

Summary Bat Report		
Title: Summary of Proposed BusConnects Galway: Dublin Road Scheme Bat Surveys		
Memo To: NPWS Memo From: Amy Adwan (APEM), Jason Guile (APEM)		
Project: Galway BusConnects: Dublin Road	Client: JB Barry and Partners (now EGIS)	Date: 23/09/2024
ITEM	DETAILS	OTHER NOTES / ACTIONS
Summary of survey results	A summary of bat surveys undertaken for Galway BusConnects : Dublin Road Scheme	<i>Derogation Licence and Mitigation is required. See Conclusions Section</i>

BACKGROUND

JB Barry and Partners (now EGIS) commissioned APEM to carry out bat surveys for the Galway BusConnects: Dublin Road Scheme (hereafter referred to as the Proposed Scheme). These surveys have been carried out as part of surveys and reporting requirements for planning, including an NIS and EIAR Biodiversity Chapter. Figure 1 outlines the extent of the Proposed Scheme.

This summary report is being prepared to support the application for a derogation licence with the National Parks and Wildlife Service (NPWS). This is required in advance of planning following the results of bat surveys undertaken at the site. A number of trees are required to be felled to facilitate the development. Approximately 5 of these trees were assessed as having low potential for bats, due to the number of Potential Roost Features (PRFs) recorded, their location adjacent to the existing R338 road, and artificial lighting in the area. However, surveys cannot rule out the potential for these trees to be used by bats due to their transient nature, and thus a derogation licence is being sought as a precautionary measure. Nonetheless, details of the proposed works, surveys undertaken at the Proposed Scheme over 2023 and 2024, and proposed mitigation measures are outlined in this report.

PROPOSED WORKS

The Proposed Scheme has an overall length of approximately 3.9km, the extent of which is set out in Figure 1. The Proposed Scheme comprises the provision of public transport facilities and active travel facilities from east of the Moneenageisha Junction to the Doughiska Junction. This route is a main arterial route into Galway City Centre for both commuters and tourists. It also runs adjacent to the Atlantic Technological University (ATU), Merlin Park Hospital, Bon Secours Hospital and a number of schools and other amenity locations. Throughout the Proposed Scheme, bus stops will be enhanced to improve the overall journey experience for bus passengers, and cycle facilities will be substantially improved with segregated cycle tracks provided along the links and protected junctions with enhanced signalling for cyclists. Moreover, pedestrian facilities will be upgraded, and additional signalised crossings be provided. In addition, urban realm works will be undertaken at key locations with higher quality materials, planting and street furniture provided to enhance pedestrians' experience.

For the majority of the works associated with the Proposed Scheme, it is envisaged that normal working hours will be followed. In specific circumstances, such as road crossings or road resurfacing, the works will be carried out at night. The works on the R338 Dublin Road comprise the installation of inbound and outbound bus lanes, raised adjacent cycle tracks and footpaths on both sides of the road. This is to be achieved via a combination of carriageway widening, repurposing of existing traffic lanes and setting back the existing footpath. Additional land will be required throughout the Proposed Scheme. The Proposed Scheme ties in with the Galway BusConnects: Cross City Link Scheme at the western extremity. Additional land for the proposed cross-section widening and construction of new footpaths and cycleways is primarily to the south of the existing R338 towards the junction with Renmore Park. A Temporary Construction Compound will be set up in the sports field immediately west of the Connacht Hotel. Between Renmore Park Junction and Ballyloughane Road junction, the additional land required is primarily to the north, with impacts on Galway City Council lands, the landscaped green area at the front of the Connacht Hotel, the green area at the front of

Glenina Heights housing estate, the former Galwegians RFC sports grounds and the landscaped green area at the front of Flannery’s Hotel. There is an impact to the south on the car park of a convenience store at the R338 junction with Renmore Road, where a property to the north of the road creates a pinch point.

The access to Belmont estate is proposed to be realigned to tie in with the Ballyloughane Road junction. Further east at ATU Galway City, the alignment of the cycle lane and footpath to the north is set behind the existing tree line. A new “cyclops” junction is proposed to replace the Skerritt roundabout. Between the Skerritt junction and the eastern extremity of the Proposed Scheme the additional required land is primarily to the north of the existing R338. This impacts the former Corrib Great Southern Hotel site (now demolished green space at the front of Woodhaven estate, agricultural land and HSE lands as part of Merlin Park Hospital including part of The Meadows). At the eastern end beyond a realigned Doughiska Road junction, the Proposed Scheme ties in with the Martin junction. Tree felling is required along the south of The Meadows to facilitate minor widening and creation of a buffer zone in this area. The relevant section of the landscaping plan is included in Figure 2.

SURVEY METHODOLOGY

Desk Study

A desk study was initially undertaken to obtain available information on the usage of the study area by bats. Existing information collated included previous records from the Bat Conservation Ireland (BCI) database on National Biodiversity Data Centre (NBDC) as well as any previous reporting for the area. Bat Landscape Suitability was also obtained from the landscape suitability index on NBDC, generated by Lundy *et al.*, (2011) for all bat species.

Preliminary Roost Assessment

A bat preliminary roost assessment (PRA) was conducted by licenced Bat Ecologist, Amy Adwan (Licence No DER/BAT 2024-34) and APEM field staff on the 13th of June 2023 and 27th March 2024. An assessment was made of habitat suitability to support bats based on standard guidelines (Collins, 2016 and 2023) along with cognisance of BTHK 2018. This provides guidelines for assessing the potential suitability of habitat features to support a bat roost. PRFs are assessed to see if they offer a *Negligible*, *Low*, *Moderate* or *High* potential for usage by roosting bats.

Trees and / or structures suitable for roosting bats and potential suitable bat foraging / commuting habitat were noted where they occurred within the study area. Buildings affected by the proposed development (i.e. demolition) were inspected externally. Trees / structures within the study area were visually inspected from the ground level for PRFs where it was considered likely that they may be suitable for use by roosting bats. These includes features such as knotholes, cracks / splits in limbs, dense ivy, loose or lifting bark, or hollows / cavities. Potential roosts / roost features and bat foraging habitat were evaluated using the criteria set out Collins (2023).

Activity / Transect Surveys

Walked bat activity surveys (transects) were undertaken on four occasions over two years, the first-year surveys being on 13th June 2023 and 2nd July 2023, and the second-year surveys on the 30th of July and 20th of August 2024. Details of weather conditions for each survey are outlined in Table 1 below.

Table 1 Transect surveys and weather conditions.

Survey Date	Weather Conditions
13 th July 2023	Warm, dry night following a day with thundery showers
2 nd July 2023	Warm, dry night following a warm, dry day
30 th July 2024	Warm, dry night following a warm, dry day
20 th August 2024	Dry night with light breeze, following an unsettled period of wet and windy weather

An appropriate transect route focussing on areas with moderate to high habitat suitability for bats was identified during the initial PRA. The areas with moderate to high habitat suitability for bats were identified as areas south of Merlin Woods and within The Meadows and associated treelines here along the existing R338 road.

This transect was walked for the duration of each survey, which commenced from 30 minutes before dusk to 2 hours after dusk. Two ecologists were present for the duration of each survey and maintained a steady walking pace to ensure the sampling area is the same per unit time as per the guidelines. Information collected include species recorded,

number of bats, flight direction and behaviour (e.g., commuting or foraging). Equipment used for the duration of the survey included the Titley Scientific Anabat Scout bat detector, the BatLogger M Bat detector, an InfraRed torch, NightFox Night Vision Goggles and the Canon XA60 InfraRed camera.

RESULTS

Desk Study

Bat records returned from the study area are outlined in Table 2 below.

Table 2 Transect surveys and weather conditions.

Species	Legal Protection	Year of Last Record	Record Count
Lesser Horseshoe Bat (<i>Rhinolophus hipposideros</i>)	EU Habitats Directive: Annex II, Annex IV. Wildlife Act 1976.	2015	3
Brown Long-eared Bat (<i>Plecotus auritus</i>)	EU Habitats Directive: Annex IV. Wildlife Act 1976.	2008	1
Lesser Noctule (<i>Nyctalus leisleri</i>)	EU Habitats Directive: Annex IV. Wildlife Act 1976.	1999	1
Pipistrelle (<i>Pipistrellus pipistrellus sensu lato</i>)	EU Habitats Directive: Annex IV. Wildlife Act 1976.	2009	2
Soprano Pipistrelle (<i>Pipistrellus pygmaeus</i>)	EU Habitats Directive: Annex IV. Wildlife Act 1976.	2009	3

Previous surveys were also undertaken by RPS (2020) in the study area for a previous version of the Proposed Scheme, but the footprint has not changed significantly and there is significant overlap in areas covered. This involved a site walkover survey to assess habitats in Merlin Park. In relation to bats, the report notes the presence of Lesser Horseshoe Bat records within the 10 km grid square M32. RPS (2020) also state '*Lesser horseshoe bat are unlikely to utilise habitats within the proposed development footprint or its immediate environs as a breeding or roosting habitat. Some features such as established buildings, treeline and hedgerow habitats in the wider vicinity may be utilised as a summer roosting and foraging habitat*'.

The landscape suitability index, as generated by Lundy *et al.*, (2011) for bat species within the study area, is detailed in Figure 3 and 4. To the western extent of the scheme, landscape suitability is noted to be High, likely due to Lough Atalia, and Moderate to the east of the scheme where Merlin woods is located.

PRA

Buildings and Structures

Within the study area, the Proposed Scheme requires the demolition of two single storey buildings within the grounds of the Brothers of Charity to the eastern extent of the Proposed Scheme. These buildings are located immediately adjacent to the road and behind a stone wall. An external inspection was undertaken of these affected buildings on the 27th of March 2024. The buildings are single storey and have a flat felt roof. The buildings were found to be in generally good condition, well-sealed and no suitable potential entry / exit points were noted in the structures that could be used by bats. Security lighting was also noted on site and is likely to be resulting in significant light spill in the vicinity. No droppings or other evidence of bat usage was found during the inspection. The buildings were assessed as having negligible potential for bat roosting and therefore were not required to be subject to further surveys.

Trees

There are multiple mature trees within the study area that have potential to be used by roosting bats. In general, the majority of these mature trees are located on the fringes of woodland habitat in Merlin Park south of the hospital. While there are some conifer species which are unsuitable, species such as oak, beech and some common ash covered in dense ivy were identified as having moderate potential for bats. PRFs identified include ivy, lifting bark, knotholes, and broken limbs. Much of these are located to the north of the middle and eastern Merlin Meadows fields and are not within the footprint of the Proposed Scheme and thus do not require felling as part of the scheme. It is noted however that these trees are affected by some light spill from the existing R338, due to the lack of treeline along the boundary providing no barrier to light spill. Some trees along the R338 on the western field that will require felling to facilitate

the proposed development were found to have low potential for bat roosting, but many of these trees are also in good condition and have a lack of PRFs. A total of approximately 5 trees were identified to have Low Potential along this area. These trees include one Beech *Fagus sylvatica*, two Sycamore *Acer pseudoplatanus*, Ash *Fraxinus excelsior* and a row of less than 5 Ash trees. These trees are shown in Figure 5. Artificial lighting does reduce the suitability of some mature trees along the road from moderate to low.

Some trees bounding the road along Rosshill Park Woods, located south of the existing road, were found to have some potential for bats. A small number of sycamore, common ash and horse chestnut trees were noted to have PRFs in the form of dense ivy, which may conceal further PRFs. However, due to their location along the busy R338 road and the presence of street lighting, these trees are considered unlikely to be used and are noted to have a negligible suitability for bats. These trees near the Rosshill Park Woods are not within the footprint of the Proposed Scheme and do not require felling.

Two Sycamore trees to the eastern boundary of the temporary construction compound were noted to have low potential for bats due to PRFs noted. However, flood lighting is also present here as the area is currently used and maintained as a sports pitch, and this reduces the likelihood of these trees being used by bats to negligible potential.

Activity / Transect Surveys

13th June 2023

The activity survey on 13th June 2023 revealed that three species of bat use the study area for foraging and commuting, common pipistrelle, soprano pipistrelle and Leisler's bat. Transects were walked along the Meadows, fringes of Merlin Park woodland and along the eastern section of the existing R338. Figure 6 shows the transects walked and the results of this survey. These areas were identified during the daytime walkover as having moderate to high potential habitat for bats and so the transects were focussed on these areas. Leisler's bat were the first species recorded, which is typical of this species, being an early emerger. Leisler's bat were the most commonly recorded species foraging throughout the Meadows fields. Leisler's bats frequently roost in trees and so there is potential for a roost to be located within the area of Merlin park due to the early recordings. Soprano pipistrelle were commonly recorded along the woodland edges north of the Meadows, as well as near streetlights on the eastern Meadows field southern treeline. Common pipistrelle were recorded mostly along the northern boundaries of the Meadow fields near the woodland. The most significant foraging corridor is along the woodland edges north of the Meadows fields. Activity was noted to be low-moderate within the first hour of the survey, with activity levels dropping significantly after this point. Very little activity was recorded along the eastern end of the R338 road. Light spill was noted to be significant from the road, affecting commuting and foraging corridors in the vicinity. The western Meadows field is the least affected, due to the dense mature treeline to the southern boundary providing a barrier to light spill. Lights are noted to be bright white LED streetlights.

2nd July 2023

The activity survey on 2nd July 2023 revealed similar results to the initial survey in June. The transects walked were similar as those during the June surveys; along the Meadows, fringes of Merlin Park woodland and the eastern section of the R338. Figure 6 shows the transects walked and the results of this survey. Species recorded include common pipistrelle, soprano pipistrelle and Leisler's bat. However, Soprano pipistrelle were noted to be more commonly recorded during the July 2023 survey when compared to the June 2023 survey. Activity levels were noted to be higher, in particular with regard to soprano pipistrelle, which may be due to the change of weather conditions. The July survey was conducted following a warm dry day, whereas the June survey was conducted following some thundery showers during the day. Activity was concentrated on the northern boundary of the meadows on the fringes of woodland. Similar to June's results, very little activity was recorded along the road, the eastern end of the R338. Activity also dropped significantly after the first hour of the survey. Light spill was noted to be the same as the June 2023 survey.

30th July 2024

The activity survey on the 30th of July 2024 was found to have similar results to those in 2023. The transects walked were the same as those previously, along the Meadows, fringes of Merlin Park woodland and the eastern section of the R338. Figure 7 shows the transects walked and the results of this survey. Species recorded include common pipistrelle, soprano pipistrelle and Leisler's bat. Weather conditions were warm, followed by a dry day. Activity levels were noted to be similar to those in the 2023 surveys, if slightly lower than previous, with activity focussed either on the northern boundary of the meadows on the fringes of woodland, or ad hoc commuting to the south of these fields. Again, very

little activity was recorded along the road itself. No changes were noted with regards to the lighting regime. It is noted that the Meadows fields had been cut earlier that day, which could have resulted in lower abundances of prey items.

20th August 2024

The activity survey on the 20th of August followed the same transects as those undertaken previously, along the Meadows, fringes of Merlin Park woodland and the eastern section of the R338. Figure 7 shows the transects walked and the results of this survey. Species recorded include common pipistrelle and soprano pipistrelle, with no Leisler's bat recorded as before. This survey was undertaken following a period of unsettled wet and windy weather, but the night was dry with a light breeze. Activity during this survey was considered to be notably lower than previous surveys in 2023 and 2024, with only a few common or soprano pipistrelles recorded for the duration of the survey. This is considered likely to be due to weather conditions being unsettled, but also may be due to the lower prey abundance due to an earlier cut of the meadow fields than previous years. This may have resulted in some foraging displacement. However, bats recorded were found to use the same areas of habitat as previous, with the main foraging / commuting corridor being towards the north of the meadow fields along the fringes of woodland, and very little activity recorded along the R338 road itself.

CONCLUSION

The PRA survey has shown that there are no buildings within the affected footprint of the proposed scheme that have potential for bat roosting habitat. Some trees within the study area were identified as having low potential for bat roosting habitat, and approximately 5 of these trees are required to be felled to facilitate the proposed development. Mitigation is required, and a derogation licence is required in advance of planning. Other trees are required to be felled to facilitate the Proposed Scheme however, no other trees were deemed to have bat roost potential.

Regarding foraging and commuting habitat, the four activity surveys undertaken across 2023 and 2024 have shown that the species utilising the study area are common pipistrelle, soprano pipistrelle and Leisler's bat, and activity levels were assessed as being low-moderate. Treelines and scrub along the R338 and the southern edge of The Meadows fields will be removed to facilitate widening of the road along this point. Of the three Meadows fields, two fields along the eastern extent have very little vegetation to separate from the existing road and are affected by artificial lighting. It is proposed to create a buffer zone along all three Meadows fields with planting and a landscaping plan. This is considered to in time, improve the separation of The Meadows fields and the more northern Merlin Park from the existing road here, and will provide a barrier against artificial lighting. The landscaping plan of the area in question is provided in Figure 2.

The derogation licence is however being sought for the felling of approximately 5 trees that have low potential for bats. These trees include one Beech *Fagus sylvatica*, two Sycamore *Acer pseudoplatanus* and Ash *Fraxinus excelsior*. These trees are scattered along the existing treeline here as shown in Figure 5. It is considered that bats could use these trees in any capacity over the course of the year, however suitability is limited with each of these trees assessed as having low potential. No active bat roosts were identified during the current surveys of the study area. In the absence of confirmation of these potential tree roosts, it must be assumed that these trees could be used by bats at any time of the year.

PROPOSED MITIGATION

Mitigation is therefore proposed for tree felling:

- Pre-construction survey of trees to be felled undertaken by a suitably qualified bat ecologist
- Suitably qualified bat ecologist will be present on site for felling of identified trees with low potential
- Follow NRA (2006) bat guidelines for the treatment of bats where relevant
- Tree felling undertaken from late August to late October / early November, during which time all bats will be capable of flight but are not yet in hibernation
- Felling should follow a procedure to include:
 - a first warning, nudging the tree two or three times with a pause in between
 - trees felled in sections, cutting from the canopy first and removing and checking each section for bats
 - Rate of fall of cut trees not accelerated by the use of chain and vehicle and should be undertaken carefully
 - Cut tree sections should be left on the ground overnight before mulching or removing from the area

- If bats are found throughout the process, NPWS will be notified
- Alternative accommodation will be provided as a bat box scheme:
 - Bat boxes will be erected on mature trees in the study area, a season prior to felling of the trees
 - An ecologist will advise on the location and orientation of bat boxes
 - A total of 3 bat boxes per low potential tree removed will be installed
 - Preferred that Schwegler 2F (1no.) and 1FF (2no.) per tree felled would be used, if available
 - Information on bat boxes installed will be shared with local NPWS ranger and Bat Conservation Ireland

Other mitigation measures for bats, including landscaping, reducing light spill will be included in the EIAR Biodiversity Chapter for the project. Mitigation measures listed here pertain to the tree felling and subject of the required derogation licence to be submitted with the application.

Alternative options considered included avoiding this area altogether and adjusting the design of the scheme and retaining all trees on site. This option is not considered feasible, as the Proposed Scheme must allow for appropriate distances to include bike and bus lanes and the current footprint of the existing road here must be widened to facilitate this. The Proposed Scheme has included road widening but has endeavoured to reduce required land-take as much as is possible, with the majority of trees retained where possible. It was decided that on considering alternatives, there is no alternative option for the Proposed Scheme. Mitigation is proposed to ensure that the risk to bats is reduced insofar as possible.

RESIDUAL IMPACT

The proposed mitigation measures above, as well as all mitigation measures listed in the EIAR for the Proposed Scheme, ensure that there will be no significant residual impact on bats. There is likely to be a net positive impact on bats with additional planting, extended buffer from the existing road, and barriers to existing lighting present on foraging and commuting areas.

REFERENCES

BTHK (2023). *Bat Roosts in Trees: A Guide to Identification and Assessment for Tree-Care and Ecology Professionals*. Pelagic Publishing.

Collins, J. (ed.) (2016) *Bat Surveys for Professional Ecologists: Good Practice Guidelines (3rd edn)*. The Bat Conservation Trust, London. ISBN-13 978-1-872745-96-1.

Collins, J. (ed.) (2023) *Bat Surveys for Professional Ecologists: Good Practice Guidelines (4th edition)*. The Bat Conservation Trust, London. ISBN-978-1-7395126-0-6.

Marnell, F., Kelleher, C. & Mullen, E. (2022). *Bat mitigation guidelines for Ireland v2. Irish Wildlife Manuals, No. 134*. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.

NRA (2006) . *Guidelines for the treatment of bats during National Road Schemes*. National Roads Authority.

FIGURES

Figure 1 – Site Location

531000

534000



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P00008775

Site Location

Legend

- Site Boundary
- Temporary Works Boundary
- Study Area
- Watercourse



Notes

Basemap: Contains open source data 'Google Hybrid', 'OpenStreetMaps'

Coordinate System:
IRENET95 / Irish Transverse
Mercator

0 0.6 1.2 km

0 0.1 0.2 NM

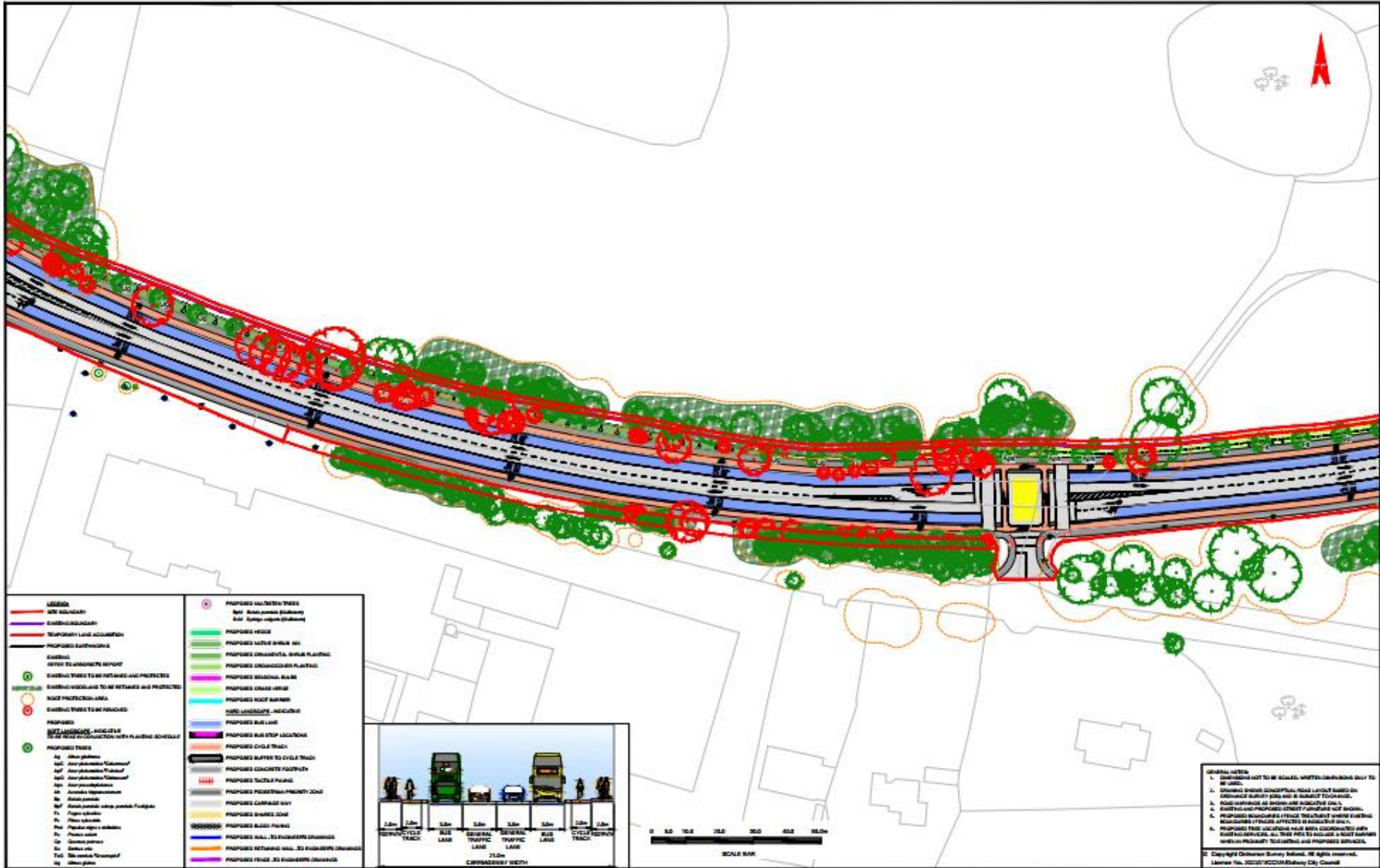
Scale: 1:20000 @ A4 Date: 08/11/2023 AA Drawn by: JG Checked by: ET Approved by: ET

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Figure 1

Figure 2 - Landscaping Plan – Affected Section



GENERAL NOTES:

1. DEVELOPMENTS NOT TO BE SCALED, WHETHER OTHERWISE SHOWN OR NOT.
2. DISTANCE BETWEEN CONCEPTUAL ROAD LAYOUT BASED ON DISTANCE BETWEEN CORNER POINTS AND IS SUBJECT TO CHANGE.
3. ROADWAY WIDTHS AS SHOWN ARE INDICATIVE ONLY.
4. PROPOSED ROADWAY WIDTHS ARE SUBJECT TO CHANGE AND ARE NOT TO BE USED AS A BASIS FOR DESIGNING OR CONSTRUCTION.
5. PROPOSED TREE LOCATIONS MUST BE COORDINATED WITH LOCAL AUTHORITIES, AND TREE PLOTS TO INCLUDE A HOST NUMBER WHEN IN PROximity TO PUBLIC SERVICES.

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No.	Date	By	Description	Checked

Project Title:	BUSCONNECTS GALWAY: DUBLIN ROAD	Status:	SD
Drawing Title:	LANDSCAPE GENERAL ARRANGEMENT	Sheet:	101
	SHEET 07 OF 11		
Designer:	ORLAN SURVEY	Client:	BARRY TRANSPORTATION
Drawn:	ORLAN SURVEY	Scale:	AS SHOWN
Approved:	ORLAN SURVEY	Date:	OCT 2023
Revised:	ORLAN SURVEY		

Figure 3 - Bat Habitat Suitability Index – Western Extent of Proposed Scheme

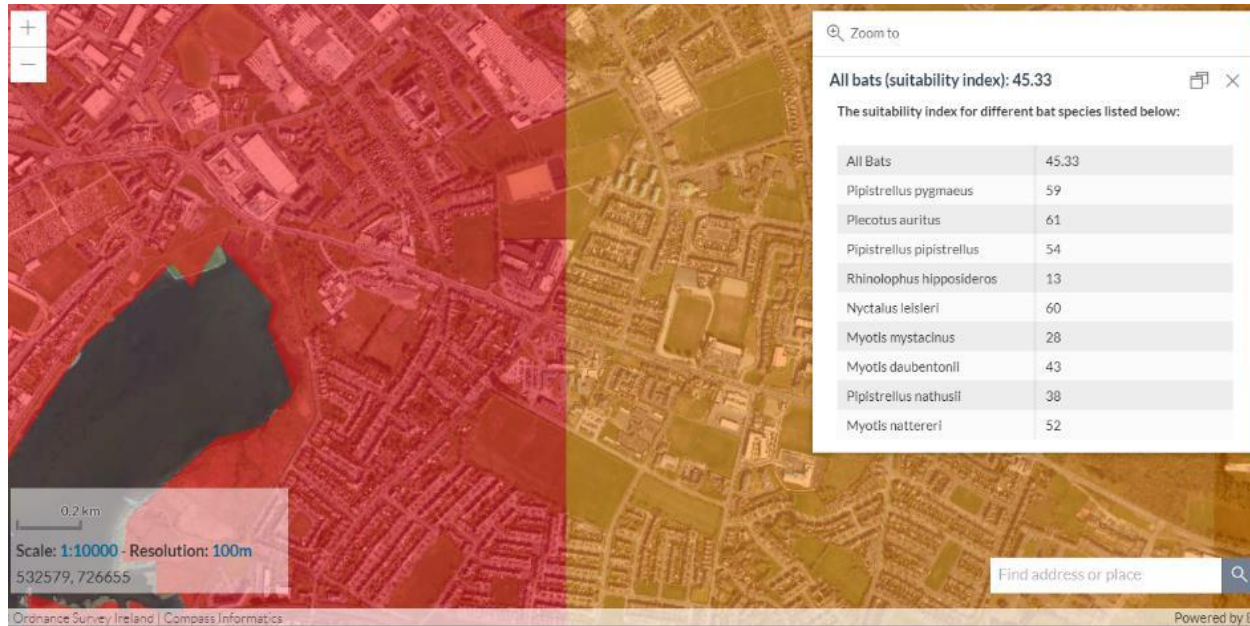


Figure 4 - Bat Habitat Suitability Index – Eastern Extent of Proposed Scheme

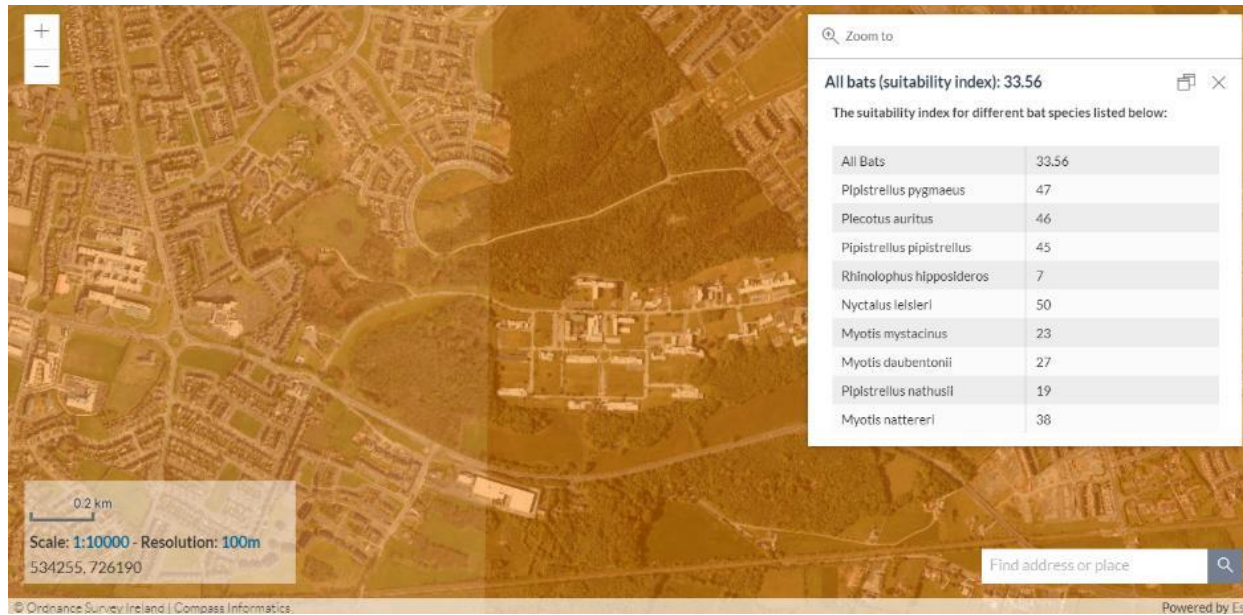


Figure 5 - Affected Low Potential PRF Trees.



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Low Potential Trees

Legend

- Site Boundary
- Temporary Works Boundary
- Study Area
- Watercourse
- Low PRF Trees to be Removed



Notes

Basemap: Contains open source data 'Google Hybrid' and 'OpenStreetMap'

Coordinate System:
IRENET95 / Irish Transverse
Mercator

0 0.03 0.06 km

0 0.01 0.02 NM

Scale: 1:1102 @ A4 Date: 16/09/2024 AA Drawn by: JG Checked by: MKD Approved by:

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Figure 5

Figure 6 - Bat Activity Transect 2023 Results

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Bat Transect Results 2023

Legend

- Site Boundary
- Temporary Works Boundary
- Study Area
- Watercourse
- Soprano pipistrelle (*Pipistrellus pygmaeus*)
- Common pipistrelle (*Pipistrellus pipistrellus*)
- Leisler's bat (*Nyctalus leisleri*)
- Bat transect June
- Bat transect August



Notes

Basemap: Contains open source data 'Google Hybrid' and 'OpenStreetMap'

Coordinate System:
IRENET95 / Irish Transverse
Mercator

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0 0.05 0.1 NM

Scale: 1:6576 @ A4 Date: 10/09/2024 Drawn by: AA Checked by: JG Approved by: ET

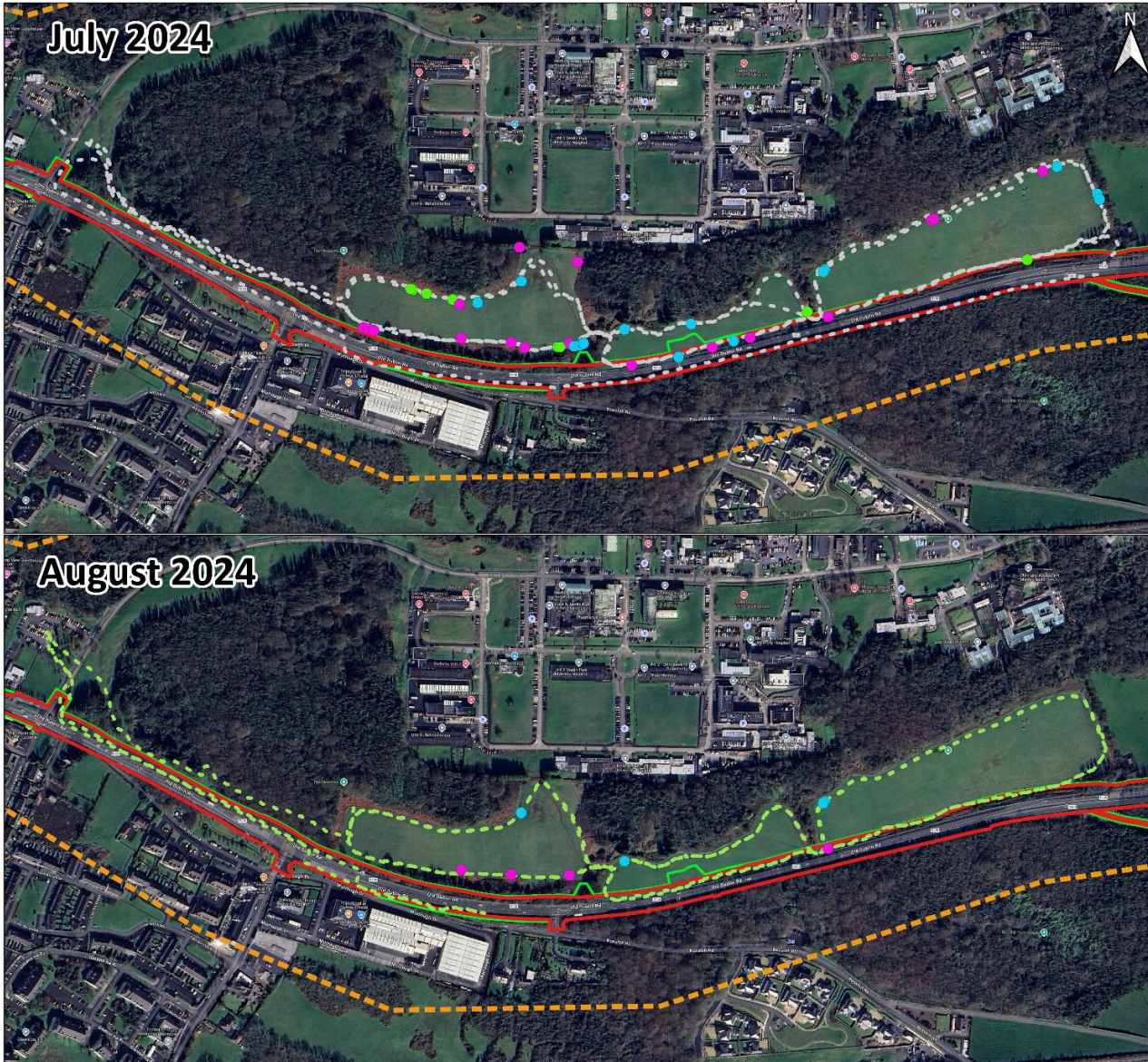
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Figure 10

Figure 7 - Bat Activity Transect 2024 Results

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Bat Transect Results 2024

Legend

- Site Boundary
- Temporary Works Boundary
- Study Area
- Watercourse
- Soprano pipistrelle (*Pipistrellus pygmaeus*)
- Common pipistrelle (*Pipistrellus pipistrellus*)
- Leisler's bat (*Nyctalus leisleri*)
- Bat transect July
- Bat transect August



Notes
Basemap: Contains open source data 'Google Hybrid' and 'OpenStreetMap'

Coordinate System:
IRENET95 / Irish Transverse
Mercator

0 0.1 0.2 km

0 0.05 0.1 NM

Scale: 1:6576 @ A4 Date: 16/09/2024 Drawn by: AA Checked by: JG Approved by: ET

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Figure 11

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