was a flight path. It is recommended surveys at these locations are repeated in 2018.

4.7.2 A total of 8 crossing point locations were not assessed, as access could not be arranged. A further 3 crossing point locations only received only one dusk/dawn survey before access was declined. It is recommended surveys at these locations are attempted again in 2018.

A second year of baseline data is also recommended in the Defra report[62].

DEFRA LANDSCAPE EFFECTS SURVEY

It is recommended that a second year of data is collected during the 2018 bat active season to contribute to the baseline data collected in 2017, as per the recommendations in the Defra report[63].

[61] Table 1.1

[62] Berthinussen A and Altringham JD (2015a) Development of a cost-effective method for monitoring the effectiveness of mitigation for bats crossing linear transport infrastructure. Defra research report WC1060.

[63] Berthinussen A and Altringham JD (2015a) Development of a cost-effective method for monitoring the effectiveness of mitigation for bats crossing linear transport infrastructure. Defra research report WC1060.

5 FIGURES

0 500 1000 m

DO NOT SCALE

KEY:

Scheme Options Footprints

- 1
- 3
- 5A

- 250m Survey Area
- 1km Study Area
- 6km Desk Study Area

Rev.	Date	Description	By	Chk'd	App'd
P01		FIRST ISSUE			

Drawing Status: Work In Progress

Suitability: S1

WSP House
70 Chancery Lane
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Tel: +44 (0)20 7314 5000
www.wsp.com

Client: Working on behalf of highways england

Project Title: REGIONAL INVESTMENT PROGRAMME A27 ARUNDEL

Drawing Title: Bat Activity: Survey, Study and Desk Study Areas

Scale	Drawn	Checked	Aproved	Authorised
1:16,000	GY	HB		-

Original Size	Date	Date	Date	Date
A3	22/10/18			

Drawing Number Project	Originator	Volume	Project Ref. No.
HE551523	WSP	GEN	3511134A

Location	Type	Role	Number	Revision
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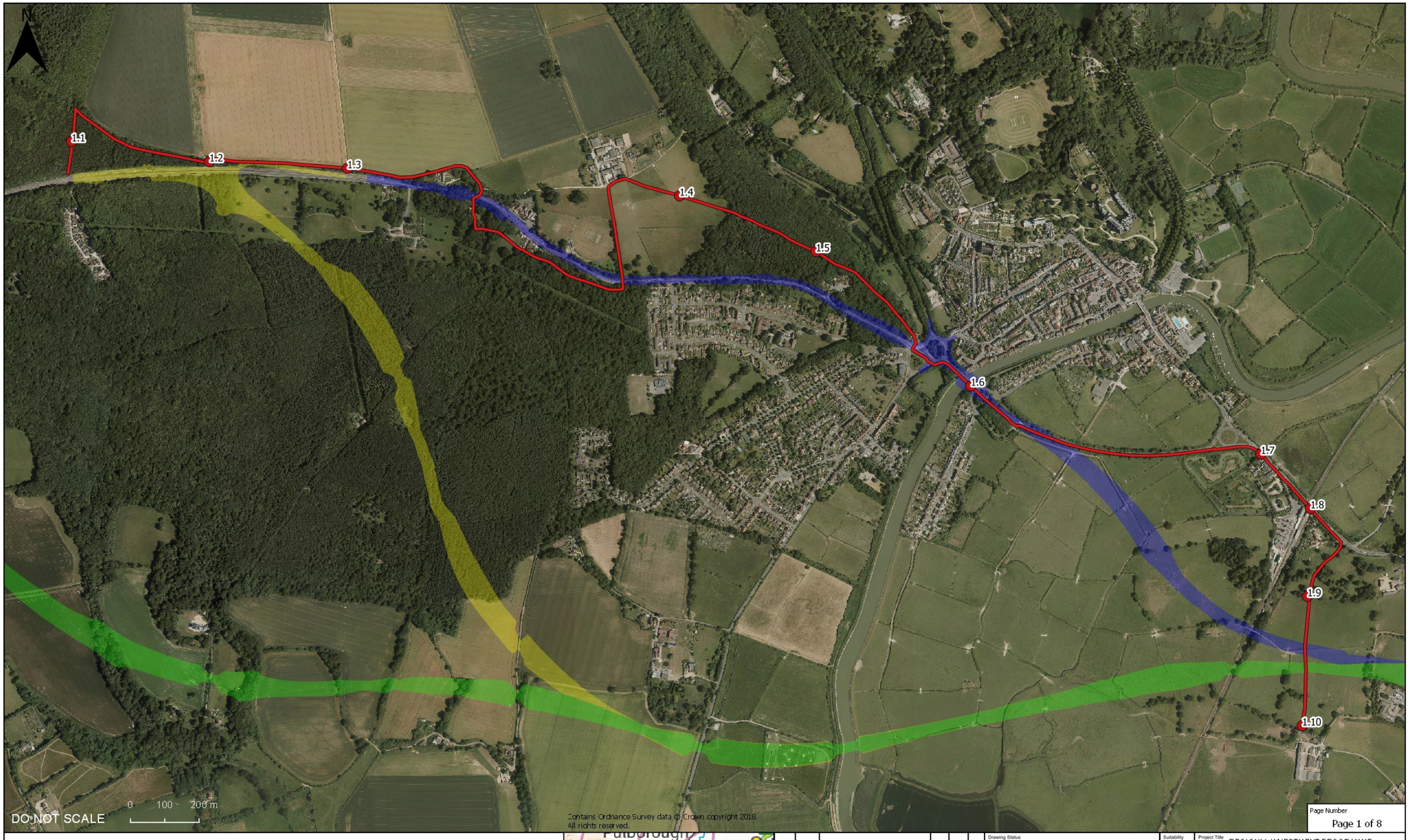


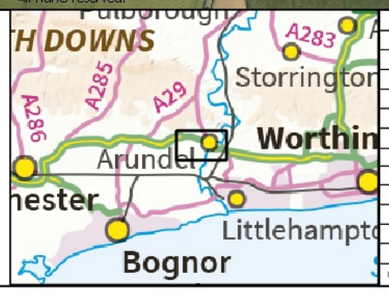
Page Number
Page 1 of 8

KEY:

Options
- 1
- 3
- 5A

BCT Transect
- T1 (May - Oct)
- T2 (May - Oct)
- T3 (May - Oct)
- T4a (June (1))
- T4b (June (2))
- T4c (July (2))
- T4d (Sept (1), Oct (1))
- T4e (Sept (2), Oct (2))

BCT Listening Points
- T1
- T2
- T3
- T4a
- T4b
- T4c
- T4d
- T4e



Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: WORK IN PROGRESS
Suitability: S0

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70 Chancery Lane
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Client: Working on behalf of highways england

Project Title: REGIONAL INVESTMENT PROGRAMME
A27 ARUNDEL

Drawing Title: BCT Activity - Transects

Scale	Drawn	Checked	Aproved	Authorised
1:10,234	JR	KJ		-

Original Size	Date	Date	Date	Date
A3	04/04/18			-

Drawing Number Project	Originator	Volume	Project Ref. No.
HE551523	WSP	-GEN	35111 34A

Location	Type	Role	Number	Revision
A27AR	-FI	-GIS	01	P01

N

2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
2.10

0 100 200 m

DO NOT SCALE

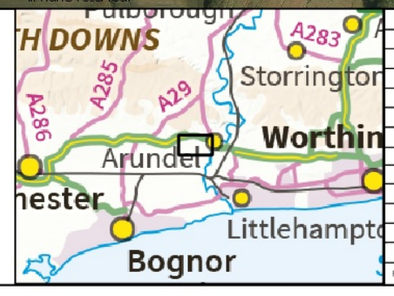
Page Number
Page 2 of 8

KEY:

Options
- 1
- 3
- 5A

BCT Transect
- T1 (May - Oct)
- T2 (May - Oct)
- T3 (May - Oct)
- T4a (June (1))
- T4b (June (2))
- T4c (July (2))
- T4d (Sept (1), Oct (1))
- T4e (Sept (2), Oct (2))

BCT Listening Points
- T1
- T2
- T3
- T4a
- T4b
- T4c
- T4d
- T4e



Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: WORK IN PROGRESS
Suitability: S0

WSP House
70 Chancery Lane
London
WC2A 1AF
Tel: +44 (0)20 7314 5000
www.wsp.com

Client: Working on behalf of highways england

Project Title: REGIONAL INVESTMENT PROGRAMME
A27 ARUNDEL

Drawing Title: BCT Activity - Transects

Scale	Drawn	Checked	Aproved	Authorised
1:6,899	JR	KJ		-

Original Size	Date	Date	Date	Date
A3	04/04/18			-

Drawing Number: Project HE551523 | Originator WSP | Volume -GEN | Location A27AR | Type -FI | Role -GIS | Number 01

Project Ref. No.: 35111 34A

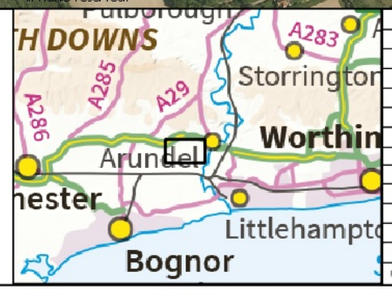
Revision: P01

KEY:

Options
- 1
- 3
- 5A

BCT Transect
- T1 (May - Oct)
- T2 (May - Oct)
- T3 (May - Oct)
- T4a (June (1))
- T4b (June (2))
- T4c (July (2))
- T4d (Sept (1), Oct (1))
- T4e (Sept (2), Oct (2))

BCT Listening Points
- T1
- T2
- T3
- T4a
- T4b
- T4c
- T4d
- T4e



Rev.	Date	Description	By	Chk'd	App'd

Drawing Status: WORK IN PROGRESS
Suitability: S0

WSP House
70 Chancery Lane
London
WC2A 1AF
Tel: +44 (0)20 7314 5000
www.wsp.com

Client: Working on behalf of highways england

Project Title: REGIONAL INVESTMENT PROGRAMME
A27 ARUNDEL

Drawing Title: BCT Activity - Transects

Scale	Drawn	Checked	Aproved	Authorised
1:8,125	JR	KJ		-

Original Size	Date	Date	Date	Date
A3	04/04/18			-

Drawing Number: Project HE551523 | Originator WSP | Volume -GEN | A27AR Location | -FI Type | -GIS Role | 01 Number
Project Ref. No.: 35111 34A
Revision: P01

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BCT Listening Points
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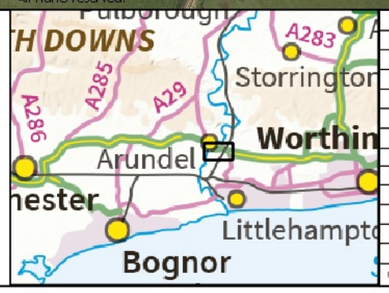

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Drawing Title: BCT Activity - Transects

Scale	Drawn	Checked	Aproved	Authorised
1:5,871	JR	KJ		-
Original Size: A3	Date: 04/04/18	Date	Date	Date: -

Drawing Number: Project HE551523 | Originator WSP | Volume -GEN | Location A27AR | Type -FI | Role -GIS | Number 01
Project Ref. No.: 35111 34A
Revision: P01

N

4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8
4.9
4.10

0 100 200 m

DO NOT SCALE

KEY:

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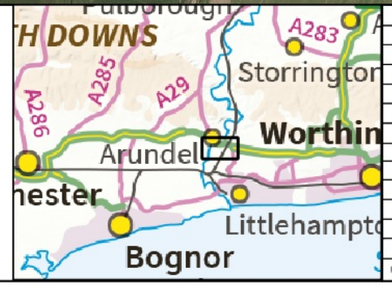

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Project Title: REGIONAL INVESTMENT PROGRAMME
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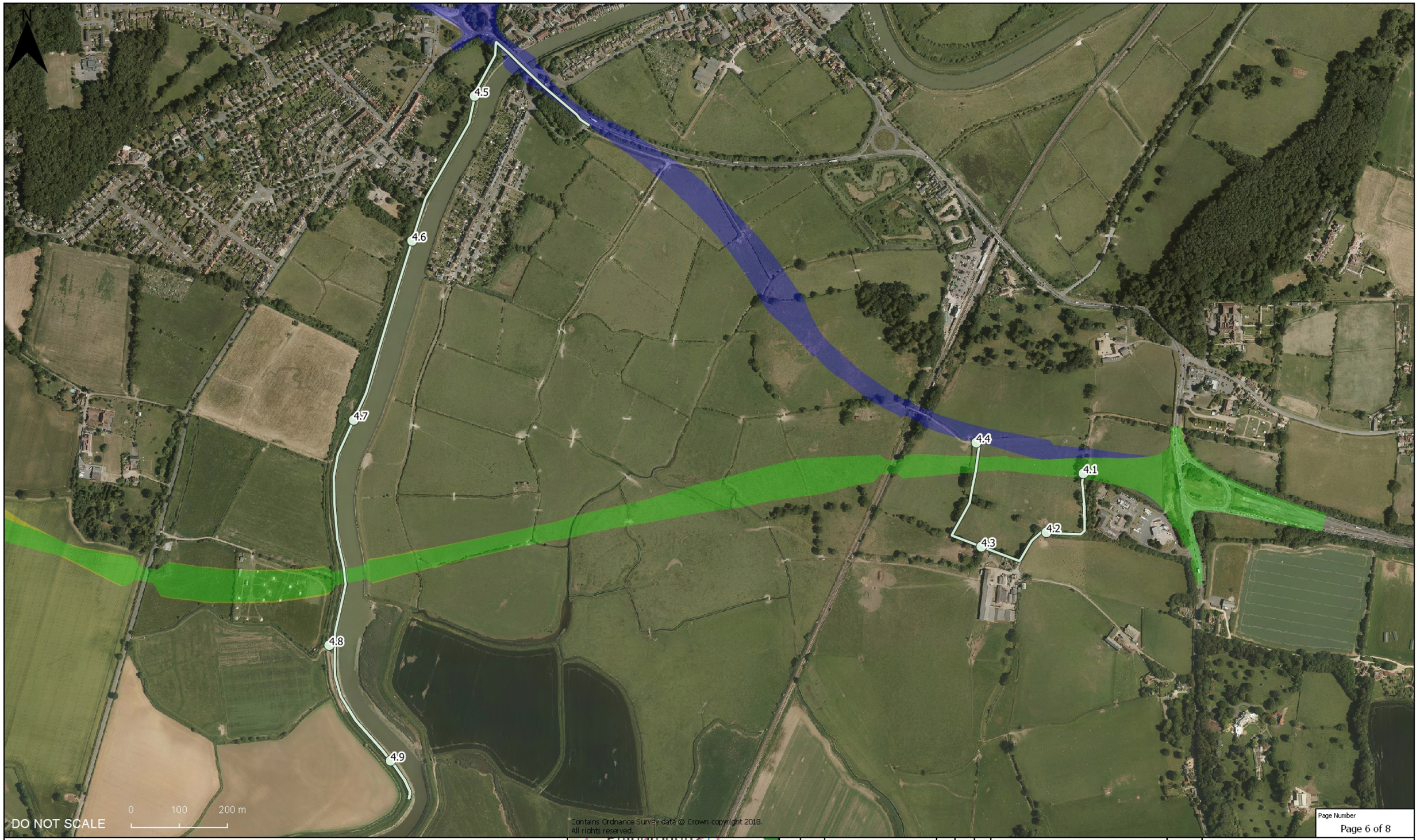
Scale	Drawn	Checked	Aproved	Authorised
1:7,356	JR	KJ		-
Original Size	Date	Date	Date	Date
A3	04/04/18			-

Drawing Number Project	Originator	Volume	Project Ref. No.
HE551523	WSP	-GEN	35111 34A
Location	Type	Role	Number	Revision
A27AR	-FI	-GIS	01	P01



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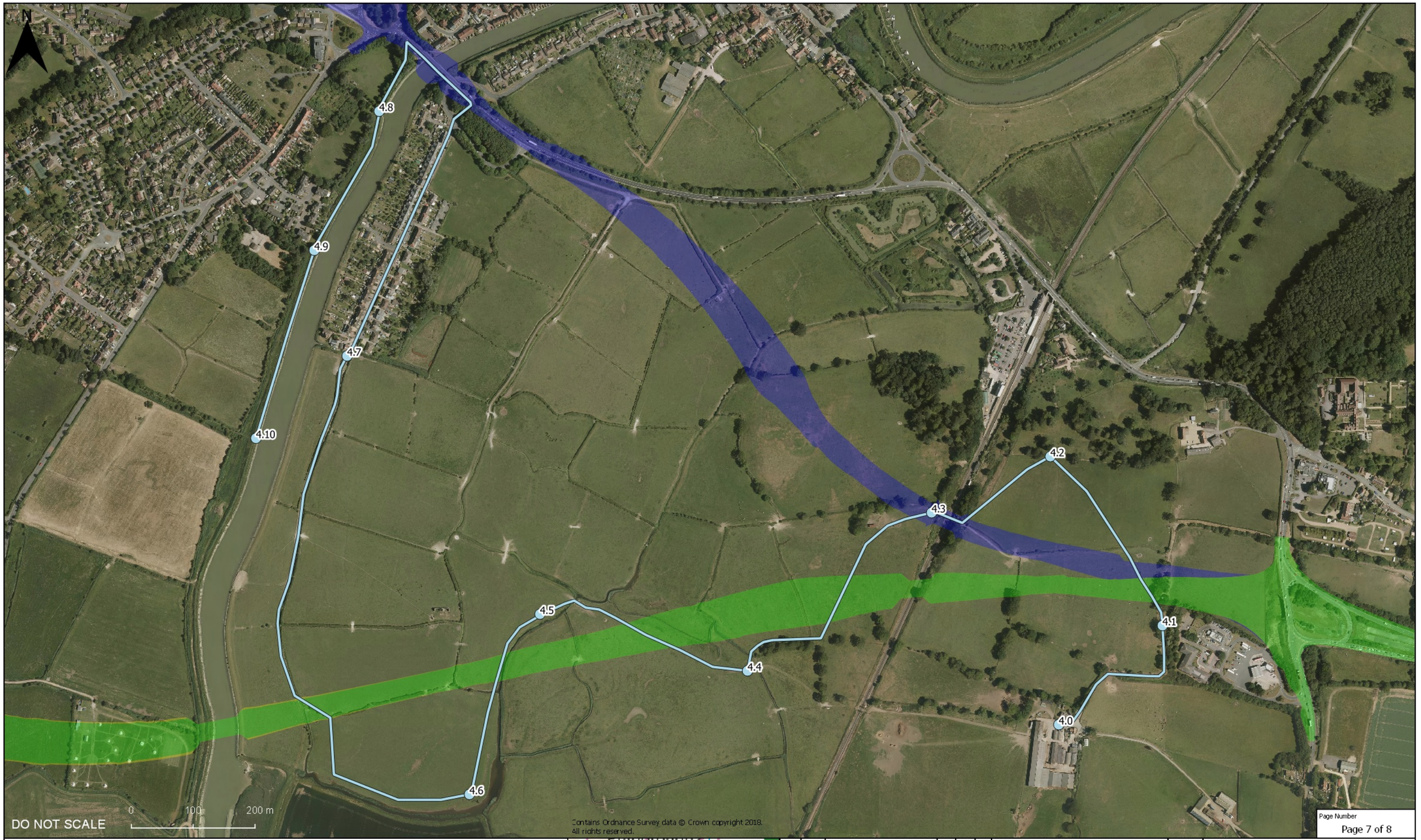
Scale	Drawn	Checked	Aproved	Authorised
1:7,352	JR	KJ		-
Original Size	Date	Date	Date	Date
A3	04/04/18			-

Drawing Number	Originator	Volume	Project Ref. No.
Project HE551523	WSP	-GEN	35111 34A
Location A27AR	Type -FI	Role -GIS	Number 01
			Revision P01



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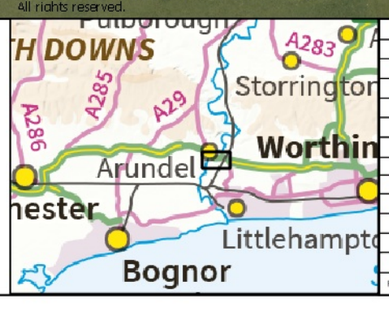

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Scale	Drawn	Checked	Aproved	Authorised
1:5,717	JR	KJ		-

Original Size	Date	Date	Date	Date
A3	04/04/18			-

Drawing Number Project	Originator	Volume	Project Ref. No.
HE551523	WSP	-GEN	35111 34A

Location	Type	Role	Number	Revision
A27AR	-FI	-GIS	01	P01