EIAR VOLUME III
Appendices

CHAPTER 8 – ORNITHOLOGY

Appendix 8.1: Ornithology Baseline Report

Tullacondra Green Energy Limited

Appendix 8.1 – Ornithology Baseline Report

Tullacondra Green Energy Project

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MAY 2023

RSK GENERAL NOTES

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1.0 INTRODUCTION

1.1 Purpose of this report

This report presents the methodology and findings of an ornithological baseline study for the proposed Tullacondra Green Energy Project (hereafter referred to as 'the Project'). This report forms a technical appendix to Chapter 8 of the Environmental Impact Assessment Report (EIAR) for the project and provides the basis for Appendix 8.2 – Ornithology Collision Risk Modelling Report, which also supports the EIAR. This ornithological baseline study was undertaken by RSK on behalf of Tullacondra Green Energy Limited.

The ornithological baseline study presented in this report includes desk studies and field surveys completed between 2020 and 2023 to inform the project, specifically:

- A desk-based review of relevant designated sites of ornithological interest and records of specially protected and notable bird species.
- Vantage Point (VP) surveys undertaken during the breeding and non-breeding seasons between 2020 and 2023, including detailed recording of flight activity for subsequent collision risk modelling.
- Walked transect surveys undertaken between 2021 and 2023.
- Targeted surveys for nesting barn owl (*Tyto alba*) and kestrel (*Falco tinnunculus*).

This document should be read in conjunction with the following figures:

- Figure 8.1 – Viewsheds and Transects.
- Figure 8.2 – Flight observations from VP surveys for target species during the breeding season 2021.
- Figure 8.3 – Flight observations from VP surveys for target species during the breeding season 2022.
- Figure 8.4 – Flight observations from VP surveys for target species during the non-breeding season 2020/21.
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- Figure 8.7 – Bird nest locations (CONFIDENTIAL).

1.2 Site overview

The proposed wind farm (hereafter referred to as 'the wind farm site') is located approximately 2km south of Lisgriffin Cross, Co. Cork. The wind farm site is rural in nature, with land cover predominantly comprising mixed agricultural land interspersed with rural settlements. The wind farm site is in a lowland location with elevation ranging from approximately 120-130 metres (m) Above Ordnance Datum (AOD) across the wind farm site.

Various designated sites for nature conservation value are present within 20km of the wind farm site, notably: Kilcolman Bog Special Protection Area (SPA), 9.1km north-east of the wind farm site; and Blackwater River (Cork/Waterford) Special Area of Conservation (SAC), 5.6km north-east of the wind farm site at its nearest point. These sites support internationally important bird populations.

1.3 Key guidance

This ornithological baseline study has been prepared in reference to current key industry standard guidance including the following:

- *Recommended bird survey methods to inform impact assessment of onshore wind farms* (Scottish Natural Heritage, 2017).
- *Best Practice Guidelines for the Irish Wind Energy Industry* (Irish Wind Energy Association, 2012).
- *Bird monitoring methods: A manual of techniques for key UK species* (Gilbert *et al.*, 1998).
- The *Birds of Conservation Concern in Ireland* (BoCCI) Red and Amber Lists (Gilbert *et al*., 2021).
- *Wind energy development and Natura 2000* (European Commission, 2011).

Information on relevant legislation to this report is provided in Annex A.

2.0 METHODOLOGIES

2.1 Desk study

In accordance with best practice guidance, a desk study was undertaken to identify relevant designated sites and specially protected and notable bird species to the Project. This enabled a broad overview of potential ornithological constraints to be established and helped guide the identification of target bird species for subsequent field surveys.

A search was made for any relevant statutory designated sites for nature conservation value (e.g. SPAs and Ramsar sites) with features of ornithological interest, and any other relevant protected and priority habitats, within 20km of the wind farm site boundary. A search for non-statutory designated sites with features of ornithological interest was undertaken within 2km of the wind farm site boundary.

To provide information on the presence of specially protected and notable species in the wider area, records were obtained from The National Biodiversity Information Data Centre for a polygon spanning 10km beyond the wind farm site boundary in September 2022. Records were obtained for:

- Species afforded protection under wildlife legislation (i.e., the Wildlife Acts).
- Species considered to be of conservation concern (e.g. Red or Amber Listed Bird species of Conservation Concern in Ireland).
- Invasive Non-native Species (INNS).

In addition, supporting data on specially protected and notable bird species were obtained from the National Parks & Wildlife Service (NPWS) in July 2023 for a 10km radius around the centre of the wind farm site. Any relevant Irish Wetland Bird Surveys (I-WeBS) data were also reviewed[1].

2.2 Field survey overview

Detailed ornithological field surveys of the wind farm site were undertaken in 2020 to 2023 inclusive to identify the bird populations using the wind farm site and immediately adjacent land (i.e. the ornithological baseline of the wind farm site) and to gather supporting data to enable detailed impact assessment (e.g. through collision risk modelling).The surveys undertaken in 2023 found that the habitats on the wind farm site and their management had not changed significantly since the time in which the baseline surveys first commenced (2020). Therefore, bird populations are also unlikely to have changed significantly since the detailed ornithological surveys were undertaken

Ornithological field surveys were undertaken by suitably experienced Malachy Walsh and Partners ornithologists lead by Paul Murphy. Paul is a highly knowledgeable Irish ornithologist with extensive experience of leading ornithological field surveys in relevant habitats for the focal species addressed in this report. Ornithological surveys were also led by John Murphy. John is a highly experienced Senior Consultant Ornithologist with

[1] Available at: Irish Wetland Bird Survey (I-WeBS) - BirdWatch Ireland (accessed 05/07/2023).

extensive knowledge of Irish bird populations, who collaborates regularly with NPWS on different projects throughout the country.

The survey approach adopted was based on best practice guidance and professional judgement, in reference to known bird-habitat associations and best practice survey methods for target species (as identified later in Section 2.2). The geographical scope of the field surveys was determined in reference to Scottish Natural Heritage (SNH) and the Chartered Institute of Ecology and Environmental Management (CIEEM) guidance (SNH, 2017; CIEEM, 2018).

Field surveys undertaken to inform the project were as follows:

- VP surveys during the breeding season (i.e. April to September inclusive) in 2021 and 2022, and during the non-breeding season (i.e. October to March inclusive) in 2020/21, 2021/22 and 2022/23.
- Walked transect surveys in 2021, 2022 and 2023.
- Targeted surveys for nesting barn owl and kestrel in July 2022.

Field surveys were carried out by MWP ornithologists on behalf of Tullacondra Green Energy Limited. Surveyors were all experienced ornithologists competent in bird identification and survey methods for onshore wind farm developments. Surveys were undertaken in suitable weather conditions to record breeding, wintering and passage bird activity, and at various times of day. Surveys were also undertaken over multiple years to provide more detailed information on the site's ornithological baseline, and to account for variation between years (e.g. due to weather conditions).

Target species

Based on the desk study, best practice guidance and professional judgement, certain bird species were identified as 'target species' for particular consideration within field surveys and subsequent impact assessment in relation to the project. Identification of target species was informed by the following:

- Their known or likely presence within or in close proximity to the wind farm site.
- Their likely sensitivity to the project (particularly their potential collision risk and/or susceptibility to disturbance from new wind turbines).
- Their level of legislative protection and conservation concern.
- Their relevance to any nearby designated sites (e.g. SPAs or Ramsar sites).

Target species for this ornithological baseline study and subsequent impact assessment and collision risk modelling were as follows:

- All species of waterfowl
- All species of raptor
- All species of owl
- All species of grouse
- All species of wader

- All species of gull and skua.

2.3 Vantage Point surveys

VP surveys were undertaken in accordance with best practice guidance (SNH, 2017) in order to record bird activity throughout the wind farm site during the breeding and non-breeding seasons, including flight activity by target species. In accordance with best practice guidance, VP surveys were undertaken over multiple years in order to establish a more detailed ornithological baseline for the site and to account for potential temporal variations in bird activity.

Vantage Point selection

To enable detailed coverage of the wind farm site, an initial four VP locations (VPs 1-4) were identified for the surveys, as detailed in Table 1 below. To provide increased coverage of the site, two additional VPs, VP5 and VP6, were surveyed during the 2022 breeding season and the 2022/23 non-breeding season. VP locations and viewsheds (i.e. the area in which birds could be observed by the ornithologist when surveying from a given VP) are indicated in Figure 8.1. Photographs of viewsheds from the six VP locations are provided in Annex D.

Due to the wind farm site's topography, not all of the wind farm site was visible to ground level from the VPs. Instead, VP locations were selected to maximise coverage of the site's airspace (particularly the proposed turbine locations) and to aid observation of any likely flight lines and habitat assessed as being most suitable for target species. VP locations were reviewed to ensure they:

- Covered as much of the wind farm site as possible, such that no airspace surveyed within the wind farm site was further than 2km from a VP.
- Minimised blind spots.
- Did not exceed a maximum arc of 180 degrees of visibility.
- Were an appropriate distance from areas in which birds were likely to be susceptible to disturbance (e.g. key feeding areas, roosts and nesting areas).

Table 1. Vantage point locations

VP	Location	Viewshed orientation	Seasons surveyed
1	Lat. 52.199927 Long. -8.7431259	North-west	Breeding seasons 2021 / 2022 Non-breeding seasons 2020/21 / 2021/22 / 2022/23
2	Lat. 52.198329 Long. -8.7361307	West-west	Breeding seasons 2021 / 2022 Non-breeding seasons 2020/21 / 2021/22 / 2022/23
3	Lat. 52.193186 Long. -8.7342301	North-west	Breeding seasons 2021 / 2022 Non-breeding seasons 2020/21 / 2021/22 / 2022/23

VP	Location	Viewshed orientation	Seasons surveyed
4	Lat. 52.195218 Long. -8.7446097	South-west	Breeding seasons 2021 / 2022 Non-breeding seasons 2020/21 / 2021/22 / 2022/23
5	Lat. 52.205831 Long. -8.7502134	West	Breeding season 2022 Non-breeding season 2022/23
6	Lat. 52.204772 Long. -8.725499	West	Breeding season 2022 (September only) Non-breeding season 2022/23

Vantage Point survey effort

Where possible, two surveys from each VP were undertaken monthly during the breeding season in 2021 and 2022, and during the non-breeding season in 2020/21, 2021/22 and 2022/23 (with the exception of VP5 and VP6, as indicated in Table 1 above). As such, VP survey data were collected for two complete breeding seasons and three complete non-breeding seasons. Monthly coverage year-round ensured the recording of species using the wind farm site at all times of year, including breeding species, wintering species, and spring and autumn passage species.

Full details of all VP survey times, weather conditions and field surveyors are provided in Annex B.

The VP survey effort during the breeding seasons of 2021 and 2022 is summarised in Table 2 below. In accordance with SNH best practice guidance (SNH, 2017), VP surveys aimed to achieve a survey effort of 36 hours per breeding season for each VP surveyed.

Table 2. Summary of breeding Vantage Point survey effort

VP	Hours of survey effort												
	2021						2022						Total
	Apr	May	Jun	Jul	Aug	Sep	Apr	May	Jun	Jul	Aug	Sep	
1	6	6	6	6	6	6	6	6	6	6	6	6	72
2	6	6	6	6	6	6	6	6	6	6	6	6	72
3	6	6	6	6	6	6	6	6	-	12	-	12	72
4	6	6	6	6	6	6	6	6	6	6	6	6	72
5	Not surveyed in 2021						6	6	6	6	6	6	36
6	Not surveyed in 2021						-	-	-	-	-	6	6

The VP survey effort during the non-breeding seasons of 2020/21, 2021/22 and 2022/23 is summarised in Table 3 below. In accordance with best practice guidance, surveys aimed to achieve a survey effort of 36 hours per non-breeding season for each VP surveyed.

Table 3. Summary of non-breeding Vantage Point survey effort

VP	Hours of survey effort																		
	2020/21						2021/22						2022/23						Total
	Oct	Nov	Dec	Jan	Feb	Mar	Oct	Nov	Dec	Jan	Feb	Mar	Oct	Nov	Dec	Jan	Feb	Mar	
1	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	108
2	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	108
3	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	108
4	6	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	107
5	-	-	-	-	-	-	-	-	-	-	-	-	6	6	6	6	6	6	36
6	-	-	-	-	-	-	-	-	-	-	-	-	6	6	6	6	6	6	36

Vantage Point survey methods

The VP surveys followed a standard approach in accordance with SNH best practice guidance (SNH, 2017). Surveyors scanned the pre-determined viewshed from the VP location (as identified during the VP selection process later in Section 2.2) for a period of three hours per survey. VP surveys covered a range of times of day, aiding the recording of species that are active at different times of day. All flight activity and aggregations of target species were recorded onto standardised recording forms and maps, with flight parameters recorded as described below. Counts were also recorded for non-target species. Bird identification and counting was aided by the use of high-powered optical equipment (e.g. binoculars, telescopes) where necessary.

VP surveys were undertaken in suitable weather conditions, avoiding extreme temperatures, heavy rain, snow or fog during which bird activity may be atypical and/or surveying may be impractical.

Flight parameters

During each VP survey, the following flight parameters were recorded for any flights by target species observed:

- Start time of flight observation.
- Duration of flight observation.
- Species and number of individuals

- The flight path taken by the bird(s), mapped as accurately as possible.
- Approximate flight height in metres, with the time spent in each flight height category (non-flight, 0-20m, 20-50m, 50-100m, 100-180m and >180m) recorded.
- The likely purpose of the flight (e.g. foraging, displaying, commuting, etc.).

2.4 Transect surveys

In accordance with best practice guidance (SNH, 2017), VP surveys were accompanied by transect surveys to record supplementary information on bird usage of the wind farm site. As for VP surveys, transect surveys were undertaken during multiple years. Transect surveys initially focused on activity during the breeding season and autumn passage periods, with additional transect surveys undertaken in winter 2022/23 to supplement VP survey data.

Transect route selection

Due to the size of the site, two transect routes were initially surveyed (as indicated in Figure 8.1); Transect A and Transect B. These transect routes were designed to maximise coverage of the wind farm site where access permitted, whilst enabling detailed observation of habitats assessed as likely to be of value to bird populations, particularly for target species. During the non-breeding season of 2022/23, an additional two transect routes were surveyed (Transect C and Transect D) based on emerging access (see Figure 8.1).

Transect survey effort

Transect surveys were undertaken between June and October 2021 inclusive and between April 2022 and March 2023 inclusive. These visits were timed to aid recording of breeding, wintering and passage birds that might be difficult to record from VPs, such as songbirds and smaller waders.

Full details of all transect survey times, weather conditions and field surveyors are provided in Annex B.

Transect survey methods

During each transect survey the ornithologist walked the predetermined transect route, recording target species onto standardised maps using recommended British Trust for Ornithology (BTO) species codes and behaviour notation (Marchant, 1983). Counts for non-target species were also recorded. Transect routes were interspersed with stops, during which the ornithologist scanned for birds using optical equipment. Transect surveys were undertaken at different times of day, ensuring that different areas of the wind farm site were surveyed at a range of times of day and therefore aiding the recording of species that are active at different times of day.

Transect surveys were undertaken in suitable weather conditions, avoiding extreme temperatures, heavy rain, snow or fog during which bird activity may be atypical and/or surveying may be impractical.

2.5 Nesting barn owl and kestrel surveys

The selection of target species identified barn owl and kestrel as being of potential relevance in the context of the project, with buildings within and in close proximity to the wind farm site potentially providing suitable nesting habitat. A detailed search was therefore undertaken for any evidence of nesting by these species, with reference to species-specific information and methodologies (BirdWatch Ireland, 2014/2021 and Shawyer, 2011).

All safely accessible buildings within the wind farm site and within 1km of the wind farm site boundary with potential for use by barn owl or kestrel were subject to a detailed search for evidence of barn owl and kestrel use on 24th July 2022 and 2nd May 2023 by a suitably experienced ornithologist. Other suitable buildings encountered opportunistically outside of this 1km buffer were also surveyed on a precautionary basis.

Evidence of barn owl and kestrel use searched for included moulted feathers, pellets, feeding remains and droppings ('whitewash'). Any barn owl or kestrel sightings during this survey or any other surveys of the site (i.e. VP surveys, transect surveys) were recorded and mapped to supplement understanding of use of the site by these species and assist in locating any occupied breeding sites and other important areas of habitat for these species.

2.6 Constraints and limitations

Surveys during the breeding season often commenced after dawn. As many species are typically more active around dawn, this could have led to under-recording of breeding bird activity on the wind farm site. This increased level of activity around dawn is typically more pronounced in songbirds (passerines), whilst the target species for this ornithological baseline study were non-passerines, many of which typically exhibit a less marked drop-off in detectability and/or breeding activity after dawn. Those target species which are particularly active around dawn and may therefore have been under-recorded during field surveys include barn owl. This has been taken into consideration when evaluating the potential importance of the wind farm site to this and other species, with a precautionary approach implemented.

SNH best practice guidance (SNH, 2017) recommends positioning VP locations outside of (i.e. looking into) the wind farm site. However, due to access restrictions VP1 and VP4 were positioned inside the wind farm site boundary, whilst VP2 was positioned on the wind farm site boundary. Surveyors (and therefore viewsheds) were oriented to maximise coverage of the habitats within/airspace above the wind farm site.

Due to the number and placement of VPs, there was a degree of overlap between VP viewsheds. Where ornithologists surveyed different VPs with overlapping viewsheds simultaneously, to minimise the likelihood of double-counting birds ornithologists used walkie-talkies to immediately verify sightings and ensure only one ornithologist recorded the bird. As a further precaution, a subsequent desk-based review was undertaken to identify areas in which viewsheds from different VPs overlapped, to facilitate an exercise of identifying any potential duplicate records. Any records identified as being duplicates were resolved to avoid double-counting of birds. As such, these overlapping viewsheds did not adversely affected the validity of the survey findings and or any subsequent assessment.

SNH best practice guidance (SNH, 2017) recommends a survey effort of 72 hours per VP per year (i.e. 36 hours during the breeding season and 36 hours during the non-breeding season). VPs were surveyed for 36 hours per breeding season, and for 35-36 hours per non-breeding season (with the exception of VP6, for which surveys commenced in September 2022). Considering the high number of VPs surveyed from relative to the wind farm site's size, the relatively low suitability of the habitats on the wind farm site for breeding and non-breeding birds, and that VP surveys were undertaken over multiple years, this survey effort is not deemed to pose a significant constraint to the validity of the VP survey results.

As the wind farm site is more suitable for significant non-breeding bird populations (which include the designated features of Kilcolman Bog SPA) than for significant breeding bird populations, it should be noted that survey effort for three of the four initial VPs achieved 36 hours during the non-breeding seasons of 2020/21 and 2021/22, with the other VP (VP4) only surveyed for one hour less than the recommended survey effort (in 2020/21). The inclusion of a third season (2022/23) of non-breeding VP surveys (during six VPs were each surveyed for 36 hours) provides additional data on non-breeding birds and greater coverage of the north of the wind farm site.

Due to access constraints and health and safety considerations (notably those posed by the Covid-19 pandemic), transect surveys were undertaken between June and October 2021 inclusive and between April 2022 and March 2023 inclusive. These visits provided supplementary information on species which are less easily recorded during VP surveys (e.g. songbirds, smaller wader species). Considering the level of VP survey effort, and the greater detectability of most target species (e.g. waterfowl, raptors, larger waders) during VP surveys, the combined survey effort from the VP and transect surveys is considered sufficient to record the populations of target species on site and any significant populations of non-target species.

In accordance with best practice guidance for wind farm developments (SNH, 2017), the wind farm site was surveyed year-round. To facilitate analysis of site usage by bird species at different times of year, surveys undertaken in October to March inclusive have been broadly categorised as 'non-breeding' surveys, whilst surveys undertaken in April to September inclusive have been broadly categorised as 'breeding' surveys. It is recognised that species differ in their patterns of seasonal use of the wind farm site, with some species likely to exhibit breeding behaviour outside of April to September inclusive, whilst species present in April to September were not necessarily breeding on the wind farm site. This has been taken into consideration with this report, such as when discussing bird usage patterns of the site in Section 7.

Whilst desk study data are useful in providing supplementary ecological information for a site, it should be acknowledged that these data are dependent on the submission of records to the relevant organisation. As such, a lack of records for a particular species does not necessarily mean that the species is absent from the wind farm site and/or wider search area. Similarly, records of a particular species do not necessarily mean that the species is still present within the wind farm site and/or wider search area.

3.0 DESK STUDY RESULTS

3.1 Designated sites

The desk study identified one international statutory designated site for features of ornithological interest within 20km of the site boundary: Kilcolman Bog SPA, located approximately 9.1km north-east of the wind farm site boundary.

Kilcolman Bog is situated in the southern foothills of the Ballyhoura Mountains in Co. Cork, occupying a glacially eroded hollow in Carboniferous limestone. The wind farm site comprises a quaking fen fed by calcareous groundwater, with areas of reed swamp, freshwater marsh and wet grassland. The wind farm site is designated for its internationally important populations of the following wintering bird species (SPA citation populations are in brackets):

- Shoveler (*Spatula clypeata*) (150)
- Teal (*Anas crecca*) (690)
- Whooper swan (*Cygnus cygnus*) (95).

A conservation objective for the SPA is to maintain or restore the favourable conservation condition of those bird species listed above as Special Conservation Interests for this SPA. The wind farm site is also designated for its assemblage of wetland and waterbirds. Thus, a second conservation objective of the Kilcolman Bog SPA is to maintain or restore the favourable conservation condition of the wetland habitat at Kilcolman Bog SPA as a resource for the regularly occurring migratory waterbirds that utilise it.

Wintering shoveler populations using the site are of particular importance, comprising 5% of the national population. Other wintering species listed on the SPA's citation but not comprising qualifying features for SPA designation include golden plover (*Pluvialis apricaria*), lapwing (*Vanellus vanellus*) and wigeon (*Mareca penelope*).

Breeding species listed on the SPA's citation but not comprising qualifying features for SPA designation include little grebe (*Tachybaptus ruficollis*) and mute swan (*Cygnus olor*).

A second Natura 2000 site, Blackwater River (Cork/Waterford) Special Area of Conservation (SAC), is located approximately 5.6km north-east of the wind farm site boundary at its nearest point. This extensive site includes the Blackwater Callows and Blackwater Estuary SPAs which are designated for internationally important waterbird populations. However, these SPAs are far outside of the 20km search area adopted in this assessment. The wider areas of river and marginal habitats within the SAC (including those within 20km of the project) are recognised on the SAC citation as being of value to several species including cormorant (*Phalacrocorax carbo*), dipper (*Cinclus cinclus*), grey heron (*Ardea cinerea*) and long-eared owl (*Asio otus*), although these species are not identified as being present in internationally important numbers and are not qualifying features of this Natura 2000 site.

No other relevant designated sites (e.g. relevant Natural Heritage Areas or Proposed Natural Heritage Areas) with features of ornithological interest were identified within 20km of the wind farm site boundary.

3.2 Protected and notable bird species

Table 4 details the specially protected and notable bird species records from within 2km of the wind farm site boundary, provided by The National Biodiversity Data Centre (NBDC) during the desk study. No records of any specially protected species were returned. Records were returned for 12 species of conservation concern including two Red Listed species: kestrel and yellowhammer (*Emberiza citrinella*).

Table 4. Protected and notable bird species recorded within 2km of the site

Common name	Scientific name	Conservation status	Number of records	Most recent record
Goshawk	*Accipiter gentilis*	Amber Listed	1	31/12/2011
House martin	*Delichon urbicum*	Amber Listed	3	31/12/2011
House sparrow	*Passer domesticus*	Amber Listed	7	31/12/2011
Kestrel	*Falco tinnunculus*	Red Listed	3	21/02/2013
Linnet	*Linaria cannabina*	Amber Listed	3	31/12/2011
Little grebe	*Tachybaptus ruficollis*	Amber Listed	2	31/12/2011
Mute swan	*Cygnus olor*	Amber Listed	2	31/12/2011
Sand martin	*Riparia riparia*	Amber Listed	3	31/12/2011
Skylark	*Alauda arvensis*	Amber Listed	3	31/12/2011
Starling	*Sturnus vulgaris*	Amber Listed	7	31/12/2011
Stock dove	*Columba oenas*	Amber Listed	3	31/12/2011
Yellowhammer	*Emberiza citrinella*	Red Listed	5	31/12/2011

Data obtained from NPWS in 2023 identified relevant records of additional specially protected and notable bird species during the last ten years[2]; notably:

- Hen harrier (*Circus cyaneus*): whilst no breeding records were identified within 10km of the wind farm site, two confirmed breeding sites 10-20km from the wind farm site were identified during the national breeding survey in 2015 (Ruddock *et al*., 2016).
- Peregrine (*Falco peregrinus*): at least five possible breeding locations were identified within 5km of the wind farm site in 2017.

A review of I-WeBS data identified two sites within 10km of the wind farm site: Blackwater Valley (c.7.1km south of the wind farm site), and Kilcolman Marsh (c.9.5km north-east of the wind farm site). Whilst peak counts since 2011 were not published for Blackwater Valley, peak counts for 24 waterbird species recorded at Kilcolman Marsh between 2011 and 2019 included shoveler (155), teal (1,000), whooper swan (78) and wigeon (259).

[2] Obtained via email from Jochen Roller, National Parks & Wildlife Service (21/07/2023).

4.0 VANTAGE POINT SURVEY RESULTS

The results of VP surveys for birds undertaken during the breeding and non-breeding seasons are described below. VP surveys were undertaken during the breeding season in 2021 and 2022, and during the non-breeding season in 2020/21, 2021/22 and 2022/23. Detailed survey data are provided in Annex C.

4.1 Breeding season

A total of 56 species were recorded during the breeding VP surveys in 2021 and 2022, including 11 target species. Survey results are described below, including detailed accounts for target species.

2021

A total of 46 species were recorded during the VP surveys undertaken between April and September 2021 inclusive. These were largely common and widespread non-target species recorded in relatively low numbers. Peak counts[3] for specially protected and notable non-target species recorded are provided below (Birds Directive Annex 1 species are indicated bold; BoCCI Red and Amber Listed species are indicated in red and amber text respectively):

- Goldcrest (*Regulus regulus*) – 2
- Grasshopper warbler (*Locustella naevia*) – 1
- House martin – 14
- House sparrow – 17
- Linnet – 100
- Meadow pipit (*Anthus pratensis*) – 10
- Mistle thrush (*Turdus viscivorus*) – 2
- Skylark – 8
- Starling – 200
- Stock dove – 12
- Swallow (*Hirundo rustica*) – 23
- Swift (*Apus apus*) – 7
- Willow warbler (*Phylloscopus trochilus*) – 2
- Yellowhammer – 6.

[3] To avoid generating falsely high estimates of species' population sizes through likely double-counting of birds, 'peak counts' refer to the maximum number of individuals of a given species recorded during one survey of a single VP location. As such, considering that each VP covered a discrete section of the site rather than the entire site, peak counts are likely to be a conservative indication of population size within the site as a whole. This is taken into consideration within subsequent evaluation of population importance.

Of the 46 species recorded during the VP surveys undertaken between April and September 2021, seven were target species. Peak counts for these species are provided below:

- Buzzard (*Buteo buteo*) – 4
- Great black-backed gull (*Larus marinus*) – 5
- Grey heron – 1
- Kestrel – 3
- Lesser black-backed gull (*Larus fuscus*) – 2
- Mallard (*Anas platyrhynchos*) – 2
- **Peregrine** – 1.

Flight activity by seven target species was recorded during these VP surveys, as summarised in Table 5 below. Flight lines recorded for target species during the 2021 breeding season VP surveys are indicated in Figure 8.2.

Table 5. Summary of flight activity by target species during the 2021 breeding VP surveys

Species	Total no. of observations	Total flight time (seconds)
Buzzard	62	10,334
Great black-backed gull	1	60
Grey heron	1	12
Kestrel	29	5,561
Lesser black-backed gull	6	144
Mallard	2	171
Peregrine	5	63

Descriptions of activity by target species observed during these VP surveys are provided below. Context on their conservation statuses and distributions provided in Sections 4.1 and 0 is in reference to BirdWatch Ireland (2022).

Buzzard

Buzzard is regarded as a widespread resident species and winter migrant in Ireland and is not considered to be of particular conservation concern (Gilbert *et al.* 2021) or afforded special legal protection (i.e. over and above the general legal protection afforded to all wild birds through the Wildlife Act and relevant amending legislation).

Buzzard was the most frequently recorded target species during the 2021 breeding VP surveys, with a total of 62 observations recorded. Multiple observations were made from all four VPs, with 26 observations from VP1, 18 observations from VP4, 10 observations from VP3 and 8 observations from VP2. The total duration of the observed buzzard flight activity was 10,334 seconds. The longest observation occurred on 13th May 2021, during which a solitary bird was observed flying and perching for 2,160 seconds. Whilst most observations were of solitary birds, multiple birds were also recorded together, with a maximum of three birds observed at any one time. Observations were typically of circling, soaring and perching birds throughout the wind farm site.

Based on the number and locations of buzzard observations recorded, and their observed behaviour, two buzzard territories were identified overlapping with wind farm the site boundary, with nest sites located in woodland outside of the wind farm site boundary to the west and north-west respectively.

Great black-backed gull

Great black-backed gull is regarded as a widespread species in Ireland and is not considered to be of particular conservation concern or afforded special legal protection. They breed on the ground in colonies around the coast of Ireland, with most colonies located on well-vegetated offshore islands and other inaccessible areas. Very few breed inland. Resident birds are joined by winter migrants (predominantly from Norwegian populations), at which time they are more likely to move inland.

Great black-backed gull was observed on one occasion during the 2021 breeding VP surveys; specifically five birds flying eastwards over improved grassland at a height of 40m for 60 seconds on 13th May 2021. Given the behaviour and time of year, these birds are considered likely to have been migrating.

Grey heron

Grey heron is regarded as a widespread resident species in Ireland and is not considered to be of particular conservation concern or afforded special legal protection.

Grey heron was observed on one occasion during the 2021 breeding VP surveys; specifically one bird flying north-east over improved grassland south-east of (i.e. outside of) the wind farm site at a height of 30m for 12 seconds.

Kestrel

Kestrel is regarded as a species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List. It is a widespread breeding species throughout the country in various open habitats including coasts, moorland, farmland, wetlands, roadside verges and town parks (Hardey *et al*. 2006). Individuals often remain within or near to their breeding territories throughout the year.

The desk study identified three records of kestrel from within 2km of the wind farm site, most recently in 2013.

Kestrels were observed on 29 occasions during the 2021 breeding VP surveys. Most observations were from VP1 and VP3 (10 observations each), followed by VP2 (seven observations) and VP4 (two observations). The total duration of the observed kestrel flight activity was 5,561 seconds. The longest observation occurred on 13th May 2021 from VP1, during which a solitary bird was observed flying and perching in improved grassland for 3,300 seconds. Most observations were of solitary birds flying at heights below 50m within or immediately north and south of the wind farm site boundary. Behavior observed within the wind farm site included hunting, mobbing and perching.

Based on the number of kestrel observations recorded, and their observed behavior, the species is considered likely to have been nesting near to the wind farm site in 2021, with the wind farm site overlapping with at least one kestrel territory.

Lesser black-backed gull

Lesser black-backed gull is an Amber Listed bird species of conservation concern in Ireland (Gilbert *et al.* 2021). They nest on the ground at colonial breeding sites (often with other gull species) including offshore islands, islands in inland lakes, sand dunes and coastal cliffs. In winter they use a wide variety of habitats both inland and along the south and east coasts. The greatest numbers are typically recorded in autumn after the breeding season when large numbers pass through Ireland on migration.

Lesser black-backed gulls were observed on six occasions during the 2021 breeding VP surveys. Most observations were from VP2 (three observations). The total duration of observed flight activity was 144 seconds, with the longest observation occurring on 9th July 2021, during which a bird was recorded from VP3 flying north-west for 60 seconds.

Mallard

Mallard is an Amber Listed bird species of conservation concern in Ireland. Resident populations in Ireland are supplemented by winter migrants from western Europe, during which time they are found in almost all wetland habitats throughout Ireland. Breeding occurs in dense vegetation near waterbodies.

Mallards were observed on two occasions during the 2021 breeding VP surveys. Both observations were from VP4 in May, with a combined flight duration of 171 seconds. The longest observation was of a single bird flying southwards at a height of 30m for 165 seconds. Both observations took place immediately west of the wind farm site boundary, with one flight line recorded within the south-west part of the wind farm site.

Peregrine

Peregrine is afforded additional legal protection due to its inclusion on Annex 1 of the Birds Directive. The species is considered to be locally common and increasing in Ireland and is therefore Green Listed under the Birds of Conservation Concern in Ireland (Gilbert *et al.* 2021). Peregrines predominantly nest on cliffs, crags, or manmade structures such as church spires, but will occasionally use other features such as trees (Hardey *et al*. 2006). Foraging occurs within a diverse range of habitats, often in predominantly open areas with abundant prey. Breeding birds disperse in winter to coastal and wetland areas.

Peregrines were observed on five occasions during the 2021 breeding VP surveys. Four of these observations were from VP3 and one was from VP2. The total duration of flight activity observed was 63 seconds, with the longest observation being of a bird initially flying north before turning south and subsequently heading east on 9th July 2021. All observations were of solitary birds, with an average flight height of 14m. None of the recorded observations took place within the wind farm site boundary, with most observed to the south-east, although one observation was immediately adjacent to the southern boundary of the wind farm site.

Whilst grassland within the wind farm site was suitable for foraging, the wind farm site lacked suitable nesting features for peregrine, and no evidence of nesting within or in close proximity to the site was observed in 2021. It is understood that peregrines were potentially nesting at a quarry in excess of 5km west of (i.e. outside of) the wind farm site boundary. Other potential nest sites are also located to the east of Knocklane approximately 3km to the east of the wind farm site and to the southeast of Lisgriffin Cross approximately 2.5km to the northeast of the wind farm site. Potential peregrine nest sites are shown on Confidential Figure 8.6.

2022

A total of 50 species were recorded during the VP surveys undertaken between April and September 2022 inclusive. Again, these were largely common and widespread non-target species recorded in relatively low numbers. Peak counts for specially protected and notable non-target species recorded are provided below:

- Goldcrest – 1
- Grey wagtail (*Motacilla cinerea*) – 1
- House martin – 10
- Linnet – 90
- Meadow pipit – 20
- Mistle thrush – 10
- Skylark – 22
- Spotted flycatcher (*Muscicapa striata*) – 5
- Starling – 60
- Stock dove – 20
- Swallow – 50
- Willow warbler – 2
- Yellowhammer – 18.

Of the 50 species recorded during the VP surveys undertaken between April and September 2022, nine were target species. Peak counts for these species are provided below:

- Black-headed gull (*Chroicocephalus ridibundus*) – 9
- Buzzard – 6
- Herring gull (*Larus argentatus*) – 1
- Kestrel – 2
- Lesser black-backed gull – 30
- Mallard – 3

- **Peregrine** – 1
- Snipe (*Gallinago gallinago*) – 2
- Sparrowhawk (*Accipiter nisus*) – 1.

Flight activity by nine target species was recorded during these VP surveys, as summarised in Table 6. Flight lines recorded for target species during the 2022 breeding season VP surveys are indicated in Figure 8.3.

Table 6. Summary of flight activity by target species during the 2022 breeding VP surveys

Species	Total no. of observations	Total flight time (seconds)
Black-headed gull	4	325
Buzzard	52	2,340
Herring gull	1	17
Kestrel	18	982
Lesser black-backed gull	16	1,960
Mallard	1	30
Peregrine	3	40
Snipe	1	5
Sparrowhawk	5	252

Descriptions of activity by target species observed during these VP surveys are provided below.

Black-headed gull

Black-headed gull is an Amber Listed bird species of conservation concern in Ireland. They are found widely at the coast and inland in winter, when their populations are bolstered by migrants from northern and eastern Europe.

Black-headed gull was observed on four occasions during the 2022 breeding VP surveys. Two observations were towards the north-east of the wind farm site from VP5, comprising a group of three birds circling over improved grassland at a height of 70-80m for 57 seconds, and a single bird flying over improved grassland at a height of 15m for 18 seconds. A group of nine was also observed flying adjacent to the site at a height of 100m for 100 seconds on 22nd September 2022.

Buzzard

Buzzard was the most frequently recorded target species during the 2022 breeding VP surveys, with a total of 52 observations recorded including multiple observations from all five VPs. The total duration of the observed buzzard flight activity was 2,340 seconds. Whilst most observations were of solitary birds, multiple birds were also recorded together, with a maximum of three birds observed at any one time. Observations were typically of circling, soaring and perching birds, with reduced levels of activity recorded within the north and centre of the wind farm site.

As in 2021, based on the number of buzzard observations recorded, and their observed behavior, two buzzard territories were identified overlapping with the wind farm site, with nest sites located outside of the wind farm site boundary to the west and north-west respectively.

Herring gull

Herring gull is an Amber Listed bird species of conservation concern in Ireland. They are a widespread resident species in coastal areas and are often found inland in winter.

Herring gull was observed on one occasion during the 2022 breeding VP surveys; specifically one flying south-east of the wind farm site at a height of 30-40m for 17 seconds.

Kestrel

Kestrels were observed on 18 occasions during the 2022 breeding VP surveys, including observations from four VP locations. The total duration of the observed kestrel flight activity was 982 seconds. The longest observation occurred on 31st May 2022 from VP5, during which an adult male was observed flying for 460 seconds at a height of 40-80m. Observations were concentrated towards the north of the wind farm site and the south-west of the wind farm site.

Based on the number of kestrel observations recorded, and their observed behavior, the species is considered likely to have been nesting near to the wind farm site in 2022, with the site overlapping with at least one kestrel territory.

Lesser black-backed gull

Lesser black-backed gull was observed on 16 occasions during the 2022 breeding VP surveys. These observations were of small groups flying in various directions across the north-east and south-west of the wind farm site at a range of heights, with one larger group of 30 birds recorded. Observations ranged in duration between 8 and 400 seconds and were much more frequent in late September (likely comprising migratory birds flying over the wind farm site).

Mallard

Three mallards were observed flying northwards over the wind farm site on 22nd September 2022 at a height of 5m for 30 seconds.

Peregrine

Peregrine was observed on three occasions during the 2022 breeding VP surveys. This included one flying southwards along the south-east boundary of the wind farm site at a height of 10-15m for 7 seconds, and one flying north-east of the wind farm site at a height of 100m for 23 seconds.

Snipe

Snipe is regarded as a species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List. Wintering birds arriving from the Faroe Islands, Iceland and northern Scotland are highly dispersed throughout Ireland, favouring a variety of wetland habitats for foraging and sheltering, particularly the fringes of lowland lakes.

Two snipe were observed flying northwards over the site on 22nd September 2022 at a height of 60m for 5 seconds.

Sparrowhawk

Sparrowhawk is regarded as a widespread species and is not considered to be of particular conservation concern in Ireland (Gilbert *et al.* 2021). They are resident in varied habitats throughout Ireland, although scarcer in some parts of western Ireland. Resident populations are bolstered by wintering birds from Britain and Europe.

Sparrowhawk was observed flying over the wind farm site on five occasions in September 2022 at heights ranging from 5-100m. Observations were of adult males and females hunting, commuting and circling for a combined 252 seconds.

4.2 Non-breeding season

A total of 57 species were recorded during the non-breeding VP surveys in 2020/21 and 2021/22, including 14 target species. Survey results are described below, including detailed accounts for target species.

2020/21

A total of 52 species were recorded during the VP surveys undertaken between October 2020 and March 2021 inclusive. These were largely common and widespread non-target species recorded in relatively low numbers. Peak counts for specially protected and notable non-target species recorded are provided below:

- Goldcrest – 8
- Grey wagtail – 1
- House sparrow – 16
- Linnet – 72
- Meadow pipit – 24
- Mistle thrush – 6
- Redwing – 282
- Skylark – 36
- Starling – 283
- Stock dove – 23
- Yellowhammer – 70.

Of the 52 species recorded during the VP surveys undertaken between October 2020 and March 2021, 11 were target species. Peak counts for these species are provided below:

- Black-headed gull – 16
- Buzzard – 6
- **Golden plover** – 14
- Great black-backed gull – 1
- Kestrel – 1
- Lesser black-backed gull – 12
- Mallard – 4
- **Merlin (*Falco columbarius*)** – 1
- **Peregrine** – 2
- Snipe – 4
- Sparrowhawk – 1.

Flight activity by 11 target species was recorded during these VP surveys, as summarised in Table 8 below. Flight lines recorded for target species during the 2020/21 non-breeding VP surveys are indicated in Figure 8.4.

Table 7. Summary of flight activity by target species during the 2020/21 non-breeding VP surveys

Species	Total no. of observations	Total flight time (seconds)
Black-headed gull	1	240
Buzzard	18	7,331
Golden plover	6	385
Great black-backed gull	1	120
Kestrel	10	475
Lesser black-backed gull	1	240
Mallard	1	70
Merlin	3	165
Peregrine	7	740
Snipe	4	99
Sparrowhawk	6	866

Descriptions of activity by target species observed during these VP surveys are provided below.

Black-headed gull

Black-headed gulls were observed on two occasions during the 2020/21 non-breeding VP surveys, with only one observation of flight activity recorded. Both observations were from VP3 in February 2021; specifically, ten birds feeding west of the wind farm site boundary, and 16 birds circling east of the wind farm site boundary at a height of 180m for 180 seconds before flying north-east. None were recorded within the wind farm site boundary.

Buzzard

Buzzard was the most frequently recorded species during the 2020/21 non-breeding VP surveys, with a total of 18 observations recorded including observations from all VPs and in all months. Most observations were from VP4, with the longest observation being of two birds soaring and circling over grassland for 3,600 seconds at a height of 60-100m on 29th March 2021, exhibiting behaviour suggesting they were occupying a territory in this area. Most observations were of solitary birds soaring over the wind farm site, with additional observations adjacent to the wind farm site. Multiple birds were also recorded, with a maximum of four birds seen at any one time.

Golden plover

Golden plover is regarded as a species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List (Gilbert *et al.* 2021). Golden plover is also afforded additional legal protection due to its inclusion on Annex 1 of the Birds Directive. In winter golden plovers are regularly found throughout Ireland, often in large, densely packed flocks in coastal and inland habitats including agricultural land.

Golden plovers were observed on six occasions during the 2020/21 non-breeding VP surveys, including three observations recorded from VP2. All observations were of birds in flight, with the longest observations of flocks flying over the site and adjacent land for 180 seconds on 16th and 25th February 2021. The largest flock recorded numbered 14 birds. Observations were all from the south-east of the wind farm site and land further south-east of the wind farm site.

Great Black-backed gull

Great black-backed gull was recorded once during the 2020/21 non-breeding VP surveys. This observation was of one bird flying north-west, immediately south of the wind farm site boundary, from VP3 on 16th February 2021. The bird flew at a height of 30m for 120 seconds.

Kestrel

Kestrel was the second most frequently recorded species during the 2020/21 non-breeding VP surveys, with a total of 10 observations recorded with a combined flight time of 475 seconds. Birds were most frequently observed from VP2 (four observations), whilst the longest flight observation was of an adult male flying eastwards at a height of 20m for 120 seconds on 25th February 2021 from VP4. All observations were of solitary birds, with most recorded within the wind farm site boundary. Birds were often seen perching prior to being observed flying over the site.

Lesser black-backed gull

Lesser black-backed gull was observed once during the 2020/21 non-breeding VP surveys; specifically 12 birds circling outside of the wind farm site boundary for 240 seconds at a height of 180m from VP3.

Mallard

Mallard was observed once during the 2020/21 non-breeding VP surveys; specifically four birds flying into the wind farm site for 70 seconds from an initial height of 50m on 24th March 2021 from VP3.

Merlin

Merlin is an Amber Listed bird species of conservation concern in Ireland and is afforded additional legal protection due to its inclusion on Annex 1 of the Birds Directive. Merlins are much more widely distributed in winter than during the breeding season, moving away from uplands to wetland and coastal habitats.

Merlin was observed on three occasions during the 2020/21 non-breeding VP surveys, with a total flight time of 165 seconds. The longest observation was of an adult female flying for 90 seconds and perching in a tree for 10 minutes, from VP2 on 26th November 2020. All observations were of solitary birds, with activity concentrated towards the south-east of the wind farm site.

Peregrine

Peregrine was observed seven times during the 2020/21 non-breeding VP surveys, with a total flight time of 740 seconds. Four of these eight observations were from VP4. Observations were mainly of solitary birds flying over the wind farm site, with some observations south of the wind farm site boundary. Two observations were of two birds. The longest observation was of a bird perching for ten minutes before flying (including hunting) for five minutes from VP4 on 24th November 2020.

Snipe

Snipe was observed on four occasions during the 2020/21 non-breeding VP surveys, with a total recorded flight time of 99 seconds. The longest flight recorded was of one bird flying west at a height of 15-20m for 60 seconds west of the wind farm site on 25th January 2021 from VP3. Only one observation was of multiple birds, with three observed flying south-east over the wind farm site on 25th October 2020 from VP1. Most observations took place within the wind farm site boundary.

Sparrowhawk

Sparrowhawk was recorded on six occasions during the 2020/21 non-breeding VP surveys, with a total flight time of 866 seconds. Observations were from October, November and December 2020 and February 2021. The longest flight observation was of a bird flying over at a height of up to 40m for 240 seconds on 24th November 2020 from VP3. All observations were of solitary birds, with most records occurring within the wind farm site boundary.

2021/22

A total of 46 species were recorded during the VP surveys undertaken between October 2021 and March 2022 inclusive. Again, these were largely common and widespread non-target species recorded in relatively low numbers. Peak counts for specially protected and notable non-target species recorded are provided below:

- Brambling (*Fringilla montifringilla*) – 1
- Goldcrest – 2
- Linnet – 50
- Meadow pipit – 17
- Mistle thrush – 3
- Redwing – 30
- Skylark – 34
- Starling – 90
- Stock dove – 8
- Swallow – 18
- Yellowhammer – 14.

Of the 46 species recorded during the VP surveys undertaken between October 2020 and March 2021, nine were target species. Peak counts for these species are provided below:

- Buzzard – 1
- **Golden plover** – 100
- Kestrel – 1
- **Hen harrier** – 1
- Lesser black-backed gull – 1
- **Merlin** – 1
- **Peregrine** – 2
- Snipe – 2
- Whooper swan: 1.

Flight activity by nine target species was recorded during these VP surveys, as summarised in Table 8 below. Flight lines recorded for target species during the 2021/22 non-breeding VP surveys are indicated in Figure 8.5.

Table 8. Summary of flight activity by target species during the 2021/22 non-breeding VP surveys

Species	Total no. of observations	Total flight time (seconds)
Buzzard	4	115

Species	Total no. of observations	Total flight time (seconds)
Golden plover	1	30
Hen harrier	1	20
Kestrel	2	15
Lesser black-backed gull	1	30
Merlin	2	25
Peregrine	1	15
Snipe	1	10
Whooper swan	1	120

Descriptions of activity by target species observed during these VP surveys are provided below.

Buzzard

Buzzard was the most frequently recorded species during the 2021/22 non-breeding VP surveys, with five observations recorded. Buzzard was observed from all four VPs, with observations including one bird calling from ground level. Observations were of individual birds, generally flying/circling over the site and adjacent land. The longest observation was of one bird circling at a height of 200m for 60 seconds from VP3 on 3rd March 2022.

Golden plover

Golden plover was observed on a single occasion during the 2021/22 non-breeding VP surveys: specifically a flock of 100 birds flying over improved grassland east of the wind farm site at a height of 50m for 30 seconds from VP1 on 7th March 2022.

Hen harrier

Hen harrier is an Amber Listed bird species of conservation concern in Ireland and is afforded additional legal protection due to its inclusion on Annex 1 of the Birds Directive. They winter in coastal and lowland areas throughout Ireland, with breeding largely confined to heather moorland and young forestry plantations.

A hen harrier was observed on a single occasion during the 2021/22 non-breeding VP surveys: specifically, an adult female flying over semi-improved grassland in the south-east of the wind farm site at a height of 3m for 20 seconds on 2nd December 2021 from VP2.

Kestrel

Kestrel was observed twice during the 2021/22 non-breeding VP surveys: specifically, one bird flying over improved grassland at a height of 5m for 10 seconds from VP2 on 2nd November 2021, and one bird flying over improved grassland at a height of 10m for 5 seconds from VP3 on 7th February 2022.

Lesser black-backed gull

Lesser black-backed gull was observed on one occasion during the 2021/22 non-breeding VP surveys: specifically, one bird flying over the north of the wind farm site for 30 seconds at a height of 50m from VP1 on 1st October 2021.

Merlin

Merlin was observed on two occasions during the 2021/22 non-breeding VP surveys, with a total flight time of 25 seconds. The longest flight observation was of an adult female flying at a height of 2m for 20 seconds from VP1 on 1st November 2021. The second observation was of an adult flying at a height of 5m for 5 seconds.

Peregrine

Peregrine was observed on one occasion during the 2021/22 non-breeding VP surveys: specifically, an adult and a juvenile flying over improved grassland for 15 seconds at a height of 5m from VP3 on 5th October 2021.

Snipe

Snipe was observed on one occasion during the 2021/22 non-breeding VP surveys: specifically, one bird flying over the south of the wind farm site at a height of 20m for ten seconds from VP4 on 6th October 2021.

Whooper swan

Whooper swan is an Amber Listed bird species of conservation concern in Ireland and is afforded additional legal protection due to its inclusion on Annex 1 of the Birds Directive. This species is a relatively widespread winter migrant, although scarcer in Ireland south of Limerick. They winter mostly on lowland open farmland around inland wetlands, feeding in grassland and stubble fields.

Whooper swan is a qualifying species for the designation of Kilcolman Bog SPA, located approximately 9.1km north-east of the wind farm site. The citation for this internationally designated site specifies a wintering population of 95 individuals (NPWS, 2014).

Whooper swan was observed on one occasion during the 2021/22 non-breeding VP surveys: specifically, one bird flying southwards over the southern end of the wind farm site at a height of 30m for 120 seconds on 3rd November 2021 from VP3.

2022/23

A total of 51 species were recorded during the VP surveys undertaken between October 2022 and March 2023 inclusive. Again, these were largely common and widespread non-target species recorded in relatively low numbers. Peak counts for specially protected and notable non-target species recorded are provided below:

- Goldcrest – 4
- Grey wagtail – 1
- House sparrow – 24

- Linnet – 83
- Meadow pipit – 72
- Mistle thrush – 10
- Redwing – 450
- Skylark – 78
- Starling – 274
- Stock dove – 123
- Yellowhammer – 35.

Of the 51 species recorded during the VP surveys undertaken between October 2022 and March 2023, 12 were target species. Peak counts for these species are provided below:

- Black-headed gull – 18
- Buzzard – 4
- **Golden plover** – 7
- Grey heron – 1
- Kestrel – 1
- Lesser black-backed gull – 34
- Mallard – 3
- **Merlin** – 1
- **Peregrine** – 1
- Pomarine skua (*Stercorarius pomarinus*) – 1
- Snipe – 19
- Sparrowhawk – 3.

Flight activity by 12 target species was recorded during these VP surveys, as summarised in Table 9 below. Flight lines recorded for target species during the 2022/23 non-breeding VP surveys are indicated in Figure 8.6.

Table 9. Summary of flight activity by target species during the 2022/23 non-breeding VP surveys

Species	Total no. of observations	Total flight time (seconds)
Black-headed gull	4	127
Buzzard	43	5,355
Golden plover	2	150
Grey heron	3	35
Kestrel	22	1,945

Species	Total no. of observations	Total flight time (seconds)
Lesser black-backed gull	14	897
Mallard	1	9
Merlin	1	25
Peregrine	5	260
Pomarine skua	1	60
Snipe	16	890
Sparrowhawk	15	566

Descriptions of activity by target species observed during these VP surveys are provided below.

Black-headed gull

Black headed gull was observed on four occasions during the 2022/23 non-breeding VP surveys for a combined 127 seconds, with the largest flock numbering 18 birds. All observations were recorded in December 2023 east of the wind farm site.

Buzzard

Buzzard was the most frequently recorded species during the 2022/23 non-breeding VP surveys, with 43 observations recorded ranging from one to four birds. Observed throughout the wind farm site from all six VPs, with activity including displaying, soaring, hunting and circling.

Golden plover

Golden plover was observed on two occasions during the 2022/23 non-breeding VP surveys: specifically, a flock of seven birds and a single bird circling low over arable fields for 120 seconds and 30 seconds respectively in January 2023.

Grey heron

Three flights by individual grey herons were observed during the 2022/23 non-breeding VP surveys. All observations were of birds flying southwards within the south-east corner of the wind farm site in March 2023.

Kestrel

Kestrel was frequently recorded during the 2022/23 non-breeding VP surveys, with birds observed hunting, perching and flying over. Kestrel activity was concentrated towards the south of the wind farm site.

Lesser black-backed gull

Observed passing through the site throughout the 2022/23 non-breeding VP survey period, with the largest flock numbering 34 birds. Most activity was of birds flying over the south of the wind farm site, with a total of 14 registrations recorded.

Mallard

One observation was recorded during the 2022/23 non-breeding VP surveys; specifically a group of three birds flying southwards from the south of the wind farm site in March 2023.

Merlin

One observation was recorded during the 2022/23 non-breeding VP surveys; specifically a solitary bird flying over farmland north of the wind farm site in January 2023.

Peregrine

Five observations were recorded during the 2022/23 non-breeding VP surveys. These were all solitary birds flying over and perching within and (more typically) east of the wind farm site boundary in November, December and January.

Pomarine skua

Pomarine skua is a scarce passage species in Ireland typically recorded in coastal areas. One observation was recorded during the 2022/23 non-breeding VP surveys; specifically a solitary bird flying southwards over the wind farm site in November 2022.

Snipe

Snipe was frequently recorded during the 2022/23 non-breeding VP surveys, flocks of up to 19 birds recorded. Birds were observed flying over the site and feeding/roosting within the wind farm site throughout the winter months, with the highest levels of activity recorded towards the east of the wind farm site.

Sparrowhawk

Sparrowhawk was frequently recorded during the 2022/23 non-breeding VP surveys, with individual birds observed displaying, hunting and soaring within the wind farm site. Activity was concentrated towards the south and east of the wind farm site.

5.0 TRANSECT SURVEY RESULTS

A total of 47 species were recorded during the transect surveys in 2021, 2022 and 2023, as summarised below. Peak counts for all species recorded during the transect surveys are provided in Annex C.

2021

A total of 31 species were recorded during the transect surveys undertaken between June and October 2021 inclusive. These were largely common and widespread non-target species recorded in relatively low numbers. Peak counts for specially protected and notable species recorded are provided below:

- Goldcrest – 1
- Lapwing – 2
- Linnet – 50
- Mistle thrush – 1
- Skylark – 6
- Snipe – 1
- Starling – 3
- Swallow – 2
- Wheatear (*Oenanthe oenanthe*) – 4
- Yellowhammer – 6.

2022

A total of 38 species were recorded during the transect surveys undertaken between April and November 2022 inclusive. These were largely common and widespread non-target species recorded in relatively low numbers. Peak counts for specially protected and notable species recorded are provided below:

- House sparrow – 3
- Kestrel – 1
- Linnet – 50
- Meadow pipit – 24
- Redwing – 1
- Skylark – 5
- Snipe – 2
- Starling – 13
- Swallow – 8
- Yellowhammer – 14.

2023

A total of 38 species were recorded during the transect surveys undertaken in January and March 2023. These were largely common and widespread non-target species recorded in relatively low numbers. Peak counts for specially protected and notable species recorded are provided below:

- Linnet – 4
- Meadow pipit – 34
- Redwing – 57
- Skylark – 6
- Snipe – 3
- Starling – 270
- Stock dove – 2
- Whooper swan – 4 (one group flying over the centre of the wind farm site in January at a height of 5-20 m)
- Yellowhammer – 2.

6.0 NESTING BARN OWL AND KESTREL SURVEY RESULTS

The desk study did not identify any recent records of barn owl within 2km of the wind farm site boundary, and no observations of barn owl were recorded during the field surveys of the site undertaken in 2020-2023. Barn owl is regarded as a species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List (Gilbert *et al.* 2021).

The desk study identified three records of kestrel from within 2km of the wind farm site, most recently in 2013. Kestrel was frequently observed within and adjacent to the wind farm site during the field surveys undertaken in 2020-2023, including activity during the breeding season that suggested the presence of at least one territory overlapping with the wind farm site boundary.

Together, the initial desk-based reviews and subsequent field surveys undertaken on 24th July 2022 within the wind farm site and a minimum 1km buffer identified 19 buildings (or clusters of buildings) requiring further surveys; specifically, ten buildings within 1km of the wind farm site boundary, and nine buildings more than 1km from the wind farm site boundary (hereafter referred to as 'Sites 1-19'). No trees, artificial boxes or other structures within the wind farm site or within 1km of the wind farm site boundary were identified as supporting nesting barn owl or kestrel. A large stone farm shed located approximately 160m to the southwest of the proposed location of turbine T9 contained three barn owl pellets and a barn owl feather on the ground below a joist inside the western end of the shed during an inspection undertaken in May 2023. The age of the pellet and lack of any suitable nesting cavities in the shed or nearby would indicate that this site was used infrequently as a winter roost.

Regarding buildings within 1km of the wind farm site boundary, no evidence of barn owl or kestrel nesting was recorded. Only one building, a two-storey derelict farmhouse at Templemary (Site 6; Grid Reference IR 4771 05884), was suitable for nesting barn owl, with the central chimney and internal attic space both providing potential nest sites. No buildings were suitable for nesting kestrel. Sites 1, 3, 5, 6, 7 and 9 were potentially suitable as temporary roost sites for both species, although no evidence of use by either species was recorded.

Regarding potentially suitable buildings identified more than 1km from the wind farm site boundary, an active barn owl nest site was confirmed approximately 1.8km east of the wind farm site boundary (refer to confidential Figure 8.6). The nest was present within a wall cavity in the building, with evidence of long-term use including numerous pellets and moulted feathers recorded. Two recently fledged barn owl chicks were observed on 24th July 2022, at an estimated age of 70+ days (i.e. nearing dispersal from the nest site, potentially towards the wind farm site). No other evidence of barn owl nesting was recorded in buildings surveyed more than 1km from the wind farm site boundary.

No evidence of kestrel nesting was recorded in buildings surveyed more than 1km from the wind farm site boundary. Sites 11, 12, 15 and 19 were potentially suitable as temporary roost sites for barn owl and kestrel, although no evidence of use by either species was recorded.

7.0 DISCUSSION

The bird surveys of the site and adjacent land undertaken between October 2020 and March 2023 inclusive recorded a total of 70 bird species; specifically 58 species during the breeding season and 57 species during the non-breeding season (with many species observed during both periods).

Of the 70 species recorded, 17 were target species. Sixteen of these target species were recorded in flight (i.e. all except lapwing) over or near to the wind farm site:

- Black-headed gull
- Buzzard
- **Golden plover**
- Great black-backed gull
- Grey heron
- **Hen harrier**
- Herring gull
- Kestrel
- Lapwing
- Lesser black-backed gull
- Mallard
- **Merlin**
- **Peregrine**
- Pomarine skua
- Snipe
- Sparrowhawk
- **Whooper swan**.

Target species recorded included five species listed on Annex 1 of the Birds Directive, four BoCCI Red Listed species and seven BoCCI Amber Listed species (Gilbert *et al.* 2021). In addition, a range of non-target species were recorded including ten BoCCI Red Listed species and 21 BoCCI Amber Listed species.

Significance of breeding and non-breeding bird populations

Regarding use of the wind farm site during the breeding season, most target species recorded were present in low numbers and/or were only recorded occasionally; specifically great black-backed gull, grey heron, herring gull, lesser black-backed gull and mallard. As such, the site is considered to be of low value to these species during the breeding season. Similarly, most target species recorded during the non-breeding season were present in low numbers and/or were only recorded occasionally; specifically great black-backed gull, hen harrier, lesser black-backed gull, mallard, pomarine skua, snipe and whooper swan.

As such, the wind farm site is considered to be of low value to these species during the non-breeding season.

Other species recorded within the wind farm site during the non-breeding season included golden plover, merlin, and sparrowhawk. These species were recorded flying over the wind farm site on multiple occasions, and the wind farm site comprised suitable wintering habitat for feeding and/or roosting by these species. Considering the levels of activity recorded in the context of their conservation statuses in Ireland, the wind farm site is considered to be local value to these species during the non-breeding season.

Peregrine was recorded on multiple occasions during the breeding and (particularly) non-breeding season, including observations of juveniles. Whilst no peregrine nest sites were identified within or in close proximity to the wind farm site, hinterland surveys identified four confirmed or possible peregrine nest sites in the wider area in 2022, the nearest of which was approximately 2.5km north-east of the wind farm site boundary. Supporting data obtained from NPWS identified at least five possible peregrine nest sites within 5km of the wind farm site in 2017. Considering the presence of nesting sites in the surrounding area, and the level of activity on the wind farm site, the wind farm site is considered to be of local value to peregrine during the breeding and non-breeding seasons.

Two target species were recorded frequently within and adjacent to the wind farm site during the breeding and non-breeding VP surveys: buzzard and kestrel. Buzzard is a common and widespread species in Ireland, whilst kestrel is regarded as a species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List. Both species were observed flying over the wind farm site on many occasions, with activity indicating the presence of at least one kestrel territory overlapping with the wind farm site. Two buzzard territories were identified overlapping with the wind farm site, with nest sites located outside of the wind farm site boundary to the west and north-west respectively. Considering the levels of buzzard and kestrel activity recorded in the context of their conservation statuses in Ireland, the wind farm site is considered to be of local value to both species.

Detailed nest searches identified an active barn owl nest approximately 1.77km east of the wind farm site in 2022, although no observations of barn owl were recorded within or in close proximity to the wind farm site. Barn owl is regarded as a species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List, although the wind farm site is not considered to be of more than local value for barn owl.

Relevant designated sites

The desk study identified Kilcolman Bog SPA, located approximately 9.1km north-east of the wind farm site. Only one qualifying species for the designation of this SPA was recorded during the surveys of the wind farm site in 2020-2023: whooper swan, with one bird observed flying over the wind farm site in November 2021 and four birds observed flying over the wind farm site in January 2023. Considering the level of whooper swan activity recorded, and the distance between the wind farm site and the SPA, the wind farm site is not considered to be of significant value to the whooper swan populations of Kilcolman Bog SPA.

Other non-qualifying species included on the SPA citation recorded within the wind farm site (golden plover, great black-backed gull, lesser black-backed gull and mallard) were recorded infrequently and/or in relatively low numbers within the wind farm site.

Considering this, and the distance between the wind farm site and the SPA, the wind farm site is not considered to be of significant value to these non-qualifying wintering bird populations of the SPA.

Grey heron, a non-qualifying species of Blackwater River (Cork/Waterford) SAC), was recorded using the wind farm site and immediately adjacent land during the field surveys. Considering the low number of grey herons recorded, the distance between the wind farm site and Blackwater River (Cork/Waterford) SAC, and the great extent of this SAC (predominantly more than 20km from the wind farm site boundary), the wind farm site is not considered to be of significant value to the grey heron populations of Blackwater River (Cork/Waterford) SAC.

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FIGURES

- Figure 8.1 – Viewsheds and Transects;
- Figure 8.2 – Flight observations from VP surveys for target species during the breeding season 2021;
- Figure 8.3 – Flight observations from VP surveys for target species during the breeding season 2022;
- Figure 8.4 – Flight observations from VP surveys for target species during the non-breeding season 2020/21;
- Figure 8.5 – Flight observations from VP surveys for target species during the non-breeding season 2021/22;
- Figure 8.6 – Flight observations from VP surveys for target species during the non-breeding season 2022/23; and
- Figure 8.7 – Bird nest locations (CONFIDENTIAL)

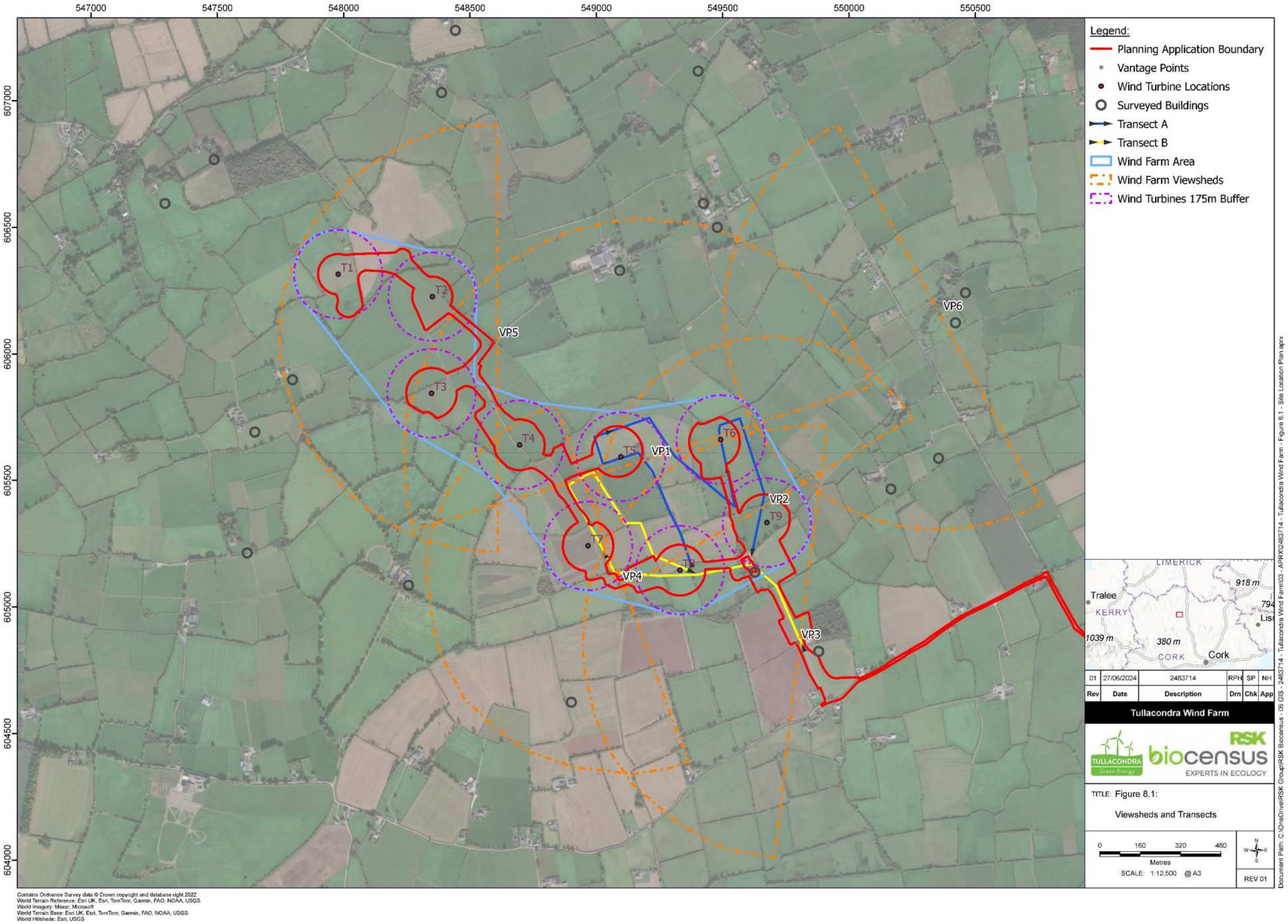
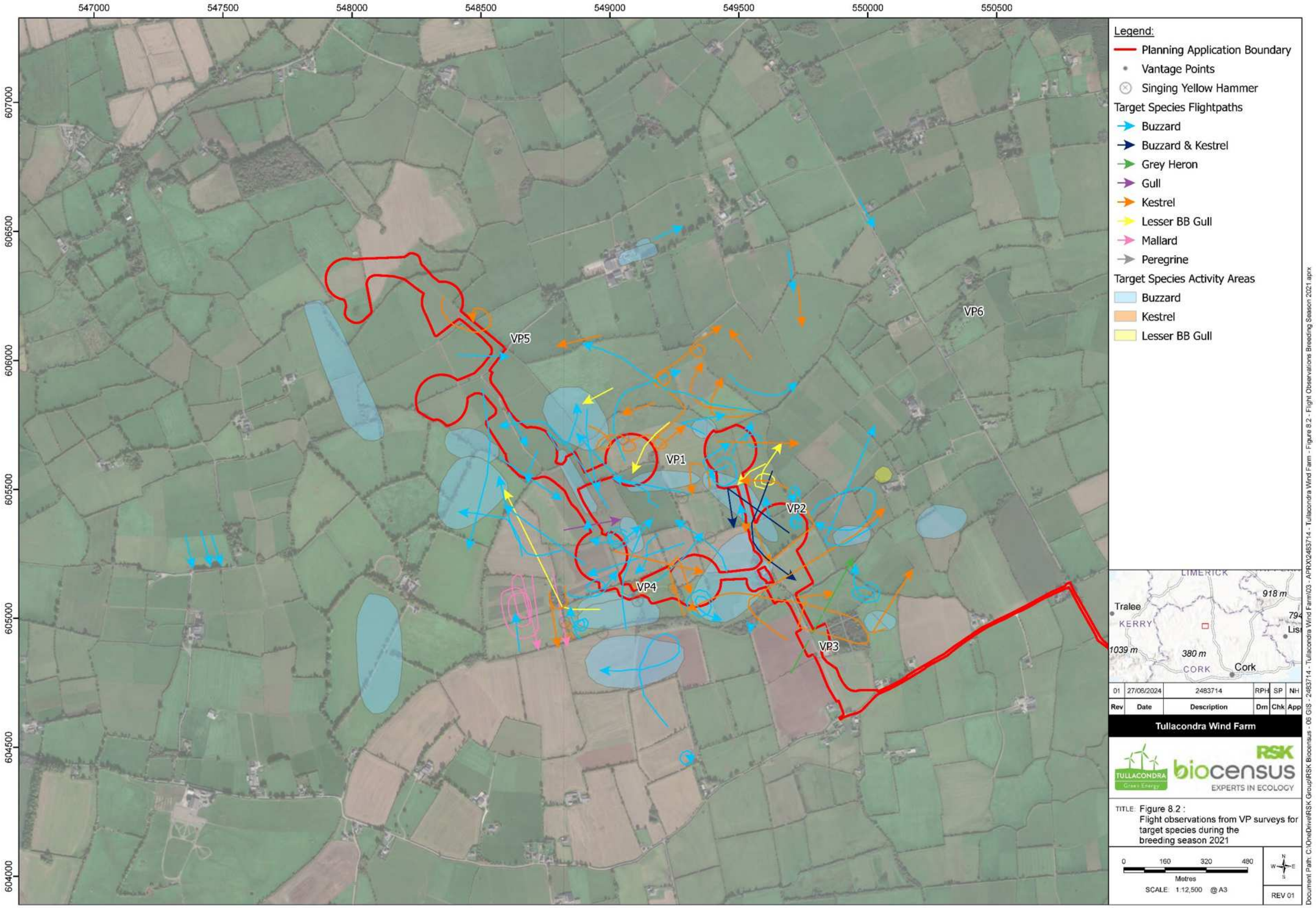


Figure 8.1 - Viewsheds and Transects



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World Hillshade: Esri, USGS

Figure 8.2 – Flight observations from VP surveys during the breeding season 2021

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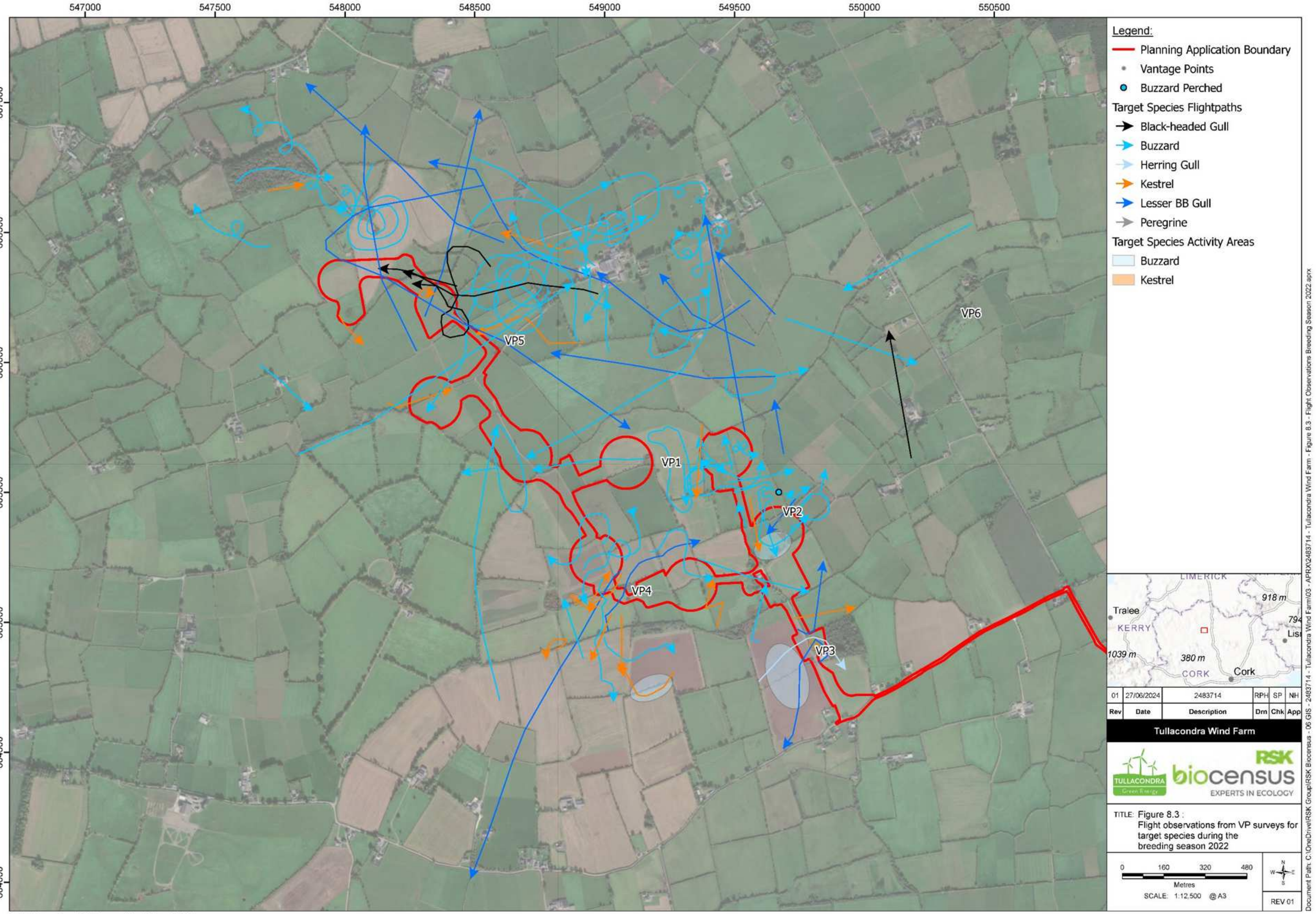

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World Hillshade: Esri, USGS

Figure 8.3 – Flight observations from VP surveys during the breeding season 2022

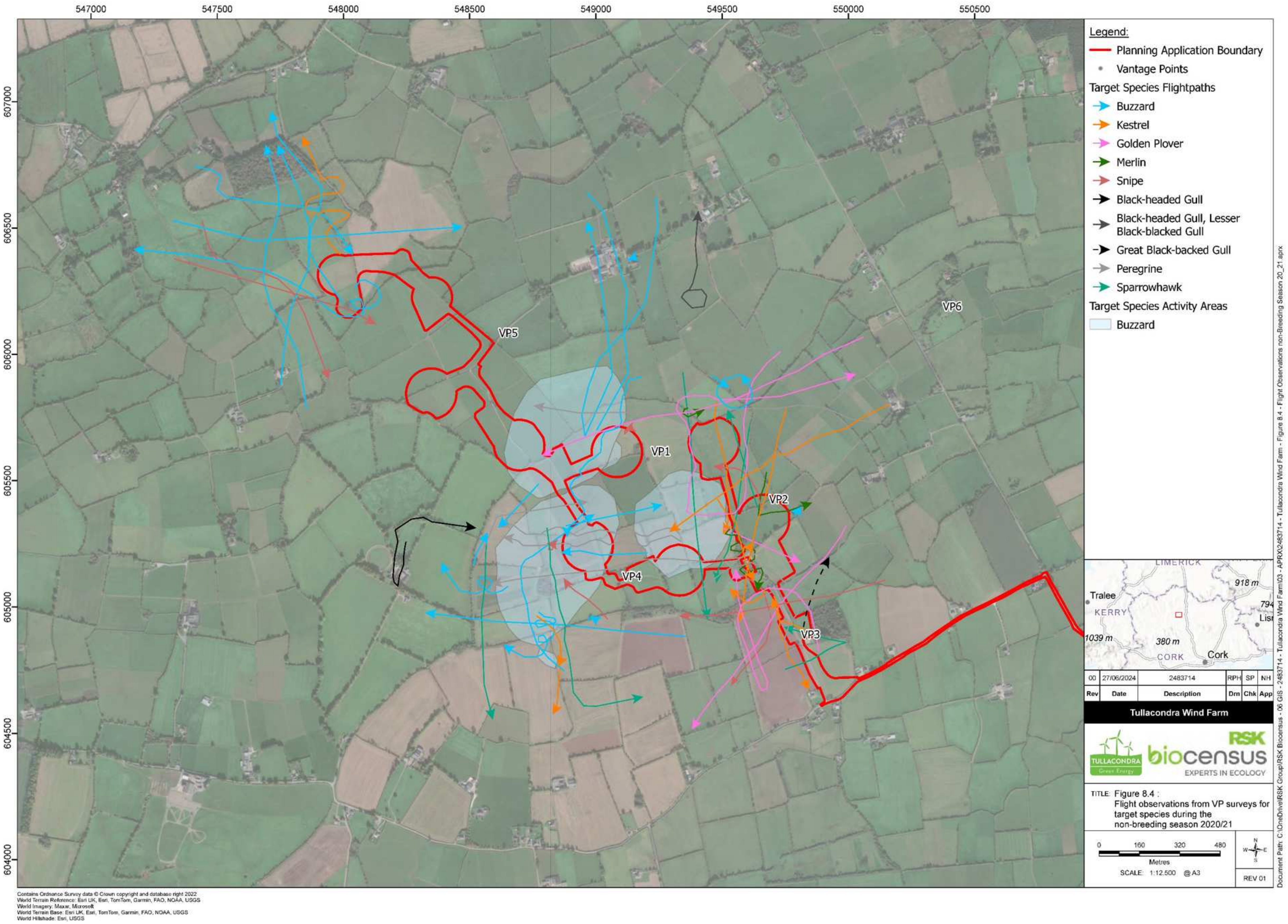
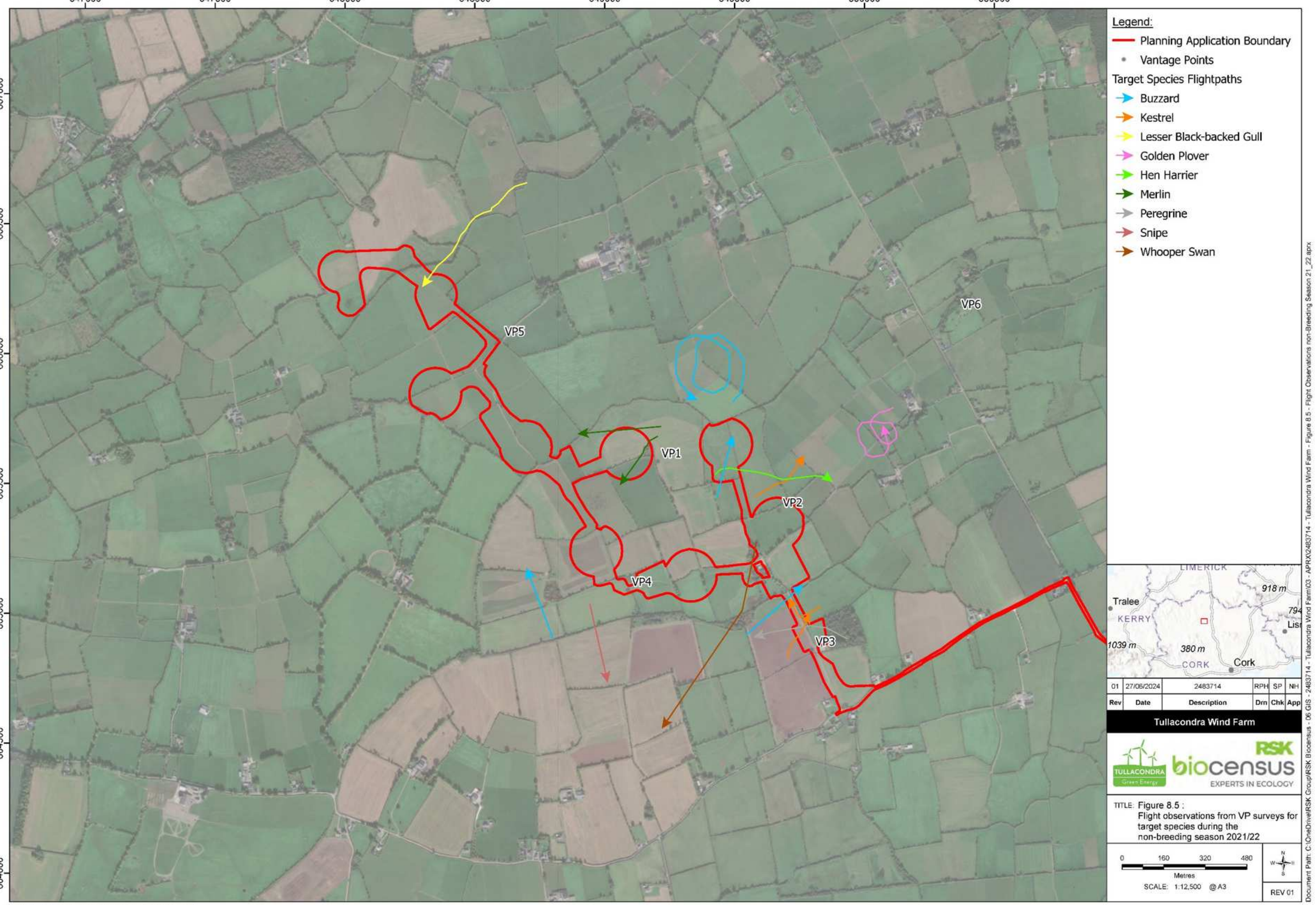


Figure 8.4 – Flight observations from VP surveys during the non-breeding season 2020/21



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World Hillshade: Esri, USGS

Figure 8.5 – Flight observations from VP surveys during the non-breeding season 2021/22

Figure 8.6 – Flight observations from VP surveys during the non-breeding season 2022/23

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Figure 8.7 – Bird nest locations (CONFIDENTIAL)

ANNEX A – RELEVANT LEGISLATION

International legislation

Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (Birds Directive) 2009

The Birds Directive 2009 relates to the conservation of all species of naturally occurring birds in their wild state in the territory of the EU Member States (MSs) to which the treaty applies. Under the Birds Directive, the most suitable areas of conservation of the Annex 1 species are to be designated as Special Protection Areas (SPAs), as part of the European Natura 2000 network. Maintaining a coherent network of protected sites with overarching conservation objectives is required in order to fulfil the commitment made by governments to maintain environmental protections and continue to meet their international legal obligations.

Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive) 1992

The Habitats Directive 1992 requires EU MSs to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of community interest, which are listed under Annex I, II, IV and/or V. Species listed under Annex IV are known as 'European Protected Species' (EPS).

Under the Habitats Directive, EU Member States are required to contribute to the Natura 2000 network through the designation of Special Areas of Conservation (SACs) for natural habitat types listed in Annex 1 and habitats of species listed in Annex II.

The Convention on Wetlands of International Importance Especially as Waterfowl Habitat 1971: the Ramsar Convention

The Ramsar Convention is an intergovernmental treaty focused on the conservation and sustainable use of wetland, primarily as habitats for water birds. Under the convention, each ratified country is required to identify and designate sites (Ramsar sites) that meet the criteria for identifying a wetland of international importance, i.e. containing representative, rare or unique wetland types. In addition, the convention promotes international co-operation to promote the wise use of all wetlands and their resources.

Natura Impact Statement (NIS)

There is a requirement under the EU nature directives, and enshrined in country-specific domestic legislation, to undertake a screening exercise to determine whether any sites that form part of the Natura 2000 site network are likely to be significantly affected by any proposal (project or plan). The assessment must consider the proposals both alone and in combination with other plans and projects, if they result from activities that are not directly connected with, or necessary to, the management of the designated sites. If significant effects are likely, an Appropriate Assessment (AA) will need to be carried out. The screening, any AA, and any subsequent assessment are collectively known as a Natura Impact Statement (NIS). The NIS needs to consider each of the 'Qualifying Features' (habitats or species) for which the Natura 2000 site is designated. Ramsar sites are treated in the same way as SACs and SPAs in a NIS, as are proposed Natura 2000 sites which have not yet been fully adopted.

The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979

The Bonn Convention was adopted in 1979 and came into force in 1985. Contracting Parties work together to conserve migratory species and their habitats by providing strict protection for endangered migratory species (listed in Appendix I of the Convention), concluding multilateral agreements for the conservation and management of migratory species which require or would benefit from international cooperation (listed in Appendix II), and by undertaking cooperative research activities.

The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 1979

The principal aims of the Bern Convention 1979 are to ensure the conservation and protection of wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention), to increase cooperation between contracting parties, and to regulate the exploitation of those species (including migratory species) listed in Appendix III. To this end, the Bern Convention imposes legal obligations on contracting parties, protecting over 500 wild plant species and more than 1,000 wild animal species.

National legislation

Wildlife Act (1976), as amended

The Wildlife Act (1976), as amended is the principal national legislation for the protection of wildlife and the control of activities that may adversely affect wildlife. This legislation also seeks to conserve a representative sample of important ecosystems and regulate game resources. It makes licences mandatory for certain activities which may interfere with ecosystems and regulates the possession, trade, and movement of wildlife. Areas of importance for wildlife may be protected under the Act, either as Nature Reserves for Fauna, or by way of management agreements.

Wildlife (Amendment) Act, 2000, 2010, 2012

The main objectives of this Act designate and give protection to Natural Heritage Areas (NHAs) and improve the conservation of wildlife and their habitats while ensuring Ireland's compliance with international biodiversity agreements. It broadens the scope the previous Wildlife Act to include hitherto omitted species. It legislates for fines and punishments and allows for the imposition of prison sentences in certain circumstances.

ANNEX B – SURVEY DETAILS

Vantage Point surveys

Table 10. 2021 Breeding VP survey details

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
April						
1	12.04.21	MK	12.30	15.30	3	Cloud cover 6/8, bright and sunny with some showers and hail but overall dry with south-westerly winds, wind F2-3, temp 9oC, and visibility excellent.
1	12.04.21	DOB	16.00	19.00	3	Cloud cover 6/8, sunny spells with light showers, very cold due to constant wind blowing, wind direction east, wind F2-3, temp 11oC, and visibility good to 2km.
2	13.04.21	MK	12.30	15.30	3	Cloud cover 2/8, bright with sunshine and light breeze, wind direction southeast, wind F1-2, temp 10oC, and visibility excellent.
2	13.04.21	DOB	15.45	18.45	3	Cloud cover 3/8 – 4/8, dry day with calm wind, wind F0-1, temp 10oC, and visibility very good to excellent.
3	13.04.21	DOB	12.20	15.20	3	Cloud cover 4/8, warm and sunny with south-easterly winds, wind F1, temp 11oC, and visibility very good to 2km.
3	13.04.21	MK	15.45	18.45	3	Cloud cover 4/8, sunny with no rain and a light breeze, wind direction southeast, wind F1, temp 12oC, and visibility excellent.
4	12.04.21	DOB	12.20	15.20	3	Cloud cover 6/8 – 8/8, showers and sunny spells with an easterly breeze, wind F1-2, temp 10oC, and visibility good.
4	12.04.21	MK	16.00	19.00	3	Cloud cover 6/8, shower at the start of VP watch but bright and sunny with southwest winds picking up, wind F3, temp 10oC, and visibility excellent.
May						
1	13.05.21	MK	08.10	11.10	3	Cloud cover 3/8, bright and sunny with westerly winds, wind F2, last half hour of the watch wind picked up to F3 and cloud cover 7/8, temp 11oC, and visibility excellent.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
1	13.05.21	CBH	11.32	14.32	3	Cloud cover 8/8 with intermittent sunshine and calm winds, cool southwest breeze picking up halfway through VP, wind F1-2, temp 12oC, and visibility very good.
2	11.05.21	MK	08.00	11.00	3	Cloud cover 5/8, bright and breezy with southerly winds, wind F2, wind speed increased in the last hour to F3 and gusting to F4, temp 9oC, and visibility excellent.
2	11.05.21	DOB	11.40	14.40	3	Cloud cover 5/8, dry, bright, and breezy with south-westerly winds, wind F3-4 and gusting to F5, temp 10oC, and visibility good to 2km.
3	11.05.21	DOB	08.00	11.00	3	Cloud cover 5/8, dry and bright with sunny spells and light drizzle, wind direction southwest, wind F2-4 and gusting to F5-6, temp 6oC, and visibility good.
3	11.05.21	MK	11.35	14.35	3	Cloud cover 7/8, overcast with south-southeast winds, wind F3-4, temp 12oC, and visibility excellent.
4	13.05.21	CBH	08.10	11.10	3	Cloud cover 2/8, dry, bright and calm morning with some dew on the grass, cloud cover increasing to 7/8 at VP end, temp 8oC, and visibility excellent.
4	13.05.21	MK	11.31	14.31	3	Cloud cover 7/8, overcast and breezy with no rain and southwest winds, wind F2, gusting to F3, temp 13oC, and visibility excellent.
June						
1	15.06.21	MK	08.10	11.10	3	Cloud cover 8/8, light showers in the first hour, cloud cover 6/8 in the last hour, wind direction southeast, wind F2, temp 16oC, and visibility excellent.
1	15.06.21	DOB	11.40	14.40	3	Cloud cover 8/8, calm and warm with light showers, wind direction southwest, wind F2, temp 17oC, and visibility good.
2	22.06.21	DOB	09.40	12.40	3	Cloud cover 7/8, warm, calm, dry, sunny and haze with westerly winds, wind F1-2, temp 11oC, and visibility very good.
2	22.06.21	MK	12.55	15.55	3	Cloud cover 7/8, bright with some haze and northwest winds, wind F3, temp 17oC, and visibility excellent.
3	22.06.21	MK	09.40	12.40	3	Cloud cover 6/8, hazy visibility but excellent to 1000m, wind direction northwest, wind F2, temp 13oC, and visibility good to excellent.
3	22.06.21	DOB	12.55	15.55	3	Cloud cover 8/8, hazy, warm and dry with a light shower towards the end of VP watch, wind direction west, wind F2, temp 16oC, and visibility good.
4	15.06.21	DOB	08.10	11.10	3	Cloud cover 7/8, warm, breezy, hazy and dull with light showers, wind direction southeast, wind F4, gusting to F5, temp 11oC-16oC, and visibility good.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
4	15.06.21	MK	11.40	14.40	3	Cloud cover 8/8, overcast and breezy with no rain, wind direction south, wind F3, temp 17oC, and visibility good.
July						
1	07.07.21	DOB	11.45	14.45	3	Cloud cover 7/8, sunny spells and drizzle with westerly winds, wind F3, temp 18oC, and visibility good to moderate.
1	08.07.21	CBH	09.00	12.00	3	Cloud cover 8/8, overcast and dull day with occasional drops of rain but calm and cool, visibility reducing to poor in second half of the 3 hour watch, temp 15oC, and visibility fair to poor.
2	09.07.21	DOB	08.30	11.30	3	Cloud cover 8/8, mist, dull and drizzly with westerly winds, wind F1, temp 13oC, and visibility good to poor.
2	09.07.21	CBH	12.19	15.19	3	Cloud cover 6/8 – 8/8, overcast with persistent rain with no winds, temp 14oC, and visibility ok to poor.
3	09.07.21	CBH	08.50	11.50	3	Cloud cover 8/8, an overcast, very dull morning with dark rain clouds, no wind but occasional rain, temp 14oC, and visibility ok.
3	09.07.21	DOB	12.20	15.20	3	Cloud cover 8/8, raining constantly with westerly winds, wind F1, temp 14oC, and visibility moderate to poor.
4	07.07.21	DOB	08.15	11.15	3	Cloud cover 8/8, dry and dull morning with rain from 10.45, wind direction west, wind F2-4, temp 15oC, and visibility good.
4	08.07.21	CBH	12.15	15.15	3	Overcast and dull but warm with occasional drops of rain, cloud cover 8/8, temp 16oC, and visibility fair to good.
August						
1	09.08.21	MK	12.10	15.10	3	Cloud cover 7/8 with periodic light rain showers, wind direction northwest, wind F4, temp 17oC, and visibility good.
1	09.08.21	DOB	15.35	18.35	3	Cloud cover 8/8 with breezy showers and sunny spells, wind direction southwest, wind F4-5, temp 18oC, and visibility moderate to good.
2	10.08.21	DOB	11.00	14.00	3	Cloud cover 5/8 but breezy, sunny and warm, wind direction southwest, wind F3, temp 17oC, and visibility good.
2	10.08.21	MK	14.30	17.30	3	Cloud cover 8/8, more overcast then the 1st watch, wind direction west, wind F3, temp 17oC, and visibility excellent.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
3	10.08.21	MK	11.00	14.00	3	Cloud cover 6/8, bright and clear with southwest winds, wind F2, temp 18oC, and visibility excellent.
3	10.08.21	DOB	14.30	17.30	3	Cloud cover 6/8, breezy and warm with sunny spells and southwest winds, wind F3, temp 19oC, and visibility good.
4	09.08.21	DOB	12.05	15.05	3	Cloud cover 8/8, rain for 1 hour, drizzly and breezy with southwest winds, wind F3, temp 17oC, and visibility good to poor when raining.
4	09.08.21	MK	15.30	18.30	3	Cloud cover 7/8, overall clear with 2 short light showers, wind direction west, wind F4, temp 18oC, and visibility good.
September						
1	07.09.21	SN	09.45	12.45	3	Clear sunny day, cloud cover 0/8 oktas. Wind S F1, temp 18oC, visibility good.
1	07.09.21	SN	13.15	16.15	3	Clear sunny day, cloud cover 1/8 oktas. Wind S F2, temp 22oC, visibility good.
2	08.09.21	SN	09.00	12.00	3	Calm cloudy day with no rain, cloud cover 7/8 oktas. Wind SE F1, temp 15oC, visibility fair to good.
2	08.09.21	SN	12.30	15.30	3	Calm cloudy day with no rain, cloud cover 7/8 oktas. Wind SE F1, temp 17oC, visibility fair to good.
3	08.09.21	DOB	15.00	18.00	3	Cloud cover 8/8, dull, drizzly and warm with constant misty drizzle clearing at times but then heavy rain towards the end, wind direction southeast, wind F1, temp 18oC, and visibility moderate to poor.
3	09.09.21	DOB	08.15	11.15	3	Cloud cover 8/8, misty, cool, drizzle and dull with southeast winds, wind F1, temp 17oC, and visibility moderate to poor.
4	07.09.21	DOB	08.20	11.20	3	Cloud cover 8/8, heavy low fog with sun, warm and dry with southeast winds, wind F1, temp 16oC-19oC, and visibility moderate for 30 minutes then good.
4	07.09.21	DOB	11.50	14.50	3	Cloud cover 0/8, clear and hazy, and a very hot sunny dry day, wind direction southeast, wind F1, temp 21oC-23oC, and visibility good.

Table 11. 2022 Breeding VP survey details

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
April						
1	25.04.22	DOB	12.00	15.00	3	Cloud cover 6/8. Warm and breezy with some dark clouds. Wind direction south west, F2 dry winds. Good Visibility. Temp 11oC.
1	25.04.22	DOB	15.30	18.30	3	Cloud cover 6/8. Warm and dry to start, cool to finish. Wind speed f2. Temp 14oC. Good visibility.
2	21.04.22	NL	14.00	17.00	3	Cloud cover 6/8. Overcast with showers. South west f4 winds. Very good visibility. Temp 9oC.
2	21.04.22	NL	17.30	20.30	3	Cloud cover 6/8. Overcast with showers. South west f4 winds. Very good visibility. Temp 9oC.
3	26.04.22	DOB	11.50	14.50	3	Cloud cover 8/8. Bright and warm. Dry f2 winds in south easterly direction. Temp 10oC. Good visibility.
3	26.04.22	DOB	15.20	18.20	3	Cloud cover 7/8. Warm and Dry. Temp 10oC. Good visibility.
4	29.04.22	UW	08.15	11.15	3	Cloud cover 6/6-8/8. Dry, warm, and calm. Very light winds, F0-1, north easterly. Temp 8-11oC. Poor-Moderate visibility
4	29.04.22	UW	11.45	14.45	3	Cloud cover 7/8-8/8. Dry, warm, calm, overcast and hazy. Very calm winds F0-F1, north easterly. Temp 13-15oC. Moderate visibility, very hazy.
5	25.04.22	MK	12.50	15.50	3	Cloud cover 6/8. Bright and clear with gentle breeze. Easterly F2 winds. Temp 13oC. Good visibility.
5	25.04.2022	MK	16.20	19.20	3	Cloud cover 7/8. Increased cloud cover but still bright. Easterly F2 winds. Temp 14oC. Good visibility.
May						
1	31.05.22	DOB	07.20	10.20	3	Cloud cover 3/8 but turned to 8/8 by last hour of survey. F2-F4 westerly winds. Breezy, cool, dry, dull. Temp 9oC-12oC. Very good visibility.
1	31.05.22	DOB	10.40	13.40	3	Cloud cover 8/8. Cloudy, dull, breezy, cool. F1-F4 westerly winds. Temp 12oC-14oC. Good visibility.
2	25.05.22	NL	12.00	15.00	3	Cloud cover 8/10. Overcast with bright spells. F4 westerly winds. Temp 13oC. Very good visibility.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
2	25.05.22	NL	15.30	18.30	3	Cloud cover 8/10. Overcast with bright spells. F4 westerly winds. Temp 13oC. Very good visibility.
3	25.05.22	DOB	07.30	10.30	3	Cloud cover 7/8. Light rain with intermittent low clouds at times. Westerly F2-F4 winds with gusts of up to F6 at times. Temp 12-13oC. Moderate visibility.
3	25.05.22	DOB	11.00	14.00	3	Cloud cover 7/8. Blustery, dry, cloudy with some sunny spells. F2, F4, and F6 winds in westerly direction with intermittent lightning. Temp 13oC. Good visibility
4	19.05.22	UW	08.45	11.45	3	Cloud cover 6/8 – 4/8. Heavy showers, breezy and warm. Wind SSW Force 2-3. Temp 13ºC. Moderate visibility.
4	19.05.22	UW	12.15	15.15	3	Cloud cover 5/8 to 7/8. Very breezy, warm and sunny. Wind SSW, F3. Temp. 16ºC. Good visibility.
5	31.05.22	CBH	10.00	13.00	3	Cloud cover 7/8. Calm overcast with intermittent sunshine. Temp 13ºC. Visibility great
5	31.05.22	CBH	13.30	16.30	3	Cloud cover 8/8. Cool, calm with intermittent sunshine. Wind NW F0-1. Temp 13ºC. Visibility good.
June						
1	15.06.22	NL	12.00	15.00	3	Cloud cover 2/8. Bright, dry, northerly wind. Temp 18ºC. Visibility good.
1	15.06.22	NL	15.30	18.30	3	Cloud cover 2/8. Bright, dry, high cloud, northerly wind. Temp 16ºC. Visibility good.
2	15.06.22	DOB	13.30	16.30	3	Cloud cover 7/8. Warm and sunny. F2 westerly dry winds. Temp 19-20oC. Very good visibility.
2	15.06.22	DOB	17.00	20.00	3	Cloud cover 4/8. Sunny and warm. F2 westerly dry winds. Temp 20oC. Very good visibility.
4	16.06.22	DOB	13.00	16.00	3	Cloud cover 7/8. Cloudy, warm, sunny spells, windy. F2-F4 westerly dry winds. Temp 21oC. Very good visibility.
4	16.06.22	DOB	16.30	19.30	3	Cloud cover 8/8. Warm cloudy, sunny spells. South westerly winds went from F4 to F2. Temp went from 20oC to 18oC. Very good visibility.
5	27.06.22	UW	09.30	12.30	3	Cloud cover 7/8 to 8/8. Overcast but bright, cool , breezy and dry. Wind SW F1-2. Temp 14ºC. Visibility moderate.
5	27.06.22	UW	13.00	16.00	3	Cloud cover 7/8 to 8/8. Overcast, breezy and wet. Wind SSW F2-3. Steady rain becoming heavier. Temp 14-13ºC. Visibility moderate-poor.
July						

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
1	11.07.22	NL	08.00	11.00	3	No cloud cover, bright warm day. Wind F2, temp. 17ºC. Visibility good.
1	11.07.22	NL	11.30	14.30	3	No cloud cover, bright warm day. Wind F2, temp. 17ºC. Visibility Very good.
2	26.07.22	DOB	06.45	09.45	3	Cloud cover 8/8. Dull, very calm still morning. No wind. Temp 12-14oC. Good visibility.
2	26.07.22	DOB	10.15	13.15	3	Cloud cover 8/8. Dull, very calm and still. Wind went from F2 to F1, north easterly. Drizzle at the start of survey. Temp 14-16oC. Good visibility.
3	01.07.22	CBH	07.00	10.00	3	Cloud cover 7/8 to 8/8. Overcast, dull, calm. Temp 15ºC. Visibility good.
3	02.07.22	CBH	13.00	16.00	3	Cloud cover 8/8. Overcast, occasional rain. Wind WNW F0-1. 11ºC. Visibility good.
3	29.07.22	CBH	06.00	9.00	3	Cloud cover 6/8 to 8/8. Overcast but dry, bright and warm. Temp17ºC. Visibility great. Cloud cover 7/8. Overcast but dry, bright and hot. Temp 21ºC. Visibility excellent.
3	29.07.22	CBH	09.30	12.30	3	Cloud cover 7/8. Overcast but dry, bright and hot. Temp 21ºC. Visibility excellent.
4	25.07.22	DOB	06.20	09.20	3	Cloud cover 8/8. Dull and breezy. Westerly wind F2-F4. Drizzling to dry. Temp 14-15ºC. Moderate visibility when raining, good visibility when not raining.
4	25.07.22	DOB	9.50	12.50	3	Cloud cover 6/8. Windy and breezy. Brightening up with some sunny spells. North westerly F4-F6 dry winds. Temp 16-17ºC. Good visibility.
5	21.07.22	UW	09.10	12.10	3	Cloud cover 7/8 clearing to 4/8. Calm, dry. Temp 15-16ºC. Visibility good.
5	21.07.22	UW	12.40	15.40	3	Cloud cover 7/8 to 8/8. Calm, dry, overcast but bright. Temp 15-17ºC. Visibility good.
August						
1	09.08.22	NL	14.00	17.00	3	Cloud cover 1/8. Bright sunny day. Wind F1. Temp 22oC. Visibility very good
1	09.08.22	NL	17.30	20.30	3	Cloud cover 1/8. Bright sunny day. Wind F1. Temp 22oC. Visibility very good
2	16.08.22	DOB	13.25	16.25	3	Cloud cover 5/8. Windy, sunny, warm. North east F5-F3 winds. Temp 17oC. Good visibility.
2	16.08.22	DOB	16.55	19.55	3	Cloud cover 5/8. Windy, warm with sunny spells. F5 winds. Temp 17oC. Good visibility.
4	15.08.22	DOB	15.35	18.35	3	Cloud cover 8/8. Warm thunder with continuous heavy showers. Westerly F0-F1 winds. Heavy rain. Temp 18-17oC. Moderate visibility.
4	16.08.22	DOB	10.20	13.20	3	Cloud cover 6/8. Dry and sunny, breezy and windy. North easterly F5-F2 winds. Temp 13-17oC. Good visibility.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
5	18.08.22	UW	09.15	12.15	3	Cloud cover 6/8 -4/8. Cloudy, showers, warm. Wind SW F1-2 Temp 18-19oC. Visibility moderate to poor.
5	18.08.22	UW	14.45	15.45	3	Cloud cover 8/8 -6/8. Breezy, damp, humid, showers. Wind WSW F2-3. Temp 18-19oC. Visibility moderate to poor.
September						
1	22.09.22	JH	09.00	12.00	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.
1	22.09.22	JH	12.30	15.30	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.
2	22.09.22	AC	09.00	12.00	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.
2	22.09.22	AC	12.30	15.30	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.
3	03.09.22	CBH	09.00	12.00	3	Cloud cover 7/8. Overcast, dull, occasional showers. Wind SW F1-2. Temp 11oC. Visibility good.
3	03.09.22	CBH	12.00	13.00	3	Cloud cover 6/8. Overcast, dry, cool breeze. Wind SW F1-2. Temp 11oC. Visibility good.
3	22.09.22	AD	09.00	12.00	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.
3	22.09.22	AD	12.30	15.30	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.
4	22.09.22	SN	09.00	12.00	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.
4	22.09.22	SN	12.30	15.30	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.
5	22.09.22	TR	09.00	12.00	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.
5	22.09.22	TR	12.30	15.30	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.
6	22.09.22	JM	09.00	12.00	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
6	22.09.22	JM	12.30	15.30	3	Cloud cover 8/8. Moderate breeze, heavy rain. South-westerly BF4 winds. Temp 13-18oC. Good visibility.

Table 12. 2020/21 Non-breeding VP survey details

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
October						
1	25.10.20	MOC	11.05	14.05	3	A sunny, breezy day with cloud cover 2/8 to 3/8 and south westerly winds F3-4. Temperature 10°C and very good visibility.
1	25.10.20	MOC	14.30	17.30	3	A sunny, breezy day with light showers and cloud cover 4/8 to 6/8. Winds south westerly to westerly F3, temperature 10°C and very good visibility.
2	31.10.20	MOC	10.20	13.20	3	A windy day with heavy showers and sunny spells. Cloud cover 5/8 to 4/8 with westerly winds F5-6 gusting to F6-7. Temperature 12°C and very good visibility.
2	30.10.20	MOC	14.15	17.15	3	A calm, sunny day with some light breezes and cloud cover 4/8 to 1/8. Winds south to south easterly F 3-1. Temperature 12°C and very good visibility.
3	24.10.20	MOC	12.10	15.10	3	An overcast day 8/8 at start of VP with a light breeze and occasional showers, brightening up to sunny after 14.10 with cloud cover 2/8. Winds south westerly F3-5, temperature 10°C and very good visibility.
3	24.10.20	MOC	15.40	18.40	3	A windy, sunny afternoon with cloud cover 2/8 to 3/8 and south westerly winds F5. Temperature 12°C and very good visibility.
4	30.10.20	MOC	11.05	14.05	3	A sunny day with a light westerly breeze F3 and cloud cover 7/8 to 4/8. Temperature 11°C and very good visibility.
4	31.10.20	MOC	13.30	16.30	3	A strong breeze at the start of the VP with showers brightening to sunny spells after 14.30 with cloud cover 5/8 to 6/8. Winds west to south westerly F4 gusting to F5. Temperature 11°C and very good visibility.
November						
1	28.11.20	JNM	09.30	12.30	3	A calm, still, dull day with breeze F1. Temperature 6-8°C and good visibility.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
1	26.11.20	LOD	13.30	16.30	3	A dry, bright day with a northerly breeze F1. Temperature 7°C and good visibility.
2	26.11.20	LOD	09.30	12.30	3	A dry, overcast morning, brighter after 11.00 with a north easterly breeze F1. Temperature 5°C and good visibility.
2	28.11.20	JNM	13.30	16.30	3	A calm, still, dull day with westerly breeze F1. Temperature 6-8°C with good visibility.
3	24.11.20	LOD	09.30	12.30	3	An overcast morning with drizzle on and off and south/south westerly winds F5 swinging to north/north easterly at 12.00. Temperature 10°C and visibility good to fair.
3	24.11.20	JNM	13.00	16.00	3	A wet day with a lot of showers and a south westerly wind F5-7. Temperature 12-6°C and visibility ok.
4	24.11.20	JNM	09.30	12.30	3	A stormy, wet morning with lots of showers and south westerly winds F5-7. Temperature 11-12°C and visibility ok.
4	24.11.20	LOD	13.00	15.00	2	A continuously rainy afternoon, heavy at times and a north/north easterly wind F5. Temperature 7°C and visibility good to fair.
December						
1	16.12.20	JNM	10.00	13.00	3	A dull, overcast day with some light showers and south westerly winds F3-5. Temperature 6-8°C and good visibility.
1	18.12.20	JNM	10.00	13.00	3	A wet, damp morning clearing to a sunny day after 11.00 with south/south westerly winds F3-4. Temperature 10 - 11°C and visibility ok.
2	15.12.20	JNM	09.00	12.00	3	A cool day with glorious sunshine and slack westerly winds. Temperature 6°C and good visibility.
2	16.12.20	JNM	13.30	16.30	3	A dull, overcast day with some light showers and south westerly winds F3-5. Temperature 6-8°C and good visibility.
3	15.12.20	JNM	12.30	15.30	3	A cool day with glorious sunshine and slack westerlies picking up in the afternoon to F3-4. Temperature 6°C with good visibility.
3	22.12.20	JNM	13.15	16.15	3	Heavy rain in the afternoon with south westerly winds F1-6. Temperature 1-6°C and good visibility.
4	22.12.20	JNM	10.00	13.00	3	A dry, cold, frosty morning with a west/south westerly wind F1-5/6. Temperature from 1° to 3° to 6°C and good visibility.
4	18.12.20	JNM	13.30	16.30	3	A wet start to the day clearing to give a nice sunny afternoon with south/south westerly winds F4-5. Temperature 10-11°C and visibility ok.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
January						
1	27.01.21	JNM	09.30	12.30	3	A dull, dry morning with some showers in the afternoon and south/south easterly winds F1-4. Temperature 10 to 11°C and visibility ok.
1	27.01.21	LOD	13.00	16.00	3	Heavy rain on and off with an easterly wind F2. Temperature 11°C and fair visibility.
2	26.01.21	JNM	09.00	12.00	3	A damp, dull, misty morning with slack to no winds. Temperature 8°C and poor visibility.
2	25.01.21	JNM	13.30	16.30	3	A cold, dry, sunny day with slack winds. Temperature -3 to +4°C with good visibility.
3	25.01.21	JNM	10.00	13.00	3	A very frosty cold morning with bright sunshine, clear skies and slack winds. Temperature -3 to +3°C and good visibility.
3	26.01.21	JNM	13.00	16.00	3	A damp, dull, misty day with no winds. Temperature 8°C and poor visibility.
4	27.01.21	LOD	09.30	12.30	3	Intermittent showers with southerly winds F3. Temperature 9°C and visibility fair.
4	27.01.21	JNM	13.00	16.00	3	A dull, overcast day with light showers in the afternoon and south/south easterly winds F1-4. Temperature 10 to 11°C and visibility ok.
February						
1	26.02.21	JNM	10.00	13.00	3	A dry morning with some bright sunny periods and south westerly winds F4-6. Temperature 10°C with good visibility.
1	25.02.21	JNM	12.30	15.30	3	A fine, dry, sunny day with south westerly winds F1-3. Temperature 4-6°C and good visibility.
2	25.02.21	JNM	09.00	12.00	3	A fine, dry, sunny morning with southwest to westerly winds F1-3. Temperature 4-6°C and good visibility.
2	26.02.21	JNM	13.30	16.30	3	A generally dry day with bright sunny periods and southwest to southerly winds F4-6. Temperature 10°C and good visibility.
3	16.02.21	LOD	09.30	12.30	3	A bright day with occasional heavy showers and easterly winds F3. Temperature 9°C with good visibility.
3	16.02.21	LOD	13.00	16.00	3	A bright day with occasional heavy showers and south/south easterly winds F4. Temperature 3°C with good visibility.
4	25.02.21	LOD	10.00	13.00	3	A bright day with heavy showers and south westerly winds F2-4. Temperature 8°C and good to fair visibility.
4	25.02.21	LOD	13.45	16.45	3	A bright day with showers and south westerly winds F4. Temperature 10°C and good visibility.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
March						
1	23.03.21	CBM & DOB	12.00	15.00	3	A mostly dry day with cloud cover 7/8 and slight south easterly winds F1-2. A few raindrops from 14.50 onwards with cloud cover 8/8. Temperature 11-12°C and very good visibility.
1	24.03.21	JNM	14.15	17.15	3	A dry morning and wet in the afternoon with south westerly winds F2-5. Temperature 7-11°C and good to ok visibility.
2	24.03.21	JNM	11.15	14.15	3	A dry day with some sunny periods and south westerly winds F2-5. Temperature 7-11°C and good visibility.
2	23.03.21	FMcK	12.00	15.00	3	A mainly dry, dull day with some showers at 14.30 and south westerly winds F3-4. Temperature 8-12°C and visibility ok.
3	24.03.21	JNM	08.00	11.00	3	A dry morning with some sunny periods and south westerly winds F2-5. Temperature 7-11°C and visibility ok.
3	29.03.21	JNM	13.00	16.00	3	A dry afternoon with prolonged spells of warm sunshine and south/south westerly winds F3/4-6. Temperature 11-15°C with good visibility.
4	29.03.21	JNM	09.30	12.30	3	A dull morning with some dry, bright periods and south/south westerly winds F3/4-6. Temperature 11-15°C and good visibility.
4	23.03.21	MK	12.00	15.00	3	A cloudy day 7/8 with south/south westerly winds F3-4. Temperature 11°c and visibility excellent.

Table 13. 2021/22 Non-breeding VP survey details

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
October						
1	01.10.21	DF	08.00	11.00	3	Cloud cover 50%, dry with westerly winds, wind F3-6, temp 9oC, and visibility good.
1	01.10.21	DF	11.30	14.30	3	Cloud 80% with heavy showers at times, wind direction west, wind F3-6, temp 10oC, and visibility good to fair.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
2	04.10.21	DF	08.30	11.30	3	Cloud cover 90% - 100%, light showers at times, wind direction south, wind F2-3, temp 7oC, and visibility good.
2	04.10.21	DF	12.00	15.00	3	Cloud cover 100% with light showers, wind direction south, wind F2-3, temp 7oC, and visibility good.
3	05.10.21	DF	08.30	11.30	3	Cloud cover 60% with some showers, wind direction northwest, wind F3-6, temp 9oC, and visibility good.
3	05.10.21	DF	12.00	15.00	3	Cloud cover 60%, dry with northwest winds, wind F3-6, temp 7oC, and visibility good.
4	06.10.21	DF	08.30	11.30	3	Cloud over 100% with rain, wind direction south, wind F3-5, temp 12oC, and visibility fair.
4	06.10.21	DF	12.00	15.00	3	Cloud cover 100%, dry with southerly winds, wind F3-5, temp 12oC, and visibility good.
November						
1	01.11.21	DF	09.00	12.00	3	Cloud cover 60%, dry with northwest winds, wind F3-5, temp 8oC, and visibility good.
1	01.11.21	DF	12.30	15.30	3	Cloud cover 70%, dry with northwest winds, wind F3-5, temp 8oC, and visibility good.
2	02.11.21	DF	09.00	12.00	3	Cloud cover 10%, dry with northwest winds, wind F1-3, temp 6oC, and visibility good.
2	02.11.21	DF	12.30	15.30	3	Cloud cover 80%, dry with northwest winds, wind F1-3, temp 9oC, and visibility good.
3	03.11.21	DF	08.30	11.30	3	Cloud cover 80%, dry with northwest winds, wind F3-5, temp 8oC, and visibility good.
3	03.11.21	DF	12.00	15.00	3	Cloud cover 100%, dry with northwest winds, wind F3-5, temp 8oC, and visibility good.
4	08.11.21	DF	08.30	11.30	3	Cloud cover 70%, dry with a southerly breeze, wind F3-4, temp 13oC, and visibility good.
4	08.11.21	DF	12.00	15.00	3	Cloud cover 30%, dry with a southerly breeze, wind F3-4, temp 13oC, and visibility good.
December						
1	01.12.21	DF	08.30	11.30	3	Cloud cover 70%, dry with northwest winds, wind F5-8, temp 6oC, and visibility good.
1	01.12.21	DF	12.00	15.00	3	Cloud cover 80% with rain at times, wind direction northwest, wind F5-8, temp 8oC, and visibility good.
2	02.12.21	DF	08.30	11.30	3	Cloud cover 60%, dry with north-northwest winds, wind F2, temp 3oC, and visibility good.
2	02.12.21	DF	12.00	15.00	3	Cloud cover 60%, dry with north-northwest winds, wind F2, temp 6oC, and visibility good.
3	22.12.21	LOD	09.35	12.35	3	Cloud cover 8/8 with persistent drizzle, wind direction southeast, wind F5, temp 11oC, and visibility fair to poor.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
3	22.12.21	LOD	12.50	15.50	3	Cloud cover 8/8 with persistent drizzle, wind direction southeast, wind F5, temp 11oC, and visibility fair to poor.
4	06.12.21	DF	08.30	11.30	3	Cloud cover 60%, dry with west-northwest winds, wind F3-6, temp 4oC, and visibility good.
4	06.12.21	DF	12.00	15.00	3	Cloud cover 100% with heavy thundery showers, wind direction wet-northwest, wind F3-6, temp 6oC, and visibility poor.
January						
1	04.01.22	DF	08.30	11.30	3	Cloud cover 20%, dry with northwest winds, wind F3-5, temp 2oC, and visibility good.
1	04.01.22	DF	12.00	15.00	3	Cloud cover 40%, dry with northwest winds, wind F3-5, temp 6oC, and visibility good.
2	05.01.22	DF	08.30	11.30	3	Cloud cover 30%, dry with northwest winds, wind F2, temp 4oC, and visibility good.
2	05.01.22	DF	12.00	15.00	3	Cloud cover 50%, dry with northwest winds, wind F2, temp 5oC, and visibility good.
3	06.01.22	DF	08.30	11.30	3	Cloud cover 100% with showers at times, wind direction west, wind F4-7, temp 2oC, and visibility good.
3	06.01.22	DF	12.00	15.00	3	Cloud cover 100% with showers, wind direction west, wind F4-7, temp 6oC, and visibility good.
4	07.01.22	DF	08.30	11.30	3	Cloud cover 100% with heavy rain, wind direction west, wind F4-8, temp 5oC, and visibility poor.
4	07.01.22	DF	12.00	15.00	3	Cloud cover 100% with heavy rain, wind direction west, wind F4-8, temp 5oC, and visibility poor.
February						
1	21.02.22	DF	08.30	11.30	3	Cloud cover 60%, dry with northwest winds, wind F5-7, temp 7oC, and visibility good.
1	21.02.22	DF	12.00	15.00	3	Cloud cover 60%, dry with northwest winds, wind F5-7, temp 7oC, and visibility good.
2	08.02.22	DF	08.30	11.30	3	Cloud cover 100%, dry with south-southwest winds, wind F3-6, temp 11oC, and visibility good.
2	08.02.22	DF	12.30	15.30	3	Cloud cover 100%, dry with south-southwest winds, wind F3-6, temp 11oC, and visibility good.
3	07.02.22	DF	09.00	12.00	3	Cloud cover 60%, dry with west-southwest winds, wind F3-6, temp 10oC, and visibility good.

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
3	07.02.22	DF	13.00	16.00	3	Cloud cover 60%, dry with west-southwest winds, wind F3-6, temp 10oC, and visibility good.
4	22.02.22	DF	08.15	11.15	3	Cloud cover 50%, dry with west-northwest winds, wind F4-6, temp 6oC, and visibility good.
4	22.02.22	DF	11.45	14.45	3	Cloud cover 50%, dry with west-northwest winds, wind F4-6, temp 6oC, and visibility good.
March						
1	07.03.22	DF	08.30	11.30	3	Cloud cover 100%, dry with southeast winds, wind F4-6, temp 7oC, and visibility good.
1	07.03.22	DF	12.00	15.00	3	Cloud cover 100%, dry with southeast winds, wind F4-6, temp 7oC, and visibility good.
2	04.03.22	DF	08.30	11.30	3	Cloud cover 50%, dry with northwest winds, wind F2-3, temp 4oC, and visibility good.
2	04.03.22	DF	12.00	15.00	3	Cloud cover 50%, dry with northwest winds, wind F2-3, temp 10oC, and visibility good.
3	03.03.22	DF	09.00	12.00	3	Cloud cover 5%, dry and sunny, wind direction west-northwest, wind F1-2, temp 6oC, and visibility good.
3	07.03.22	DF	09.00	12.00	3	Cloud cover 60%, dry with west-southwest winds, wind F3-6, temp 10oC, and visibility good.
4	03.03.22	DF	12.30	15.30	3	Cloud cover 20%, dry and sunny with west-northwest, winds, wind F1-2, temp 6oC, and visibility good.
4	08.03.22	DF	08.30	11.30	3	Cloud cover 100% with rain at times, wind direction south, wind F6-9, temp 7oC, and visibility good.

Table 14. 2022/23 Non-breeding VP survey details

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
October						
1	14.10.22	JNM	09.00	12.00	3	Cloud cover 90%, dry, south-west winds F1, temp 14oC and visibility good
1	14.10.22	JNM	12.30	15.30	3	Cloud cover 90%, dry, south-west winds F3, temp 14oC and visibility good
2	14.10.22	JH	09.00	12.00	3	Cloud cover 75%, dry, south-west winds F1, temp 14oC and visibility good

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
2	14.10.22	JH	12.30	15.30	3	Cloud cover 75%, dry, south-west winds F1, temp 14oC and visibility good
3	14.10.22	AC	09.00	12.00	3	Cloud cover 90%, dry, west winds F2, temp 13oC and visibility good
3	14.10.22	AC	12.30	15.30	3	Cloud cover 90%, dry, west winds F3, temp 13oC and visibility good
4	14.10.22	AD	09.00	12.00	3	Cloud cover 75%, dry, south-west winds F3, temp 14oC and visibility good
4	14.10.22	AD	12.30	15.30	3	Cloud cover 75%, dry, south-west winds F3, temp 14oC and visibility good
5	15.10.22	SN	09.00	12.00	3	Cloud cover 75%, dry, south-west winds F2, temp 12oC and visibility good
5	15.10.22	SN	12.30	15.30	3	Cloud cover 75%, dry, south-west winds F3, temp 12oC and visibility good
6	15.10.22	TR	09.00	12.00	3	Cloud cover 60%, dry, west winds F2, temp 12oC and visibility good
6	15.10.22	TR	12.30	15.30	3	Cloud cover 60%, dry, west winds F2, temp 12oC and visibility good
November						
1	08.11.22	TR	09.00	12.00	3	Cloud cover 40%, dry, south winds F3, temp 12oC and visibility good
1	08.11.22	TR	12.30	15.30	3	Cloud cover 40%, dry, south winds F3, temp 12oC and visibility good
2	08.11.22	JNM	09.00	12.00	3	Cloud cover 100%, light showers, south-west winds F2, temp 9oC and visibility good
2	08.11.22	JNM	12.30	15.30	3	Cloud cover 100%, dry, south-west winds F4, temp 11oC and visibility good
3	08.11.22	JH	09.00	12.00	3	Cloud cover 75%, light showers, south-west winds F4, temp 11oC and visibility good
3	08.11.22	JH	12.30	15.30	3	Cloud cover 75%, dry, south-west winds F4, temp 11oC and visibility good
4	08.11.22	AC	09.00	12.00	3	Cloud cover 100%, light showers, south-west winds F4, temp 9oC and visibility good
4	08.11.22	AC	12.30	15.30	3	Cloud cover 100%, dry, south-west winds F4, temp 9oC and visibility good
5	08.11.22	AD	09.00	12.00	3	Cloud cover 75%, heavy showers, south winds F3, temp 10oC and visibility good
5	08.11.22	AD	12.30	15.30	3	Cloud cover 75%, dry, south winds F3, temp 10oC and visibility good
6	08.11.22	SN	09.10	12.10	3	Cloud cover 60%, light showers, south-west winds F4, temp 9oC and visibility good
6	08.11.22	SN	12.40	15.40	3	Cloud cover 60%, dry, south-west winds F5, temp 9oC and visibility good
December						
1	08.12.22	SN	07.40	10.40	3	Cloud cover 60%, dry, north-west winds F1, temp -1oC and visibility good

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
1	08.12.22	SN	11.10	14.10	3	Cloud cover 60%, dry, north-west winds F2, temp -1oC and visibility good
2	08.12.22	TR	07.30	10.30	3	Cloud cover 25%, dry, north winds F2, temp 0oC and visibility good
2	08.12.22	TR	11.00	14.00	3	Cloud cover 100%, light drizzle, north winds F2, temp 3oC and visibility good
3	08.12.22	AD	07.44	10.44	3	Cloud cover 50%, dry, north-west winds F1, temp 1oC and visibility good
3	08.12.22	AD	11.14	14.14	3	Cloud cover 50%, light drizzle, north-west winds F1, temp 4oC and visibility good
4	08.12.22	JH	07.30	10.30	3	Cloud cover 100%, dry, north winds F2, temp -1oC and visibility good
4	08.12.22	JH	11.00	14.00	3	Cloud cover 100%, light drizzle, north winds F3, temp 3oC and visibility good
5	08.12.22	AC	07.30	10.30	3	Cloud cover 100%, dry, north-west winds F2, temp -1oC and visibility good
5	08.12.22	AC	11.00	14.00	3	Cloud cover 100%, light drizzle, north-west winds F3, temp 3oC and visibility good
6	15.12.22	AD	07.24	10.24	3	Cloud cover 25%, dry, north-west winds F1, temp -2oC and visibility good
6	15.12.22	AD	10.54	13.54	3	Cloud cover 25%, dry, north-west winds F3, temp 0oC and visibility good
January						
1	18.01.23	AD	10.57	13.57	3	Cloud cover 40%, dry, north-west winds F1, temp 2oC and visibility good
1	18.01.23	AD	14.27	17.27	3	Cloud cover 40%, dry, north-west winds F3, temp 2oC and visibility good
2	18.01.23	SN	11.00	14.00	3	Cloud cover 50%, dry, north-west winds F4, temp 4oC and visibility good
2	18.01.23	SN	14.30	17.30	3	Cloud cover 50%, dry, north-west winds F4, temp 4oC and visibility good
3	18.01.23	TR	11.00	14.00	3	Cloud cover 40%, dry, west winds F3, temp 2oC and visibility good
3	18.01.23	TR	14.30	17.30	3	Cloud cover 40%, dry, west winds F3, temp 2oC and visibility good
4	18.01.23	LOD	11.00	14.00	3	Cloud cover 25%, light showers, north-west winds F4, temp 2oC and visibility good
4	18.01.23	LOD	14.30	17.30	3	Cloud cover 25%, light showers, north-west winds F4, temp 2oC and visibility good
5	18.01.23	JH	11.00	14.00	3	Cloud cover 50%, dry, north-west winds F3, temp 3oC and visibility good
5	18.01.23	JH	14.30	17.30	3	Cloud cover 50%, light showers, north-west winds F3, temp 1oC and visibility good
6	18.01.23	AC	11.00	14.00	3	Cloud cover 10%, dry, north-west winds F3, temp 2oC and visibility good
6	18.01.23	AC	14.30	17.30	3	Cloud cover 10%, light showers, north-west winds F5, temp 1oC and visibility good

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
February						
1	14.02.23	AD	07.40	10.40	3	Cloud cover 75%, light showers, south winds F3, temp 10oC and visibility good
1	14.02.23	AD	11.10	14.10	3	Cloud cover 75%, dry, south winds F5, temp 10oC and visibility good
2	14.02.23	SN	07.30	10.30	3	90% cloud cover, light showers, south winds F4, temp 10oC and visibility good
2	14.02.23	SN	11.00	14.00	3	90% cloud cover, dry, south winds F5, temp 10oC and visibility good
3	14.02.23	TR	07.30	10.30	3	90% cloud cover, light drizzle, south winds F4, temp 11oC and visibility moderate
3	14.02.23	TR	11.00	14.00	3	90% cloud cover, heavy showers, south winds F4, temp 12oC and visibility good
4	14.02.23	LOD	07.30	10.30	3	50% cloud cover, dry, south winds F5, temp 10oC and visibility moderate
4	14.02.23	LOD	11.00	14.00	3	50% cloud cover, dry, south winds F5, temp 10oC and visibility moderate
5	14.02.23	JH	07.30	10.30	3	100% cloud cover, light drizzle, south winds F4, temp 11oC and visibility moderate
5	14.02.23	JH	11.00	14.00	3	60% cloud cover, light showers, south winds F4, temp 11oC and visibility good
6	14.02.23	AC	07.30	10.30	3	100% cloud cover, light showers, south winds F4, temp 10oC and visibility good-moderate
6	14.02.23	AC	11.00	14.00	3	75% cloud cover, light showers, south winds F7, temp 11oC and visibility good-moderate
March						
1	14.03.23	AC	12.00	15.00	3	75% cloud cover, light showers, north-west winds F3, temp 7oC and visibility good
1	14.03.23	AC	15.30	18.30	3	75% cloud cover, light showers, north-west winds F6, temp 5oC and visibility good
2	14.03.23	AD	12.04	15.04	3	60% cloud cover, light showers, west winds F2, temp 8oC and visibility good
2	14.03.23	AD	15.34	18.34	3	60% cloud cover, light showers, west winds F3, temp 8oC and visibility good
3	14.03.23	SN	12.00	15.00	3	60% cloud cover, light showers, west winds F4, temp 7oC and visibility good
3	14.03.23	SN	15.30	18.30	3	60% cloud cover, light showers, west winds F4, temp 7oC and visibility good
4	14.03.23	TR	12.00	15.00	3	60% cloud cover, light showers, north-west winds F3, temp 6oC and visibility good
4	14.03.23	TR	15.30	18.30	3	60% cloud cover, dry, north-west winds F4, temp 7oC and visibility good
5	14.03.23	PC	12.00	15.00	3	60% cloud cover, heavy showers, north-west winds F4, temp 6oC and visibility good
5	14.03.23	PC	15.30	18.30	3	60% cloud cover, heavy showers, north-west winds F6, temp 6oC and visibility good

VP	Date	Observer	Start time	Finish time	Length of VP watch (hours)	Weather
6	14.03.23	JH	12.00	15.00	3	75% cloud cover, light showers, north-west winds F4, temp 7oC and visibility good
6	14.03.23	JH	15.30	18.30	3	75% cloud cover, light showers, north-west winds F4, temp 5oC and visibility good

Transect surveys

Table 15. 2021 Transect survey details

Transect	Date	Observer	Start time	Finish time	Weather	Visibility
A / B	22.06.21	DOB	08.20	09.30	Cloud cover 8/8, wind direction west, wind F1-2, temp 9oC.	Excellent
A / B	27.09.21	DOB	12.20	13.35	Cloud cover 8/8 but clearing to 6/8 with sunny spells and heavy rain towards the end of the transect watch, wind direction southwest, wind F3-4, temp 14oC.	Good
A / B	27.09.21	DOB	13.57	15.13	Cloud cover 5/8, bright, sunny and dry with southwest winds, wind F3-5, temp 14oC.	Good
A / B	13.10.21	DOB	14.40	15.45	Cloud cover 8/8, dull, dry and cool with southwest winds, wind F2-4, temp 13oC.	Good
A / B	13.10.21	DOB	15.50	16.45	Cloud cover 8/8, dull, dry and cool with southwest winds, wind F2-3, temp 13oC.	Good

Table 16. 2022 Transect survey details

Transect	Date	Observer	Start time	Finish time	Weather	Visibility
A	26.04.22	DOB	10.15	11.00	Cloud cover 8/8. Bright and warm. Dry f2 winds in south easterly direction. Temp 10oC.	Good
B	26.04.22	DOB	11.00	11.45	Cloud cover 8/8. Bright and warm. Dry f2 winds in south easterly direction. Temp 10oC.	Good
B	01.07.22	CBH	10.00	10.45	Cloud cover 7/8 to 8/8. Overcast, dull, calm. Temp 15^{o}C.	Good
A	26.07.22	DOB	13.20	14.00	Cloud cover 8/8. Wind NE F2 Temp 16oC.	Good
B	26.07.22	DOB	14.10	15.00	Cloud cover 8/8. Wind NE F2 Temp 16oC.	Good
B	29.07.22	CBH	14.40	15.15	Cloud cover 7/8. Overcast but dry, bright and hot. Temp 21^{o}C.	Excellent
B	17.08.22	CBH	12.00	12.30	Cloud cover 6/8. Overcast, dry, cool breeze. Wind SW F1-2. Temp 11oC.	Good
A	03.09.22	DOB	09.40	10.20	Cloud cover 3/8. Sunny, warm dry. Wind F2-3. Temp 15oC	Good
A	03.11.22	JNM	13:30	14:10	Cloud cover 5/8, dry, wind SW F3, temp 11oC	Good
B	03.11.22	JNM	15:35	16:25	Cloud cover 8/8, dry, wind SW F4, temp 11oC	Good

Transect	Date	Observer	Start time	Finish time	Weather	Visibility
C	03.11.22	JNM	14:30	14:40	Cloud cover 5/8, dry, wind SW F3, temp 11oC	Good
D	03.11.22	JNM	14:40	15:20	Cloud cover 7/8, dry, wind SW F3, temp 11oC	Good

Table 17. 2023 Transect survey details

Transect	Date	Observer	Start time	Finish time	Weather	Visibility
A	23.01.23	JNM	12:00	12:50	Cloud cover 8/8, light drizzle, wind S F2, temp 10oC	Moderate
B	23.01.23	JNM	14:35	15:25	Cloud cover 8/8, light drizzle, wind S F2, temp 10oC	Moderate
C	23.01.23	JNM	13:00	13:40	Cloud cover 8/8, light drizzle, wind S F2, temp 10oC	Moderate
D	23.01.23	JNM	13:45	14:30	Cloud cover 8/8, light drizzle, wind S F2, temp 10oC	Moderate
A	22.03.23	JNM	09:30	10:15	Cloud cover 4/8, dry, wind SW F5, temp 9oC	Good
B	22.03.23	JNM	10:15	11:00	Cloud cover 4/8, dry, wind SW F5, temp 9oC	Good
C	22.03.23	JNM	11:00	11:45	Cloud cover 4/8, dry, wind SW F5, temp 11oC	Good
D	22.03.23	JNM	11:45	12:30	Cloud cover 4/8, dry, wind SW F5, temp 11oC	Good

ANNEX C – SURVEY RESULTS

All target species observations recorded during the VP surveys undertaken between 2020 and 2023 are outlined in Table 19 – Table 34 below. All flight activity is shown in *Figures 2-5 in Volume IV of the EIAR*. The vantage point peak count results and transect survey results are shown in Table 36 to Table 38.

Table 18. Annex C Table of Contents

Target Species Observations

Table 19. Black headed gull observations

Black headed gull														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2020/21														
16.02.21	3	Unknown	Unknown	Improved grassland	10	09:30	Feeding	0	10800	-	-	-	-	-
16.02.21	3	Unknown	Unknown	Improved grassland	16	13:43	Circling/ flying	180	-	-	-	-	240	-
Breeding 2022														
27.06.22	5	Unknown	Unknown	Improved grassland	3	10:27	Circling, soaring, flying	70-80	-	-	-	57	-	-
18.08.22	5	Unknown	Unknown	Improved grassland	1	10:14	Flying	15	-	18	-	-	-	-
Non-breeding 2022/23														
15.12.22	6	Unknown	Unknown	Improved grassland	16	09:37	Flying	0-50	-	10	10	-	-	-
15.12.22	6	Unknown	Unknown	Improved grassland	5	09:52	Flying	20-50	-	-	35	-	-	-
15.12.22	6	Unknown	Immature	Improved grassland	1	12:09	Flying	0-20	-	-	52	-	-	-
15.12.22	6	Unknown	Immature	Improved grassland	1	12:39	Flying	20-50	-	20	-	-	-	-

Table 20. Buzzard observations

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2020/21														
25.10.20	1	Unknown	Juvenile	Improved grassland/ Thicket/ Pole stage forest	2 2	11:41 11:58	Flying Flying	15-30 20-35	- -	12 -	22 35	- -	- -	- -
25.10.20	1	Unknown	Juvenile	Improved grassland	3 2	14:36 15:08	Flying Flying	30-50 90-140	- -	- -	110 -	- 20	- 25	- -
25.10.20	1	Unknown	Unknown	Improved grassland	2 1	16:06 16:45	Flying Flying/ circling	20-30 150-200	- -	15 -	22 -	- -	- 190	- -
31.10.20	2	Unknown	Unknown	Improved grassland	3	11:03	Flying/ circling/ soaring	60-90	-	-	-	175	-	-
24.11.20	4	Unknown	Unknown	Improved grassland	1	-	Flying	20+	-	-	240	-	-	-
26.11.20	1	Unknown	Unknown	Improved grassland	1	16:05	Flying	0-20	-	20	-	-	-	-
18.12.20	1	Unknown	Unknown	Improved grassland	1	12:12	Flying/ hunting	4-8	-	60	-	-	-	-
27.01.21	4	Unknown	Adult	Improved grassland	1	09:30	Perched/ flying	0-18	9240	60	-	-	-	-
27.01.21	4	Unknown	Unknown	Improved grassland	1	14:04	Flying	50	-	-	60	-	-	-
16.02.21	3	Unknown	Unknown	Improved grassland	4	13:44	Circling/ flying	200	-	-	-	-	-	200

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
25.02.21	2	Unknown	Unknown	Improved grassland/ Rough grassland	2	11:03	Soaring/ circling/ displaying	150	-	-	-	-	120	-
25.02.21	4	Unknown	Adult	Improved grassland	2	10:54	Flying/ circling	80-120	-	-	-	360	360	-
25.02.21	4	Unknown	Adult	Improved grassland	3	12:22	Flying/ circling/ mobbing	80	-	-	-	300	-	-
26.02.21	1	Unknown	Unknown	Improved grassland/ Rough grassland	2	11:57	Flying/ soaring/ circling/ displaying	40 to 20	-	-	300	-	-	-
23.03.21	4	Unknown	Unknown	Improved grassland	2	13:12	Circling/ flying	40	-	-	35	-	-	-
24.03.21	3	Unknown	Unknown	Improved grassland	1	10:13	Soaring/ circling	100	-	-	-	30	-	-
29.03.21	4	Unknown	Unknown	Improved grassland/ Rough grassland	2	10:07-11:00	Soaring/ flying/ circling	60-100	-	-	3600	-	-	-
Breeding 2021														
12.04.21	4	Unknown	Unknown	Improved grassland	2	13:13	Soaring, circling, flying	100-200	-	-	-	-	20	20
12.04.21	1	Unknown	Unknown	Improved grassland	1	13:33	Flying	30 40	- -	- -	7 4	- -	- -	- -

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
12.04.21	4	Unknown	Unknown	Improved grassland	1	13:34	Flying, soaring, circling	30-200	-	-	15	60	60	30
12.04.21	4	Unknown	Unknown	Improved grassland	1	13:52	Flying	70	-	-	-	20	-	-
12.04.21	4	Unknown	Unknown	Improved grassland	1	14:36	Flying, circling, hovering	100-130	-	1	1	1	180	-
12.04.21	4	Unknown	Unknown	Improved grassland	3	15:10	Soaring, circling	70-150	-	-	-	30	300	240
12.04.21	4	Unknown	Unknown	Improved grassland	1	18:37	Flying, circling, perched	30-60	-	-	-	295	-	-
12.04.21	1	Unknown	Unknown	Improved grassland	1	18:43	Flying	15	-	10	-	-	-	-
12.04.21	4	Unknown	Unknown	Improved grassland	2	13:13	Soaring, circling, flying	100-200	-	-	-	-	20	20
12.04.21	1	Unknown	Unknown	Improved grassland	1	13:33	Flying	30 40	- -	- -	7 4	- -	- -	- -
12.04.21	4	Unknown	Unknown	Improved grassland	1	13:34	Flying, soaring, circling	30-200	-	-	15	60	60	30
12.04.21	4	Unknown	Unknown	Improved grassland	1	13:52	Flying	70	-	-	-	20	-	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
12.04.21	4	Unknown	Unknown	Improved grassland	1	14:36	Flying, circling, hovering	100-130	-	1	1	1	180	-
12.04.21	4	Unknown	Unknown	Improved grassland	3	15:10	Soaring, circling	70-150	-	-	-	30	300	240
12.04.21	4	Unknown	Unknown	Improved grassland	1	18:37	Flying, circling, perched	30-60	-	-	-	295	-	-
12.04.21	1	Unknown	Unknown	Improved grassland	1	18:43	Flying	15	-	10	-	-	-	-
13.04.21	3	Unknown	Unknown	Improved grassland	3	12:56	Circling, soaring	>180	-	-	-	-	-	180
13.04.21	3	Unknown	Unknown	Improved grassland	1	13:36	Circling	150	-	-	-	-	136	-
13.04.21	2	Unknown	Unknown	Improved grassland	2	13:52	Circling	60	-	-	-	30	-	-
13.04.21	3	Unknown	Unknown	Improved grassland	1	14:06	Circling	160	-	-	-	-	80	-
13.04.21	2	Unknown	Unknown	Improved grassland	1	16:22	Circling, flying	20	-	56	-	-	-	-
13.04.21	3	Unknown	Unknown	Improved grassland	1	18:31	Circling	40	-	-	8	-	-	-
13.04.21	3	Unknown	Unknown	Improved grassland	3	12:56	Circling, soaring	>180	-	-	-	-	-	180
13.04.21	3	Unknown	Unknown	Improved grassland	1	13:36	Circling	150	-	-	-	-	136	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
13.04.21	2	Unknown	Unknown	Improved grassland	2	13:52	Circling	60	-	-	-	30	-	-
13.04.21	3	Unknown	Unknown	Improved grassland	1	14:06	Circling	160	-	-	-	-	80	-
13.04.21	2	Unknown	Unknown	Improved grassland	1	16:22	Circling, flying	20	-	56	-	-	-	-
13.05.21	4	Unknown	Unknown	Improved grassland	1	12:45	Circling	25 40	- -	- -	20 15	- -	- -	- -
13.05.21	4	Unknown	Unknown	Improved grassland	1	13:01	Flying, circling	30 40	- -	- -	4 13	- -	- -	- -
13.05.21	4	Unknown	Unknown	Improved grassland	2	13:13	Flying, circling	30-40	-	-	420	-	-	-
13.05.21	1	Unknown	Unknown	Improved grassland	2	13:22	Circling, flying	30	-	-	15	-	-	-
13.05.21	1	Unknown	Unknown	Improved grassland	1	13:49	Flying	20	-	4	-	-	-	-
13.05.21	1	Unknown	Unknown	Improved grassland	1	13:54	Flying, perched	10	-	2,160	-	-	-	-
15.06.21	4	Unknown	Unknown	Improved grassland, woodland	1	09:45	Flying, soaring, circling	50 100-150	- -	- -	- -	5 -	- 93	- -

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
15.06.21	1	Unknown	Unknown	Improved grassland, woodland	1	11:53	Circling	25 100-120	- -	- -	5 -	- -	- 38	- -
15.06.21	1	Unknown	Unknown	Improved grassland, woodland	1	13:26	Flying	15-20	-	26	-	-	-	-
15.06.21	1	Unknown	Unknown	Improved grassland	1	13:47	Flying	50-100	-	-	-	15	-	-
15.06.21	1	Unknown	Unknown	Improved grassland, mature hedgerow	1	13:56	Hunting	4-5	-	15	-	-	-	-
15.06.21	1	Unknown	Unknown	Improved grassland, hedgerow	1	14:04	Hunting	2	-	2	-	-	-	-
15.06.21	1	Unknown	Unknown	Improved grassland	1	14:06	Hunting, perched	2-10	30	1800	-	-	-	-
22.06.21	3	Unknown	Unknown	Crop fields, hedgerows	2	11:12	Flying, circling	25-40	-	-	45	-	-	-
22.06.21	3	Unknown	Unknown	Improved grassland	1	11:49	Circling	40	-	-	5	-	-	-
22.06.21	2	Unknown	Unknown	Improved grassland, woodland	1	12:05	Flying, perched, mobbing	0-100	15	5	-	10	-	-
22.06.21	3	Unknown	Unknown	Improved grassland, hedgerow	1	12:09	Calling, circling	150	-	-	-	-	468	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
22.06.21	2	Unknown	Unknown	Improved grassland	1	12:10	Flying	140-180	-	-	-	-	32	-
22.06.21	2	Unknown	Unknown	Improved grassland, hedgerow	1	14:30	Flying, circling	50	-	-	76	-	-	-
22.06.21	3	Unknown	Unknown	Improved grassland	1	13:34	Flying	100-110	-	-	-	-	10	-
07.07.21	4	Unknown	Unknown	Improved grassland	1	09:37	Soaring	30	-	-	15	-	-	-
07.07.21	4	Unknown	Unknown	Improved grassland	1	09:58	Flying, mobbed	30-50	-	35	130	-	-	-
07.07.21	1	Unknown	Unknown	Improved grassland, mature hedgerow	2	12:03	Soaring, flying, circling	30-80	-	-	5	115	-	-
07.07.21	1	Unknown	Unknown	Improved grassland, mature hedgerow	1	13:02	Hunting, flying, perched	5 50-100	- -	- -	20 -	5 -	- 189	- -
07.07.21	1	Unknown	Unknown	Improved grassland	1	14:02	Soaring	100-150	-	-	-	-	19	-
07.07.21	1	Unknown	Unknown	Mature hedgerow	1	14:28	Flying, circling	40-50	-	4	76	-	-	-
08.07.21	4	Unknown	Unknown	Improved grassland	1	12:15	Flying, circling	50	-	-	120	-	-	-
09.08.21	4	Unknown	Unknown	Improved grassland	1	13:18	Flying	30	-	-	2	-	-	-

Buzzard

Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
09.08.21	1	Unknown	Unknown	Improved grassland	1	13:24	Flying, circling	40 60	- -	- -	140 -	- 60	- -	- -
09.08.21	4	Unknown	Unknown	Improved grassland, hedgerow	1	13:26	Hovering, hunting, calling	2	-	14	-	-	-	-
09.08.21	1	Unknown	Unknown	Hedgerow	1	13:30	Flying, hovering	10	-	15	-	-	-	-
09.08.21	1	Unknown	Unknown	Hedgerow	1	14;38	Flying, perched	15	-	20	-	-	-	-
09.08.21	1	Unknown	Unknown	Trees	1	15:01	Flying	30 5	- -	- 8	60 -	- -	- -	- -
09.08.21	1	Unknown	Unknown	Improved grassland	1	15:30	Flying, circling	40 80	- -	- -	35 -	- 160	- -	- -
09.08.21	1	Unknown	Unknown	Improved grassland	1	15:35	Flying, calling	60	-	-	-	47	-	-
09.08.21	1	Unknown	Unknown	Improved grassland	1	17:54	Flying	30-40	-	-	20	-	-	-
09.08.21	1	Unknown	Unknown	Improved grassland	2	18:01	Perched, flying, circling	35	-	-	60	-	-	-
10.08.21	3	Unknown	Unknown	Improved grassland	1	11:22	Circling, calling, flying	40 150	- -	- -	120 -	- -	- 300	- -

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
10.08.21	2	Unknown	Unknown	Improved grassland	1	11:24	Flying, calling, circling	20-50	-	-	135	-	-	-
07.09.21	1	Unknown	Unknown	Improved grassland	1	11:25	Soaring	100-800	-	-	10	10	-	-
07.09.21	1	Unknown	Unknown	Improved grassland	1	12:40	Soaring	50-200	-	-	-	28	-	34
07.09.21	4	Unknown	Unknown	Improved grassland, hedgerow	1	14:48	Flying, perched	5	-	20	-	-	-	-
08.09.21	2	Unknown	Unknown	Improved grassland	1	11:02	Flying	10-20	-	12	-	-	-	-
08.09.21	2	Unknown	Unknown	Improved grassland, hedgerow	1	12:00	Flying	15	-	6	-	-	-	-
09.09.21	3	Unknown	Juvenile	Improved grassland	1	10:30	Flying, perched	5	-	1,200	-	-	-	-
Non-breeding 2021/22														
03.11.21	3	Unknown	Unknown	Improved grassland	1	10:05	Flying	5	-	20	-	-	-	-
03.11.21	3	Unknown	Unknown	Improved grassland	1	10:05	Flying	5	-	20	-	-	-	-
01.12.21	1	Unknown	Unknown	Improved grassland	1	10:05	Heard calling	On ground	-	-	-	-	-	-
22.02.22	4	Unknown	Unknown	Improved grassland	1	10:15	Flying	20	-	30	-	-	-	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
03.03.22	3	Unknown	Unknown	Improved grassland	1	10:50	Circling	200	-	-	-	-	-	60
04.03.22	2	Unknown	Unknown	Improved grassland	1	09:35	Flying	10	-	5	-	-	-	-
Breeding 2022														
25.04.22	1	Unknown	Unknown	Improved grassland/ Mature hedgerow	1	14:23	Circling, flying	30-50	-	-	117	-	-	-
25.04.22	1	Unknown	Unknown	Improved grassland	1	14:39	Soaring, circling	30-50, 50-100	-	-	388	328	-	-
25.04.22	5	Unknown	Unknown	Improved grassland/ Tillage	1	14:31	Flying, circling, soaring	40-100	-	-	129	180	-	-
29.04.22	4	Unknown	Unknown	Improved grassland	2	10:17	Flying, mobbing	15-25	-	15	15	-	-	-
29.04.22	4	Unknown	Unknown	Improved grassland	1	11:15	Flying, circling	10-15, 20-30	-	35	230	-	-	-
29.04.22	4	Unknown	Unknown	Improved grassland	1	11:56	Flying, circling	15-20, 40, 70	-	5	85	45	-	-
29.04.22	4	Unknown	Unknown	Improved grassland/ Scrub	2	12:07	Flying, circling, soaring	30-50, 75	-	-	85	30	-	-
29.04.22	4	Unknown	Unknown	Improved grassland	1	13:08	Flying	80	-	-	-	48	-	-
19.05.22	4	Unknown	Unknown	Scrub/ improved grassland.	1	09:38	Flying, soaring	20-25	-	-	12	-	-	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
19.05.22	4	Unknown	Unknown	improved grassland	1	09;53	Flying, soaring, hovering	20-35	-	-	145	-	-	-
25.05.22	2	Unknown	Unknown	Improved grassland	1	15:25	Flying	>180	-	-	-	-	-	90
31.05.22	1	Unknown	Adult	Improved grassland	1	09:07	Circling, flying	20-50, 50-100	-	-	54	120	-	-
31.05.22	5	Male	Adult	Improved grassland	1	11:57	Circling, flying	80- >100	-	-	-	180	360	-
31.05.22	5	Unknown	Unknown	Improved grassland	1	12:36	Circling/ flying	40-80	-	-	35	85	-	-
31.05.22	5	Unknown	Adult	Improved grassland	1	13:39	Flying	>180	-	-	-	-	-	65
31.05.22	1	Unknown	Unknown	Improved grassland	1	14:00	Hovering	15	-	10	-	-	-	-
31.05.22	5	Unknown	Adult	Improved grassland	1	14:11	Flying	30-50	-	-	25	-	-	-
15.06.22	1	Unknown	Unknown	Improved grassland	1	13:20	Hunting	150	-	-	-	-	180	-
15.06.22	2	Unknown	Unknown	Improved grassland	1	14:12	Soaring, flying	50-100	-	-	-	104	-	-
15.06.22	2	Unknown	Unknown	Improved grassland	1	14:29	Soaring, flying	50-100	-	-	-	88	-	-
15.06.22	2	Unknown	Unknown	Improved grassland	1	15:31	Soaring, flying	30	-	-	74	-	-	-
16.06.22	4	Unknown	Unknown	Improved grassland	1	14:51	Soaring	20-30	-	-	38	-	-	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
27.06.22	5	Unknown	Adult	Improved grassland, built up area.	1	11:40	Flying, circling	30	-	-	8	-	-	-
11.07.22	1	Unknown	Unknown	Improved grassland	1	11:30	Flying	70-120	-	-	-	10	220	-
11.07.22	1	Unknown	Unknown	Improved grassland	1	11:54	Flying	100	-	-	-	-	175	-
11.07.22	1	Unknown	Unknown	Improved grassland	1	13:02	Flying	80-180	-	-	-	40	100	10
21.07.22	5	Unknown	Unknown	Improved grassland	1	10:47	Flying, circling, soaring	170-190	-	-	-	-	240	180
21.07.22	5	Unknown	Unknown	Improved grassland, hedgerow	1	14:17	Flying	25	-	-	6	-	-	-
21.07.22	5	Unknown	Unknown	Improved grassland	2	14:32	Flying, circling, soaring	130-180	-	-	-	-	108	-
25.07.22	4	Unknown	Adult	Improved grassland	1	10:50	Flying	20-50	-	-	130	-	-	-
26.07.22	2	Unknown	Adult	Improved grassland	1	10:57	Flying	30	-	-	190	-	-	-
26.07.22	2	Unknown	Adult	Improved grassland	1	10:58	Flying, Soaring	50-100	-	-	-	187	-	-
09.08.22	1	Unknown	Unknown	Improved grassland	1	15:10	Flying, perched	15-100	100	120	60	40	-	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
09.08.22	1	Unknown	Unknown	Improved grassland	1	15:30	Soaring	180	-	-	-	-	240	-
16.08.22	4	Unknown	Adult	Improved grassland	1	11:27	Flying	10-20	-	27	-	-	-	-
16.08.22	2	Unknown	Adult	Improved grassland	1	13:33	Soaring, flying, mobbing.	5-10	-	23	-	-	-	-
16.08.22	2	Unknown	Adult	Improved grassland	1	13:36	Flying	5-15	-	42	-	-	-	-
16.08.22	2	Unknown	Adult	Improved grassland	1	13:51	Flying, perched	10	34	68	-	-	-	-
16.08.22	2	Unknown	Adult	Improved grassland	1	17:09	Flying	10	-	15	-	-	-	-
16.08.22	2	Unknown	Adult	Improved grassland	1	19:42	Flying	5-10	-	19	-	-	-	-
18.08.22	5	Unknown	Adult	Improved grassland, hedgerows	1	09:31	Flying	10	-	23	-	-	-	-
18.08.22	5	Unknown	Adult	Improved grassland, hedgerows	1	12:56	Flying, perching	15-25	5	12	15	-	-	-
03.09.22	3	Unknown	Adult	Improved grassland	1	10:37	Flying	80	-	-	-	15	-	-
Non-breeding 2022/23														
14.10.22	1	Male	Adult	Improved grassland	1	10:40	Flying	0-20	-	20	-	-	-	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
14.10.22	2	Unknown	Unknown	Improved grassland	1	10:42	Flying	0-20	-	20	-	-	-	-
14.10.22	5	Unknown	Adult	Improved grassland	1	11:42	Circling	50-100	-	-	-	10	-	-
14.10.22	5	Unknown	Adult	Improved grassland	1	13:25	Flying	50-100	-	-	-	10	-	-
14.10.22	6	Unknown	Unknown	Improved grassland	1	14:30	Flying	0-20	-	20	-	-	-	-
08.11.22	4	Unknown	Adult	Improved grassland	1	10:01	Soaring	20-50	-	-	480	-	-	-
08.11.22	5	Unknown	Unknown	Improved grassland	1	10:27	Flying	20-50	-	-	110	-	-	-
08.11.22	1	Unknown	Unknown	Improved grassland	1	10:30	Flying	0-50	-	60	60	-	-	-
08.11.22	6	Unknown	Adult	Improved grassland	1	11:40	Circling	50-100	-	-	-	12	-	-
08.11.22	4	Unknown	Adult	Improved grassland	1	14:33	Perching	20-50	60	-	-	-	-	-
08.11.22	1	Unknown	Unknown	Improved grassland	1	15:20	Flying	0-20	-	20	-	-	-	-
08.12.22	1	Unknown	Adult	Improved grassland	2	10:00	Flying	20-50	-	-	7	-	-	-
08.12.22	5	Unknown	Adult	Improved grassland	1	10:58	Perching	0-20	5	-	-	-	-	-
08.12.22	4	Unknown	Unknown	Improved grassland	1	12:44	Flying	0-20	-	20	-	-	-	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
08.12.22	2	Unknown	Unknown	Improved grassland	2	13:23	Flying	0-50	-	20	20	-	-	-
08.12.22	4	Unknown	Unknown	Improved grassland	1	13:48	Flying	0-20	-	30	-	-	-	-
15.12.22	6	Unknown	Unknown	Improved grassland	1	11:46	Flying	0-20	-	14	-	-	-	-
18.01.23	4	Unknown	Adult	Improved grassland	2	11:32	Mobbing	50-100	-	-	-	120	-	-
18.01.23	4	Unknown	Adult	Improved grassland	1	11:50	Hunting	0-20	-	180	-	-	-	-
18.01.23	2	Female	Adult	Improved grassland	1	12:00	Flying	20-50	-	-	20	-	-	-
18.01.23	6	Unknown	Adult	Improved grassland	1	12:52	Flying	20-50	-	-	12	-	-	-
18.01.23	2	Male	Adult	Improved grassland	1	13:32	Flying	20-50	-	-	10	-	-	-
18.01.23	4	Unknown	Adult	Improved grassland	1	15:05	Flying	0-20	-	180	-	-	-	-
18.01.23	4	Unknown	Adult	Improved grassland	1	16:25	Flying	0-20	-	30	-	-	-	-
18.01.23	4	Unknown	Adult	Improved grassland	1	16:50	Perching	0-20	10	-	-	-	-	-
14.02.23	4	Unknown	Adult	Improved grassland	2	07:30	On ground	0-20	60	-	-	-	-	-
14.02.23	5	Unknown	Unknown	Improved grassland	1	08:55	Flying	20-50	-	-	45	-	-	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
14.02.23	5	Unknown	Unknown	Improved grassland	1	10:17	Flying	0-20	-	30	-	-	-	-
14.02.23	5	Unknown	Unknown	Improved grassland	1	11:33	Flying	20-50	-	64	202	-	-	-
14.02.23	4	Unknown	Adult	Improved grassland	1	12:25	Flying	0-20	-	120	-	-	-	-
14.03.23	5	Unknown	Adult	Improved grassland	2	12:00	Hunting	20-50	-	-	1080	-	-	-
14.03.23	6	Unknown	Unknown	Improved grassland	3	12:06	Soaring	50-100	-	-	-	63	-	-
14.03.23	3	Unknown	Adult	Improved grassland	2	12:12	Circling	20-50	-	-	12	-	-	-
14.03.23	3	Unknown	Adult	Improved grassland	1	12:21	Soaring	100-180	-	-	-	-	300	-
14.03.23	4	Pair	Adult	Improved grassland	4	12:39	Displaying	0-180	-	280	300	400	400	-
14.03.23	5	Unknown	Adult	Improved grassland	1	14:17	Soaring	20-50	-	-	198	-	-	-
14.03.23	5	Unknown	Adult	Improved grassland	1	14:58	Flying	20-50	-	-	124	-	-	-
14.03.23	3	Unknown	Adult	Improved grassland	3	15:59	Flying	50-100	-	-	-	9	-	-
14.03.23	2	Unknown	Unknown	Improved grassland	1	17:02	Flying	20-50	-	-	20	-	-	-
14.03.23	3	Unknown	Adult	Improved grassland	2	17:04	Flying	20-50	-	-	12	-	-	-

Buzzard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
14.03.23	6	Unknown	Unknown	Improved grassland	2	17:06	Flying	50-100	-	-	-	82	-	-
14.03.23	5	Unknown	Adult	Improved grassland	1	17:25	Perching	0-20	10	4	-	-	-	-
14.03.23	5	Unknown	Adult	Improved grassland	1	18:02	Perching	0-20	5	-	-	-	-	-

Table 21. Golden plover observations

Golden plover														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2020/21														
30.10.20	2	Unknown	Unknown	Improved grassland	12	-	Flying	80	-	-	-	25	-	-
25.01.21	1	Unknown	Unknown	Improved grassland	14	16.04	Flying	30-40	-	-	60	-	-	-
25.01.21	3	Unknown	Unknown	Improved grassland	14	12:15	Flying	15	-	30	-	-	-	-
26.01.21	2	Unknown	Unknown	Improved grassland	2	11:42	Flying	15-20	-	30-40	-	-	-	-
16.02.21	3	Unknown	Unknown	Improved grassland	6	13:37	Flying	60	-	-	-	180	-	-

Golden plover														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
25.02.21	4	Unknown	Unknown	Improved grassland	9	14:18	Flying	60	-	-	-	180	-	-
Non-breeding 2021/22														
07.03.22	1	Unknown	Unknown	Improved grassland	1	13:50	Flying	50	-	-	30	-	-	-
Non-breeding 2022/23														
18.01.23	4	Unknown	Unknown	Improved grassland	1	11:50	Flying	0-20	-	30	-	-	-	-
18.01.23	3	Unknown	Unknown	Improved grassland	7	13:56	Circling	0-20	-	120	-	-	-	-

Table 22. Great black-backed gull observations

Great black-backed gull														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2020/21														
16.02.21	3	Unknown	Adult	Improved grassland	1	15:38	Flying	30	-	-	120	-	-	-
Breeding 2021														
13.05.21	4	Unknown	Unknown	Improved grassland	5	09:05	Flying, soaring	40	-	-	60	-	-	-

Table 23. Grey heron observations

Grey heron														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Breeding 2021														
10.08.21	3	Unknown	Unknown	Improved grassland	1	12:57	Flying	30	-	-	12	-	-	-
Non-breeding 2022/23														
14.03.23	1	Unknown	Adult	Improved grassland	1	13:18	Flying	0-20	-	20	-	-	-	-
14.03.23	2	Unknown	Unknown	Improved grassland	1	13:19	Flying	20-50	-	-	12	-	-	-
14.03.23	3	Unknown	Adult	Improved grassland	1	13:20	Flying	0-20	-	3	-	-	-	-

Table 24. Hen harrier observations

Hen harrier														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2021/22														
02.12.21	2	Female	Adult	Improved grassland	1	12:00	Flying	3	-	20	-	-	-	-

Table 25. Herring gull observations

Herring gull														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Breeding 2022														
26.04.22	3	Unknown	Unknown	Improved grassland	1	14:16	Flying	30-40	-	-	17	-	-	-

Table 26. Kestrel observations

Kestrel														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2020/21														
30.10.20	2	Female	Adult	Improved grassland	1	14:35	Flying/ hunting	25-40	-	-	45	-	-	-
25.01.21	2	Female	Unknown	Improved grassland	1	15:12	Flying	30	-	-	30-40	-	-	-
26.01.21	2	Unknown	Unknown	Improved grassland	1	09:51	Flying	30	-	-	20-30	-	-	-
16.02.21	3	Female type	Unknown	Improved grassland	1	10:16	Flying/ Perched	0-20	30	70	-	-	-	-
16.02.21	3	Unknown	Unknown	Improved grassland	1	13:59	Perched/ flying	0-20	240	30	-	-	-	-
25.02.21	4	Male	Adult	Improved grassland	1	14:47	Perched/ flying	0-20	120	180	-	-	-	-

Kestrel														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
25.02.21	4	Male	Adult	Improved grassland	1	13:52	Perched/ flying	0-8	2760	10	-	-	-	-
26.02.21	2	Unknown	Unknown	Improved grassland	1	15:20	Flying	30	-	-	30-40	-	-	-
24.03.21	3	Male	Adult	Improved grassland	1	10:42	Flying	1-2	-	20-30	-	-	-	-
29.03.21	4	Male	Adult	Improved grassland	1	11:21	Flying	20-30	-	-	?	-	-	-
Breeding 2021														
13.05.21	1	Female	Adult	Improved grassland	1	08:38	Hovering, flying	20 30	-	4 -	- 10	- -	- -	- -
13.05.21	4	Unknown	Unknown	Improved grassland, 2nd rotation forestry	1	09:22	Hovering	30	-	-	5	-	-	-
13.05.21	1	Male	Adult	Improved grassland, fence post hedgerow	1	11:55	Flying, perched	1	-	3,300	-	-	-	-
13.05.21	1	Female	Adult	Improved grassland, broad leaved woodland	1	12:11	Hunting	40	-	-	120	-	-	-
13.05.21	1	Unknown	Unknown	Improved grassland	1	12:31	Flying	30 60	- -	- -	6 -	- 4	- -	- -

Kestrel														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
13.05.21	1	Male	Adult	Improved grassland, hedgerow treeline	1	13:04	Soaring, hunting, circling	45	-	-	360	-	-	-
13.05.21	1	Unknown	Unknown	Improved grassland	1	13:18	Flying, hunting	60	-	-	7	-	-	-
13.05.21	1	Unknown	Unknown	Improved grassland	1	14:08	Flying, hunting	20	-	14	-	-	-	-
15.06.21	1	Female	Adult	Improved grassland	1	10:43	Flying, hunting, hovering	?	-	-	8	-	-	-
22.06.21	2	Female	Adult	Improved grassland	1	10:36	Flying, circling	60	-	-	-	30	-	-
22.06.21	3	Female	Adult	Rough grassland	1	11:41	Flying, hovering	120	15m 25m 50m 120 m	20 - - -	- 180 - -	- - 55 -	- - - 373	- - - -
22.06.21	2	Unknown	Unknown	Improved grassland, woodland	1	12:05	Mobbing, flying, perched	0-100	-	120	-	10	-	-
22.06.21	2	Unknown	Unknown	Improved grassland	1	12:10	Mobbing/ flying	140-180	-	-	-	-	32	-
22.06.21	3	Unknown	Unknown	Improved grassland	1	13:23	Flying	100-140	-	-	-	-	59	-

Kestrel														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
22.06.21	3	Unknown	Unknown	Improved grassland	1	1342	Flying	60	-	-	-	16	-	-
09.07.21	3	Unknown	Unknown	Improved grassland	1	09:06	Flying	10-15	-	5	-	-	-	-
09.07.21	3	Unknown	Unknown	Improved grassland	1	09:24	Flying, perched	8	-	6	-	-	-	-
09.07.21	3	Unknown	Unknown	Improved grassland	1	10:04	Flying/ perched	25	240	-	120	-	-	-
09.07.21	3	Female	Adult	Trees	1	10:15	Perched	5	-	420	-	-	-	-
09.07.21	2	Female	Adult	Mature hedgerow	1	11:28	Flying, hunting	20-50	-	-	180	-	-	-
09.07.21	3	Female & Male	Adults	Improved grassland, trees	2	11:35	Flying/ perched	20	180	2	-	-	-	-
09.07.21	2	Male	Adult	Improved grassland	1	15:05	Hunting	25	-	-	5	-	-	-
09.07.21	2	Unknown	Unknown	Improved grassland	1	15:07	Perched	On ground	15	-	-	-	-	-
09.07.21	3	Unknown	Unknown	Improved grassland	1	15:10	Flying	30-20	-	-	10	-	-	-
09.07.21	2	Male & Female	Adults	Improved grassland	2	15:15	Flying/ perched	25	3	-	15	-	-	-
07.09.21	1	Male	Adult	Cereal field	1	11:48	Flying	18	-	10	-	-	-	-
Non-breeding 2021/22														
02.11.21	2	Unknown	Unknown	Improved grassland	1	12:55	Flying, mobbed	5	-	10	-	-	-	-

Kestrel														
Date	**VP**	**Sex**	**Age**	**Habitat**	**No. Of Birds**	**Time of Flight/ Obs.**	**Activity**	**Flight Height (m)**	**Time (sec) in height category**					
									Non-flight	**0-20m**	**20-50m**	**50-100m**	**100-180m**	**>180m**
07.02.22	3	Unknown	Unknown	Improved grassland	1	10:30	Flying	10	-	5	-	-	-	-
Breeding 2022														
19.05.22	4	Unknown	Unknown	Improved Grassland	1	10:58	Hunting	50-60	-	-	-	17	-	-
19.05.22	4	Unknown	Unknown	Improved Grassland	1	11:27	Hunting/ flying/ circling	70	-	-	-	95	-	-
25.05.22	3	Unknown	Unknown	Improved Grassland	1	09:31	Hovering	10	-	7	-	-	-	-
25.05.22	3	Female	Adult	Improved grassland	1	11:36	Flying	10-20	-	8	-	-	-	-
31.05.22	5	Unknown	Unknown	Improved grassland	1	11:37	Hunting	35	-	-	20	-	-	-
31.05.22	5	Male	Adult	Improved grassland	1	15:09	Flying	30	-	-	60	-	-	-
31.05.22	5	Male	Adult	Improved grassland	1	15:09	Flying	40-80	-	-	240	220	-	-
16.06.22	4	Unknown	Unknown	Improved grassland	1	13:03	Flying	10	-	4	-	-	-	-
27.06.22	5	Male	Adult	Improved grassland, mixed woodland	1	11:37	Flying	20-25	-	-	6	-	-	-
16.08.22	4	Female	Adult	Improved grassland	1	12:17	Flying	5-10	-	32	-	-	-	-

Kestrel														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
16.08.22	4	Male	Adult	Improved grassland	1	12:53	Hovering	10-15	-	24	-	-	-	-
16.08.22	2	Unknown	Unknown	Improved grassland	2	14:36	Flying	20	-	8	-	-	-	-
18.08.22	5	Female	Adult	Improved grassland	1	11:04	Flying	15	-	34	-	-	-	-
Non-breeding 2022/23														
14.10.22	3	Unknown	Juvenile	Improved grassland	1	09:20	Perching	0	-	-	-	-	-	-
14.10.22	2	Female	Adult	Improved grassland	1	11:40	Flying	0-20	-	70		-	-	-
14.10.22	6	Female	Adult	Improved grassland	1	13:53	Flying	0-20	-	40	-	-	-	-
14.10.22	1	Unknown	Immature	Improved grassland	1	14:49	Flying	20-50	-	-	70	-	-	-
14.10.22	2	Male	Juvenile	Improved grassland	1	14:49	Flying	0-20	-	72		-	-	-
14.10.22	4	Unknown	Unknown	Improved grassland	1	15:02	Flying	20-50	-	-	3	-	-	-
14.10.22	4	Male	Adult	Improved grassland	1	15:14	Hunting	20-50	-	-	45	-	-	-
08.11.22	5	Unknown	Unknown	Improved grassland	1	09:15	Hunting	20-50	-	-	70	-	-	-
08.11.22	4	Female	Adult	Improved grassland	1	09:40	Hunting	50-100	-	-	-	240	-	-
08.11.22	3	Unknown	Unknown	Improved grassland	1	10:17	Flying	0-20	-	110	-	-	-	-

Kestrel														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
08.11.22	6	Female	Adult	Improved grassland	1	12:45	Flying	50-100	-	-	-	8	-	-
15.12.22	6	Unknown	Unknown	Improved grassland	1	09:06	Flying	0-20	-	10	-	-	-	-
18.01.23	4	Male	Adult	Improved grassland	1	13:50	Hunting	0-20	-	30	-	-	-	-
18.01.23	4	Unknown	Adult	Improved grassland	1	15:20	Flying	0-20	-	120	-	-	-	-
18.01.23	4	Male	Adult	Improved grassland	1	17:00	Hunting	0-20	-	180	-	-	-	-
14.02.23	3	Male	Adult	Improved grassland	1	08:35	Hunting	0-20	-	90	-	-	-	-
14.02.23	2	Female	Adult	Improved grassland	1	08:45	Hunting	0-20	-	7	-	-	-	-
14.03.23	4	Unknown	Unknown	Improved grassland	1	12:15	Circling	20-100	-	-	60	90	-	-
14.03.23	5	Female	Adult	Improved grassland	1	12:18	Flying	0-20	-	10	-	-	-	-
14.03.23	4	Female	Adult	Improved grassland	1	13:20	Hunting	0-50	-	60	300	-	-	-
14.03.23	4	Male	Adult	Improved grassland	1	13:39	Perching	0-20	-	70	-	-	-	-
14.03.23	4	Unknown	Unknown	Improved grassland	1	16:46	Hunting	0-20	-	190	-	-	-	-

Table 27. Lesser black-backed gull observations

Lesser black-backed gull														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2020/21														
16.02.21	3	Unknown	Unknown	Improved grassland	12	13:43	Circling/ flying	180	-	-	-	-	240	-
Breeding 2021														
11.05.21	2	Unknown	Unknown	Improved grassland	2	12:58	Flying	10-5	-	5	-	-	-	-
22.06.21	2	Unknown	Unknown	Improved grassland	2	10:09	Soaring, circling, flying	>100	-	-	-	-	30	-
08.07.21	1	Unknown	Unknown	Improved grassland	1	10:19	Flying	20	-	15	-	-	-	-
09.07.21	3	Unknown	Unknown	Improved grassland	1	09:37	Flying	100	-	-	-	-	60	-
09.07.21	2	Unknown	Unknown	Improved grassland	1	15:15	Flying	30	-	-	4	-	-	-
Non-breeding 2021/22														
01.10.21	1	Unknown	Unknown	Improved grassland	1	12:30	Flying	50	-	-	30	-	-	-
Breeding 2022														
19.05.22	4	Unknown	Adult & Immature	Improved Grassland	5	12:33	Flying/ soaring	120	-	-	-	-	65	-
31.05.22	5	Unknown	Unknown	Improved Grassland	2	15:35	Flying	45	-	-	55	-	-	-

Lesser black-backed gull														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
21.07.22	5	Unknown	Unknown	Improved Grassland, hedgerow	30	10:48	Flying	110	-	-	-	-	17	-
25.07.22	4	Unknown	Adult	Improved grassland	4	08:40	Flying	50-60	-	-	-	72	-	-
Non-breeding 2022/23														
14.10.22	4	Unknown	Juvenile	Improved grassland	1	11:00	Flying	20-50	-	-	45	-	-	-
14.10.22	6	Unknown	Unknown	Improved grassland	1	11:03	Flying	20-50	-	-	70	-	-	-
14.10.22	5	Unknown	Juvenile	Improved grassland	1	11:12	Flying	20-50	-	-	6	-	-	-
14.10.22	2	Unknown	Unknown	Improved grassland	1	14:09	Flying	20-50	-	-	30	-	-	-
14.10.22	3	Unknown	Adult	Improved grassland	1	15:14	Flying	50-100	-	-	-	120	-	-
14.10.22	2	Unknown	Adult	Improved grassland	6	15:15	Flying	50-100	-	-	-	30	-	-
14.10.22	1	Unknown	Unknown	Improved grassland	1	15:16	Flying	50-100	-	-	-	40	-	-
08.12.22	4	Unknown	Unknown	Improved grassland	3	12:54	Flying	20-50	-	-	46	-	-	-
15.12.22	6	Unknown	Adult	Improved grassland	1	11:01	Flying	0-50	-	20	25	-	-	-
18.01.23	3	Unknown	Adult	Improved grassland	34	12:20	Flying	20-100	-	-	100	70	-	-

Lesser black-backed gull														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
18.01.23	5	Unknown	Unknown	Improved grassland	34	12:23	Flying	20-50	-	-	187	-	-	-
14.02.23	1	Unknown	Immature	Improved grassland	1	11:16	Flying	20-100	-	-	35	38	-	-
14.02.23	3	Unknown	Unknown	Improved grassland	1	11:17	Flying	20-50	-	-	30	-	-	-
14.03.23	3	Unknown	Adult	Improved grassland	3	13:09	Flying	50-100	-	-	-	5	-	-

Table 28. Mallard observations

Mallard														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2020/21														
24.03.21	3	Unknown	Unknown	Improved grassland	4	10:00	Flying	30-50	-	-	70	-	-	-
Breeding 2021														
13.05.21	4	Male	Adult	Improved grassland, treeline	1	08:15	Flying	30	-	-	165	-	-	-
13.05.21	4	Female	Adult	Improved grassland, hedgerow	1	10:41	Flying	10	-	6	-	-	-	-

Non-breeding 2022/23														
14.03.23	3	Male and female	Adult	Improved grassland	3	15:59	Flying	20-50	-	-	9	-	-	-

Table 29. Merlin observations

Merlin														
Date	**VP**	**Sex**	**Age**	**Habitat**	**No. Of Birds**	**Time of Flight/ Obs.**	**Activity**	**Flight Height (m)**	**Time (sec) in height category**					
									Non-flight	**0-20m**	**20-50m**	**50-100m**	**100-180m**	**>180m**
Non-breeding 2020/21														
26.11.20	2	Female	Unknown	Improved grassland	1	10:01	Flying/ perching	0-20	600	90	-	-	-	-
28.11.20	2	Male	Adult	Improved grassland/ Farm building	1	16:20	Hunting/ flying	1	-	60	-	-	-	-
27.01.21	1	Male	Adult	Improved grassland	1	14:03	Perched/ hunting	0-20	120	15	-	-	-	-
Non-breeding 2021/22														
01.11.21	1	Female	Adult	Improved grassland	1	12:55	Flying	2	-	20	-	-	-	-
07.03.22	1	Unknown	Unknown	Improved grassland	1	12:15	Flying	5	-	5	-	-	-	-
Non-breeding 2022/23														
18.01.23	1	Male	Adult	Improved grassland	1	12:17	Flying	0-50	-	10	15	-	-	-

Table 30. Peregrine observations

Peregrine														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2020/21														
24.11.20	4	Male Pair	Adult Adult	Improved grassland	1 2	10:10 10:59	Flying Flying/ mobbing	25 25-30	- -	- -	30 50-60	- -	- -	- -
24.11.20	4	Unknown	Adult	Improved grassland	1	13:46	Perched/ hunting/ flying	5-30 30	600 -	- -	120 180	- -	- -	- -
15.12.20	3	Unknown	Unknown	Improved grassland	2	14:40	Flying	15-20	-	60	-	-	-	-
16.12.20	2	Unknown	Unknown	Improved grassland	1	14:07	Hunting/ flying	10-15	-	40-50	-	-	-	-
18.12.20	4	Unknown	Unknown	Improved grassland	1	14:44	Hunting/ flying	40	-	-	50-60	-	-	-
25.01.21	3	Male	Adult	Improved grassland	1	12:48	Flying	20	-	50-60	-	-	-	-
25.01.02	4	Unknown	Adult	Improved grassland	1	14:51	Flying	12	-	120	-	-	-	-
Breeding 2021														
13.04.21	3	Unknown	Unknown	Improved grassland	1	13:16	Flying	15	-	10	-	-	-	-
09.07.21	2	Unknown	Unknown	Improved grassland	1	14:51	Flying	10	-	30	-	-	-	-

Peregrine														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
09.07.21	3	Unknown	Unknown	Improved grassland	1	15:12	Flying	30	-	-	15	-	-	-
10.08.21	3	Unknown	Adult	Improved grassland	1	14:50	Flying	5	-	3	-	-	-	-
08.09.21	3	Unknown	Unknown	Improved grassland	1	17:07	Flying	10	-	5	-	-	-	-
Non-breeding 2021/22														
05.10.21	3	Unknown	Adult & Juvenile	Improved grassland	2	09:10	Flying	5	-	15	-	-	-	-
Breeding 2022														
21.07.22	5	Unknown	Unknown	Improved grassland	1	11:05	Flying, soaring	100	-	-	-	-	23	-
16.08.22	2	Unknown	Adult	Improved grassland	1	14:44	Flying, mobbing	10-15	-	7	-	-	-	-
Non-breeding 2022/23														
08.11.22	1	Unknown	Unknown	Improved grassland	1	14:29	Hunting, soaring	0-100	-	30	90	60	-	-
08.12.22	3	Female	Adult	Improved grassland	1	08:45	Flying	20-50	-	-	14	-	-	-
15.12.22	6	Female	Adult	Improved grassland	1	10:57	Flying	20-50	-	-	23	-	-	-
18.01.23	3	Unknown	Unknown	Improved grassland	1	11:59	Flying	0-20	-	25	-	-	-	-
18.01.23	1	Unknown	Unknown	Improved grassland	1	12:47	Flying	0-50	0	9	9	-	-	-

Table 31. Pomarine skua observations

Pomarine skua														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2022/23														
08.11.22	2	Unknown	Unknown	Improved grassland	1	14:05	Flying	50-100	-	-	-	60	-	-

Table 32. Snipe observations

Snipe														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2020/21														
25.10.20	1	Unknown	Unknown	Improved grassland	3	14.31	Flying	8-10	-	9	-	-	-	-
25.10.20	1	Unknown	Unknown	Improved grassland	1	16.18	Flying	20-25	-	-	12	-	-	-
26.11.20	2	Unknown	Unknown	Improved grassland	1	10.24	Flying	20-50	-	-	18	-	-	-
25.01.21	3	Unknown	Unknown	Improved grassland	1	11.52	Flying	15-20	-	60	-	-	-	-
Non-breeding 2021/22														
06.10.21	4	Unknown	Unknown	Improved grassland	1	12.50	Flying	20	-	10	-	-	-	-
Breeding 2022														

Snipe														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
22.09.22	4	Unknown	Unknown	Improved grassland	2	11:31	Flying	60	-	-	-	5	-	-
Non-breeding 2022/23														
14.10.22	6	Unknown	Unknown	Improved grassland	19	09:25	Circling	20-50	-		480	-	-	480
14.10.22	4	Unknown	Unknown	Improved grassland	1	09:33	Flying	0-20	-	14	-	-	14	-
14.10.22	3	Unknown	Adult	Improved grassland	1	09:36	Flying	20-50	-	-	8	-	-	8
14.10.22	2	Unknown	Unknown	Improved grassland	1	10:08	Flying	0-20	-	62	-	-	62	-
14.10.22	6	Unknown	Unknown	Improved grassland	1	10:55	Flying	20-50	-	-	30	-	-	30
14.10.22	6	Unknown	Unknown	Improved grassland	14	11:10	Circling	20-50	-	-	80	-	-	80
14.10.22	5	Unknown	Unknown	Improved grassland	2	11:15	Flying	0-20	-	3	-	-	3	-
08.11.22	1	Unknown	Unknown	Improved grassland	11	12:00	Perched, flying	0-20	-	30	-	-	30	-
08.12.22	5	Unknown	Adult	Improved grassland	1	10:58	Flying	0-20	-	4	-	-	4	-
08.12.22	4	Unknown	Unknown	Improved grassland	1	11:56	Flying	20-50	-	-	22	-	-	22
08.12.22	2	Unknown	Unknown	Improved grassland	6	11:57	Flying	50-100	-	-	-	25	-	-
08.12.22	1	Unknown	Adult	Improved grassland	1	12:24	Flying	50-100	-	-	-	10	-	-

Snipe														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
08.12.22	1	Unknown	Adult	Improved grassland	2	12:28	Flying	50-100	-	-	-	90	-	-
15.12.22	6	Unknown	Unknown	Improved grassland	2	10:23	Flying	0-50	-	6	6	-	6	6
14.02.23	1	Unknown	Unknown	Improved grassland	1	08:49	Flying	0-20	-	20	-	-	20	-

Table 33. Sparrowhawk observations

Sparrowhawk														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2020/21														
31.10.20	2	Female	Unknown	Improved grassland	1	10:29	Flying/hunting	3-7	-	26	-	-	-	-
24.11.20	3	Unknown	Juvenile	Improved grassland	1	11:17 11:27	Flying/ hunting Flying	0-20 0-20	- -	240 120	- -	- -	- -	- -
28.11.20	2	Female	Juvenile	Improved grassland	1	14:45	Hunting	25	-	-	60	-	-	-
18.12.20	1	Male	Adult	Improved grassland	1	12:55	Flying/ hunting	2-4	-	60	-	-	-	-

Sparrowhawk														
Date	**VP**	**Sex**	**Age**	**Habitat**	**No. Of Birds**	**Time of Flight/ Obs.**	**Activity**	**Flight Height (m)**	**Time (sec) in height category**					
									Non-flight	**0-20m**	**20-50m**	**50-100m**	**100-180m**	**>180m**
25.02.21	4	Unknown	Unknown	Improved grassland	1	10:26	Flying	160	-	-	-	-	240	-
25.02.21	4	Unknown	Unknown	Improved grassland	1	12:22	Flying	80	-	-	-	120	-	-
Non-breeding 2022/23														
14.10.22	4	Male	Unknown	Improved grassland	1	11:45	Hunting	0-20	-	5	-	-	-	-
14.10.22	1	Unknown	Adult	Improved grassland	1	12:42	Flying	0-20	-	10	-	-	-	-
08.11.22	2	Unknown	Unknown	Improved grassland	1	10:27	Flying	0-20	-	5	-	-	-	-
08.12.22	2	Female	Adult	Improved grassland	1	11:56	Flying	0-20	-	20	-	-	-	-
18.01.23	4	Unknown	Unknown	Improved grassland	1	11:48	Flying	0-20	-	30	-	-	-	-
18.01.23	1	Female	Adult	Improved grassland	1	12:14	Flying	0-20	-	4	-	-	-	-
18.01.23	5	Pair	Adult	Improved grassland	3	12:38	Flying	20-50	-	-	154	-	-	-
18.01.23	4	Unknown	Unknown	Improved grassland	1	13:12	Flying	0-20	-	30	-	-	-	-
18.01.23	1	Male	Adult	Improved grassland	1	13:25	Hunting	0-20	-	11	-	-	-	-
18.01.23	2	Female	Adult	Improved grassland	1	13:46	Hunting	0-20	-	12	-	-	-	-
18.01.23	1	Female	Adult	Improved grassland	1	14:30	Flying	20-50	-	-	20	-	-	-

Sparrowhawk														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
18.01.23	2	Female	Adult	Improved grassland	1	14:36	Flying	20-50	-	-	6	-	-	-
14.03.23	6	Unknown	Unknown	Improved grassland	1	13:24	Flying	100-180	-	-	-	-	240	-
14.03.23	1	Female	Adult	Improved grassland	1	15:20	Flying	0-20	-	4	-	-	-	-
14.03.23	2	Male	Adult	Improved grassland	1	16:01	Hunting	0-20	-	3	-	-	-	-
14.03.23	4	Female	Adult	Improved grassland	1	16:25	Flying	0-20	-	12	-	-	-	-

Table 34. Whooper swan observations

Whooper swan														
Date	VP	Sex	Age	Habitat	No. Of Birds	Time of Flight/ Obs.	Activity	Flight Height (m)	Time (sec) in height category					
									Non-flight	0-20m	20-50m	50-100m	100-180m	>180m
Non-breeding 2021/22														
03.11.21	3	Unknown	Unknown	Improved grassland	1	09.55	Flying	30	-	-	120	-	-	-

In addition, one group of four whooper swans was observed flying over the centre of the site (from south-west to north-east at a height of 5-20 m) during the transect survey of Transect B undertaken on 23rd January 2023.

Vantage point count surveys

Table 35. Vantage point peak count results

Species		Peak count				
Common name	Scientific name	Non-breeding 2020/21	Breeding 2021	Non-breeding 2021/22	Breeding 2022	Non-breeding 2022/23
Blackbird	*Turdus merula*	7	5	8	6	35
Blackcap	*Sylvia atricapilla*	0	0	0	2	0
Black-headed gull	*Chroicocephalus ridibundus*	0	0	0	1	18
Blue tit	*Cyanistes caeruleus*	2	0	2	4	7
Brambling	*Fringilla montifringilla*	0	0	1	0	0
Bullfinch	*Pyrrhula pyrrhula*	2	0	5	2	0
Buzzard	*Buteo buteo*	2	2	2	6	4
Chaffinch	*Fringilla coelebs*	8	4	35	12	83
Chiffchaff	*Phylloscopus collybita*	2	2	0	4	0
Coal tit	*Periparus ater*	2	3	1	1	1
Collared dove	*Streptopelia decaocto*	0	0	5	2	4
Dunnock	*Prunella modularis*	3	1	7	4	10
Fieldfare	*Turdus pilaris*	0	0	100	0	594
Goldcrest	*Regulus regulus*	0	0	2	1	4
Golden plover	*Pluvialis apricaria*	0	0	100	0	7
Goldfinch	*Carduelis carduelis*	4	0	70	8	102
Great tit	*Parus major*	2	0	2	2	5
Greenfinch	*Chloris chloris*	2	0	13	0	5
Grey heron	*Ardea cinerea*	0	1	0	0	1
Grey wagtail	*Motacilla cinerea*	0	0	0	0	1
Hen harrier	*Circus cyaneus*	0	0	1	0	0
Herring gull	*Larus argentatus*	1	0	0	1	0
Hooded crow	*Corvus cornix*	30	7	9	30	103
House sparrow	*Passer domesticus*	0	0	0	0	24
Jackdaw	*Coloeus monedula*	12	17	17	39	110
Jay	*Garrulus glandarius*	0	0	1	0	0
Kestrel	*Falco tinnunculus*	1	0	1	2	1
Lesser black-backed gull	*Larus fuscus*	0	0	18	30	34
Linnet	*Linaria cannabina*	6	0	62	7	83
Long-tailed tit	*Aegithalos caudatus*	0	0	3	2	9
Magpie	*Pica pica*	5	1	6	6	29

Species		Peak count				
Common name	Scientific name	Non-breeding 2020/21	Breeding 2021	Non-breeding 2021/22	Breeding 2022	Non-breeding 2022/23
Mallard	*Anas platyrhynchos*	4	0	0	0	3
Meadow pipit	*Anthus pratensis*	3	0	19	6	72
Merlin	*Falco columbarius*	1	0	1	0	1
Mistle thrush	*Turdus viscivorus*	1	0	3	5	10
Peregrine	*Falco peregrinus*	0	0	2	1	1
Pheasant	*Phasianus colchicus*	2	3	5	7	7
Pied wagtail	*Motacilla alba*	7	5	2	3	14
Pomarine skua	*Stercorarius pomarinus*	0	0	0	0	1
Raven	*Corvus corax*	0	1	2	7	12
Redpoll	*Carduelis flammea*	0	0	1	0	19
Redwing	*Turdus iliacus*	0	0	71	0	450
Reed bunting	*Emberiza schoeniclus*	0	0	10	0	4
Robin	*Erithacus rubecula*	5	4	10	5	25
Rook	*Corvus frugilegus*	80	23	257	240	449
Sedge warbler	*Acrocephalus schoenobaenus*	0	0	0	2	0
Skylark	*Alauda arvensis*	2	0	66	4	78
Snipe	*Gallinago gallinago*	0	0	2	0	19
Sparrowhawk	*Accipiter nisus*	1	0	0	1	3
Song thrush	*Turdus philomelos*	2	1	5	2	10
Spotted flycatcher	*Muscicapa striata*	0	0	0	5	0
Starling	*Sturnus vulgaris*	134	3	90	60	274
Stock Dove	*Columba oenas*	16	13	8	5	123
Stonechat	*Saxicola rubicola*	0	0	0	2	5
Swallow	*Hirundo rustica*	0	0	29	40	0
Whooper swan	*Cygnus cygnus*	0	0	3	0	0
Willow warbler	*Phylloscopus trochilus*	0	0	0	2	0
Woodpigeon	*Columba palumbus*	11	48	68	46	156
Wren	*Troglodytes troglodytes*	4	1	4	5	16
Yellowhammer	*Emberiza citrinella*	8	6	18	10	35

Transect surveys

Table 36. Transect survey peak count results (June to October 2021)

Species		Number of birds		
Common name	**Scientific name**	**Jun**	**Sep**	**Oct**
Blackbird	*Turdus merula*	4	2	4
Blackcap	*Sylvia atricapilla*	2	0	0
Blue tit	*Cyanistes caeruleus*	1	1	1
Buzzard	*Buteo buteo*	0	2	0
Chaffinch	*Fringilla coelebs*	1	15	4
Chiffchaff	*Phylloscopus collybita*	2	0	0
Dunnock	*Prunella modularis*	0	3	1
Goldcrest	*Regulus regulus*	1	0	0
Goldfinch	*Carduelis carduelis*	2	5	1
Great tit	*Parus major*	3	5	2
Grey heron	*Ardea cinerea*	3	0	0
Hooded crow	*Corvus cornix*	0	1	20
Jackdaw	*Coloeus monedula*	0	0	3
Lapwing	*Vanellus vanellus*	0	2	0
Linnet	*Linaria cannabina*	0	50	41
Magpie	*Pica pica*	3	1	1
Mistle thrush	*Turdus viscivorus*	0	0	1
Pheasant	*Phasianus colchicus*	0	0	2
Pied wagtail	*Motacilla alba*	0	1	0
Robin	*Erithacus rubecula*	5	2	4
Rook	*Corvus frugilegus*	36	207	105
Skylark	*Alauda arvensis*	6	1	2
Snipe	*Gallinago gallinago*	0	0	1
Song thrush	*Turdus philomelos*	1	0	1
Starling	*Sturnus vulgaris*	3	0	1
Stonechat	*Saxicola rubicola*	1	0	0
Swallow	*Hirundo rustica*	1	2	0
Wheatear	*Oenanthe oenanthe*	0	0	4
Woodpigeon	*Columba palumbus*	1	25	2
Wren	*Troglodytes troglodytes*	7	1	1
Yellowhammer	*Emberiza citrinella*	6	3	3

Table 37. Transect survey results (April to November 2022)

Species		Number of birds											
Common name	**Scientific name**	**Apr A**	**Apr B**	**Jun B**	**Jul A**	**Jul B**	**Jul B**	**Aug A**	**Aug B**	**Nov A**	**Nov B**	**Nov C**	**Nov D**
Blackbird	*Turdus merula*	1	1	2	0	2	0	1	0	6	2	2	2
Blue tit	*Cyanistes caeruleus*	0	0	0	0	0	0	0	0	0	0	0	2
Buzzard	*Buteo buteo*	0	0	0	0	0	0	0	1	0	0	2	0
Chaffinch	*Fringilla coelebs*	3	1	1	5	4	0	0	4	13	8	2	0
Chiffchaff	*Phylloscopus collybita*	0	0	0	0	1	0	0	0	0	0	0	0
Dunnock	*Prunella modularis*	0	0	0	0	0	0	0	0	5	2	1	3
Fieldfare	*Turdus pilaris*	0	0	0	0	0	0	0	0	18	25	27	17
Goldfinch	*Carduelis carduelis*	0	0	0	0	0	0	0	0	2	60	0	0
Great tit	*Parus major*	1	2	0	2	3	0	0	0	2	0	0	0
Greenfinch	*Carduelis chloris*	0	0	0	1	0	0	0	0	0	0	0	0
Hooded crow	*Corvus cornix*	0	1	0	3	0	0	0	0	0	0	4	2
House sparrow	*Passer domesticus*	0	3	0	0	0	0	0	0	0	0	0	0
Jackdaw	*Coleous monedula*	0	0	0	0	0	0	0	0	0	0	0	2
Kestrel	*Falco tinnunculus*	0	0	0	0	0	0	0	1	0	0	0	1
Linnet	*Linaria cannabina*	0	0	0	0	0	0	0	5	6	50	0	0
Long-tailed tit	*Aegithalos caudatus*	0	0	0	6	0	0	0	0	0	0	0	0
Magpie	*Pica pica*	2	0	0	0	0	0	1	0	2	0	5	5
Meadow pipit	*Anthus pratensis*	0	0	0	0	0	0	0	0	2	2	7	24
Mistle thrush	*Turdus viscivorus*	0	0	0	0	0	0	0	0	0	0	2	0
Pheasant	*Phasianus colchicus*	1	1	0	0	1	1	0	0	1	2	0	0
Pied wagtail	*Motacilla alba*	0	0	0	0	0	0	0	0	2	0	0	0
Redwing	*Turdus iliacus*	0	0	0	0	0	0	0	0	1	0	0	5

Species		Number of birds											
Common name	**Scientific name**	**Apr A**	**Apr B**	**Jun B**	**Jul A**	**Jul B**	**Jul B**	**Aug A**	**Aug B**	**Nov A**	**Nov B**	**Nov C**	**Nov D**
Reed bunting	*Emberiza schoeniclus*	0	0	0	0	0	0	0	0	1	0	0	0
Robin	*Erithacus rubecula*	1	2	0	1	1	0	2	0	0	0	0	0
Rook	*Corvus frugilegus*	11	23	3	19	3	17	0	1	15	9	21	21
Skylark	*Alauda arvensis*	2	1	0	0	5	0	0	1	2	1	2	3
Snipe	*Gallinago gallinago*	0	0	0	0	0	0	0	0	0	0	1	2
Song thrush	*Turdus philomelos*	0	0	0	0	0	0	0	0	1	0	0	0
Starling	*Sturnus vulgaris*	5	0	0	0	0	0	0	0	0	0	13	0
Stonechat	*Saxicola rubicola*	0	0	0	0	0	0	0	0	0	0	2	2
Swallow	*Hirundo rustica*	0	0	6	3	2	7	4	8	0	0	0	0
Woodpigeon	*Columba palumbus*	6	2	5	54	20	9	6	17	0	0	0	0
Wren	*Troglodytes troglodytes*	10	6	0	1	11	0	1	0	0	2	4	6
Yellowhammer	*Emberiza citrinella*	0	1	4	10	9	6	3	3	2	14	4	0

Table 38. Transect survey results (January to March 2023)

Species		Number of birds							
Common name	Scientific name	Jan A	Jan B	Jan C	Jan D	Mar A	Mar B	Mar C	Mar D
Blackbird	*Turdus merula*	5	4	8	7	3	3	2	1
Blue tit	*Cyanistes caeruleus*	2	0	2	2	0	0	0	0
Bullfinch	*Pyrrhula pyrrhula*	2	0	2	2	0	0	0	0
Buzzard	*Buteo buteo*	0	0	1	0	0	1	0	3
Chaffinch	*Fringilla coelebs*	12	23	13	0	6	5	4	4
Coal tit	*Periparus ater*	0	0	0	0	2	1	0	0
Dunnock	*Prunella modularis*	4	4	2	0	3	0	1	0
Fieldfare	*Turdus pilaris*	64	40	0	155	0	0	0	0
Goldcrest	*Regulus regulus*	0	0	0	1	0	0	0	0
Goldfinch	*Carduelis carduelis*	2	0	4	0	0	0	2	0
Great tit	*Parus major*	2	0	0	2	0	2	0	0
Greenfinch	*Carduelis chloris*	0	0	0	0	1	0	0	0
Grey heron	*Ardea cinerea*	1	0	0	0	0	0	0	0
Hooded crow	*Corvus cornix*	0	4	0	4	3	5	2	6
Jackdaw	*Coloeus monedula*	1	9	50	0	0	0	0	2
Linnet	*Linaria cannabina*	2	0	0	4	0	4	0	0
Magpie	*Pica pica*	0	7	1	0	0	0	0	0
Meadow pipit	*Anthus pratensis*	0	5	34	8	0	2	4	5
Mistle thrush	*Turdus viscivorus*	0	2	0	0	0	0	0	0
Pheasant	*Phasianus colchicus*	3	2	0	0	1	1	1	0
Raven	*Corvus corax*	2	0	0	0	0	0	0	0
Redwing	*Turdus iliacus*	57	32	14	4	0	0	0	0
Reed bunting	*Emberiza schoeniclus*	7	0	0	0	0	0	1	0
Robin	*Erithacus rubecula*	0	8	13	11	5	7	7	7
Rook	*Corvus frugilegus*	4	15	135	9	54	2	27	30
Sand martin	*Riparia riparia*	0	0	0	0	0	1	0	0
Skylark	*Alauda arvensis*	5	6	0	0	0	0	2	0
Snipe	*Gallinago gallinago*	0	0	3	0	0	0	0	0
Song thrush	*Turdus philomelos*	10	4	4	1	3	0	2	1
Starling	*Sturnus vulgaris*	50	0	270	100	5	0	2	0
Stock dove	*Columba oenas*	2	1	0	0	0	0	0	0
Stonechat	*Saxicola rubicola*	0	0	0	0	0	10	2	2
Whooper swan	*Cygnus cygnus*	0	4	0	0	0	0	0	0
Woodpigeon	*Columba palumbus*	39	0	0	7	27	0	0	7
Wren	*Troglodytes troglodytes*	8	7	5	1	3	0	5	5
Yellowhammer	*Emberiza citrinella*	1	0	0	0	2	2	1	1

ANNEX D – SITE PHOTOGRAPHS

Photograph 1. Viewshed from VP1 (photographed 19/10/2022)

Photograph 2. Viewshed from VP2 (photographed 19/10/2022)

Photograph 3. Viewshed from VP3 (photographed 19/10/2022)

Photograph 4. Viewshed from VP4 (photographed 19/10/2022)

Photograph 5. Viewshed from VP5 (photographed 19/10/2022)

Photograph 6. Viewshed from VP6 (photographed 19/10/2022)

EIAR VOLUME III
Appendices

CHAPTER 8 – ORNITHOLOGY

Appendix 8.2: Ornithology Collision Risk Modelling Report

Tullacondra Green Energy Limited

Appendix 8.2 – Ornithology Collision Risk Modelling Report

Tullacondra Green Energy Project

604162

MAY 2023

RSK

RSK GENERAL NOTES

Project No.: 604162

Title: Appendix 8.2 – Ornithology Collision Risk Modelling Report – Tullacondra Green Energy Project

Client: Tullacondra Green Energy Limited

Date: May 2023

Office: Dublin

Status: Rev01

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Date:	16/05/2023	Date:	16/05/2023

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1.0 INTRODUCTION

1.1 Purpose of this report

This report presents the methodology and findings of bird collision risk modelling for the proposed Tullacondra Wind Farm Project (hereafter referred to as ‘the Project’). This report forms a technical appendix to Chapter 8 of the Environmental Impact Assessment Report (EIAR) for the Project and has been produced using field survey data presented in Appendix 8.1 – Ornithology Baseline Report, which also supports the EIAR. This study was undertaken by RSK on behalf of Tullacondra Green Energy Limited.

This collision risk modelling study has been undertaken in order to identify the potential impacts of the Project on target bird species through collisions with new wind turbines, and to inform any requirement for mitigation measures.

The collision risk modelling study presented in this report has been prepared in reference to current best practice guidance, using field data from monthly Vantage Point (VP) surveys undertaken between 2020 and 2023 inclusive. Detailed methods for these surveys are described in Appendix 8.1 – Ornithology Baseline Report.

This report should be read in conjunction with the following figures:

- Figure 8.1 – Viewsheds and Transects.
- Figure 8.2 – Flight observations from VP surveys for target species during the breeding season 2021.
- Figure 8.3 – Flight observations from VP surveys for target species during the breeding season 2022.
- Figure 8.4 – Flight observations from VP surveys for target species during the non-breeding season 2020/21.
- Figure 8.5 – Flight observations from VP surveys for target species during the non-breeding season 2021/22.
- Figure 8.6 – Flight observations from VP surveys for target species during the non-breeding season 2022/23.

1.2 Site overview

The proposed wind farm (hereafter referred to as ‘the wind farm site’) is located approximately 2km south of Lisgriffin Cross, Co. Cork. The wind farm site is rural in nature, with land cover predominantly comprising mixed agricultural land interspersed with rural settlements (see Figure 8.1). The wind farm site is in a lowland location, with elevation ranging from approximately 120-130 metres (m) Above Ordnance Datum (AOD) across the wind farm site.

Various designated sites for nature conservation value are present within 20km of the wind farm site, notably: Kilcolman Bog Special Protection Area (SPA), approximately 9.4km north-east of the wind farm site; and Blackwater River (Cork/Waterford) Special Area of Conservation (SAC), approximately 5.6km north-east of the wind farm site at its nearest point. These sites support internationally important bird populations. Whilst the Ornithology Baseline Report established the wind farm site is not of significant value to qualifying bird populations of any Natura 2000 sites (either in the context of birds using habitats on site for feeding or roosting, or birds flying over airspace within/in close proximity to the wind farm site), as described in Section 3.3, relevant qualifying species have been included in collision risk modelling within this report on a precautionary basis.

1.3 Key guidance

This collision risk modelling study has been undertaken in reference to current key industry standard guidance including that provided by Scottish Natural Heritage (SNH, now NatureScot). Relevant guidance to this report includes:

- *Recommended bird survey methods to inform impact assessment of onshore wind farms* (SNH, 2017).
- *Wind farms and birds: Calculating a theoretical collision risk assuming no avoiding action* (SNH, 2000).
- *Avoidance Rates for the onshore SNH Wind Farm Collision Risk Model* (SNH, 2018).
- *Developing field and analytical methods to assess avian collision risk at wind farms* (Band *et al.,* 2007).
- *Calculation of collision risk for birds passing through rotor area* (Band, 2011).

Any departures from the standard approaches specified in the above best practice guidance, and any additional assumptions, are highlighted in the relevant sections of this report.

2.0 DEVELOPMENT DESIGN

2.1 Wind farm area

The site is indicated in Figure 8.1, including the locations of new wind turbines. The project consists of a wind farm development comprising nine new wind turbines. The model selected for all turbines is the Vestas V150 4.5MW measuring 175m high (as described in Section 2.2 below).

For the purposes of collision risk modelling, the Wind Farm Area (WFA) has been defined as the maximum area covered by the nine turbine bases, allowing for 75m for the span of the turbine blades and a 100m buffer to allow for any inaccuracies in mapping bird flight lines during Vantage Point (VP) surveys. On a precautionary basis, the WFA also includes land between the turbine bases. The WFA for the project measures 126.62ha (see Figure 8.1).

2.2 Turbine parameters

Collision risk modelling within this report has been based on the specifications of the selected turbine for the project: the Vestas V150 4.5MW.. Technical specifications for this turbine incorporated into collision risk modelling are provided in Table 1 below. It is understood the turbines will have an operational lifespan of 35 years.

Table 1. Turbine technical specifications

Specification	Value
Number of turbines within the project	9
Number of blades per turbine	3
Tower height	100m
Rotor radius	73.66m
Rotor diameter (including hub)	150m
Turbine height (ground to blade tip)	175m
Rotor sweep zone (RSZ)	17,671m^2
Maximum rotor chord	4.2m
Rotor pitch (degrees)	6^o
Rotor depth	4.287m
Maximum rotation period (seconds)	5s

3.0 METHODOLOGY

3.1 Overview

This section presents the methods used for collision risk modelling, including survey coverage, identification of Key Ornithological Receptors and collision risk model selection.

Collision risk modelling was undertaken using the standard approach described in the best practice guidance and calculation tools specified in Section 1.3.

Collision risk modelling is essentially a three-stage process:

1. Initial modelling uses field survey data on bird flight activity to assess the number of birds passing through the zone swept by the rotating turbine blades (i.e. the 'flight risk volume').
2. Modelling then estimates the probability of a bird being hit if it were to fly through an operational turbine, based on the estimated flight parameters of the specific bird species and the turbine parameters. This stage assumes birds take no action to avoid collisions with turbines (i.e. 'avoiding actions').
    - The outputs of Stages 1 and 2 are then multiplied together to provide an estimate of the number of collisions that would occur in the absence of avoiding actions. Assuming all collisions result in fatalities, this provides an estimate of the number of fatalities that would occur.
3. Finally modelling applies an avoidance rate to account for avoiding actions. This is based on the understanding that birds will often either avoid the wind farm entirely, fly above or below an operational turbine, or perform 'emergency' maneuvers to avoid a moving turbine blade.
    - This provides an estimate of the number of fatalities that would occur, taking into account avoiding actions (again assuming all collisions result in fatalities).

Once collision risk modelling has calculated the estimated number of fatalities for target species (taking into account avoiding actions) as a result of the new turbines, this information is applied to knowledge of the populations of the Key Ornithological Receptors to assess the potential impacts of the new turbines on the populations of those species. Where significant impacts are anticipated, mitigation measures may be required to minimise the potential for impacts and thus avoid adverse impacts on the Key Ornithological Receptors. This impact assessment is undertaken in Chapter 8 of the EIAR for the Project.

3.2 Survey coverage and methods

Field data used for collision risk modelling were collected during VP surveys undertaken at the site in 2020-2023. Survey locations, methods and effort are described in full in the Ornithology Baseline Report (see Appendix 8.1 of the EIAR).

These surveys were undertaken in accordance with best practice guidance (SNH, 2017) in order to record bird flight activity throughout the wind farm site during the breeding season (i.e. April to September inclusive) and the non-breeding season (i.e. October to March inclusive), with emphasis on recording activity by target species (see Section 3.3).

In summary, VP surveys were undertaken twice per month from an initial four VPs (VPs 1-4) from October 2020 to September 2022 inclusive[1] with the aim of generating a survey effort of 36 hours per VP per season. Across the four seasons initially surveyed (i.e. the breeding seasons of 2021 and 2022, and the non-breeding seasons of 2020/21 and 2021/22) these four VPs were surveyed for a total of at least 137 hours per VP. To provide increased coverage of the wind farm site, an additional two VPs (VPs 5-6) were surveyed in 2022 and 2023 (along with continued surveys from VPs 1-4), providing increased coverage of previously inaccessible land within the north of the site. VP locations and viewsheds (i.e. the area in which birds could be observed by the ornithologist when surveying from a given VP) are indicated in Figure 8.1. A summary of VP survey effort is provided in Table 2 below.

Table 2. Summary of Vantage Point survey effort

VP	Hours of observation					
	Breeding season 2021	Breeding season 2022	Non-breeding season 2020/21	Non-breeding season 2021/22	Non-breeding season 2022/23	Total
VP1	36	36	36	36	36	180
VP2	36	36	36	36	36	180
VP3	36	36	36	36	36	180
VP4	36	36	35	36	36	179
VP5	0	36	0	0	36	72
VP6	0	6	0	0	36	42

Recording of flight data

Parameters for target species observed flying within or in close proximity to the wind farm site were recorded to enable collision risk modelling. Parameters recorded were as follows:

- Start time of flight observation.
- Duration of flight observation.
- Species and number of individuals.

[1] Subject to the limitations to survey effort discussed in the Ornithological Baseline Report.

- Approximate height of flight in metres, with the time spent in each flight height category (non-flight, 0-20m, 20-50m, 50-100m, 100-180m and >180m) recorded.
- The likely purpose of the flight (e.g. foraging, displaying, commuting, etc.).

Some flight observations from the VP surveys were entirely within the WFA. As such, the entirety of the flight time at collision risk height from these observations was included in collision risk modelling. However, some flight observations crossed the WFA boundary (i.e. indicating birds flying into or out of the WFA). When including these flight lines within collision risk modelling, only the proportion of flight time observed within the WFA was included. To ensure a suitably precautionary approach was adopted, for flight lines where only a small fraction of the flight line was outside of the WFA, the flight line was included in its entirety. Similarly, flight lines for birds circling near the WFA boundary and occasionally leaving the WFA were also included in their entirety.

Based on the turbine parameters described in Section 2.2, flight records included within collision risk modelling (i.e. flights at 'collision risk height' and therefore included within the 'flight risk volume') were those recorded in the 20-50m, 50-100m and 100-180m height categories described above.

3.3 Key ornithological receptors

Selection of target species for VP surveys undertaken in 2020-2023 inclusive is described in detail in the Appendix 8.1 - Ornithology Baseline Report. In summary, the following species were identified as target species:

- All species of waterfowl
- All species of raptor
- All species of owl
- All species of grouse
- All species of wader
- All species of gull and skua.

Regarding determination of target species recorded during the VP surveys which require detailed collision risk modelling to assess potential impacts (referred to as 'Key Ornithological Receptors'), species were selected based on the following factors:

- Their level of legal protection (e.g. inclusion on Annex 1 of the Birds Directive) and conservation concern (e.g. inclusion on the Birds of Conservation Concern in Ireland (BoCCI) Red or Amber Lists (Gilbert *et al*., 2021)).
- Their relevance to any nearby designated sites (notably Kilcolman Bog SPA).
- The assessed importance of the wind farm site to these species at an international, national, regional or local level.
- Their level of flight activity at risk height within the WFA.

As such, six species were identified as Key Ornithological Receptors requiring detailed collision risk modelling, as indicated in Table 3 below. Considering their legal protection and conservation status, and their level of activity within the WFA, no other species were identified as Key Ornithological Receptors requiring detailed collision risk modelling.

Table 3. Key Ornithological Receptors for collision risk modelling

Species	Justification for inclusion
Buzzard (*Buteo buteo*)	Whilst a common and widespread species in Ireland, reflected by its inclusion on the BoCCI Green List, high levels of flight activity were recorded within the WFA, and the wind farm site is considered to be of local value to this species. Buzzard activity was recorded within the wind farm site throughout the breeding and non-breeding seasons.
Golden plover (*Pluvialis apricaria*)	Regarded as a species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List and is afforded additional legal protection due to its inclusion on Annex 1 of the Birds Directive. Whilst not a qualifying feature for the site's designation, wintering golden plover populations are specified on the site citation for Kilcolman Bog SPA. Golden plover activity was recorded within the site during the non-breeding season.
Kestrel (*Falco tinnunculus*)	A species of high conservation importance in Ireland due to its inclusion on the BoCCI Red List. High levels of flight activity were recorded within the WFA, and the wind farm site is considered to be of local value to this species. Kestrel activity was recorded within the site throughout the breeding and non-breeding seasons.
Peregrine (*Falco peregrinus*)	A locally common and increasing species in Ireland, reflected by its inclusion on the BoCCI Green List. Afforded additional legal protection due to its inclusion on Annex 1 of the Birds Directive. Peregrine activity was recorded within the wind farm site throughout the breeding and non-breeding seasons.
Pomarine skua (*Stercorarius pomarinus*)	Scarce passage migrant in Ireland typically recorded in coastal areas, but not included on the BoCCI Red or Amber List, and not included on Annex 1 of the Birds Directive. Pomarine skua activity (comprising a single observation) was recorded within the wind farm site during the non-breeding season.
Whooper swan (*Cygnus cygnus*)	An Amber Listed species of conservation concern in Ireland. Afforded additional legal protection due to its inclusion on Annex 1 of the Birds Directive. Whooper swan is a qualifying species for Kilcolman Bog SPA, with the site citation specifying a wintering population of 95 birds (NPWS, 2014). Whooper swan activity was recorded within the wind farm site during the non-breeding season.

Two additional species recorded during the VP surveys, hen harrier (*Circus cyaneus*) and merlin (*Falco columbarius*), would merit inclusion in collision risk modelling on account of their conservation status and potential sensitivity. However, flight activity by these species recorded during the field surveys was not within the flight risk volume (i.e. was either below the minimum risk height or was outside of the WFA). These species were therefore not subject to collision risk modelling.

To maximise the accuracy of collision risk modelling outputs, collision risk calculations were undertaken for a duration of time appropriate to the species in question. For example, for species which would only be present on the wind farm site during the non-breeding season (i.e. golden plover and whooper swan), the potential number of collisions was modelled for the non-breeding season only (October to March inclusive). Alternatively, for species which would be present on the wind farm site year-round (i.e. buzzard, kestrel and peregrine) or could be present during the breeding or non-breeding season (i.e. pomarine skua) the potential number of collisions was modelled for the entire year. As data were initially collected for two complete years (October 2020 to September 2021 inclusive, and October 2021 to September 2022 inclusive), the potential number of annual collisions for buzzard and kestrel was calculated for each of these years, and subsequently for the non-breeding season (i.e. October to March inclusive) in 2022/23 using the additional VP data collected during this period. As no peregrine flights at risk height within the WFA were recorded between October 2021 and September 2022 inclusive, the potential number of annual collisions for peregrine was only calculated for the year October 2020 to September 2021 inclusive and (on completion on the 2022/23 non-breeding VP surveys) for the year April 2022 to March 2023 inclusive.

Collision risk modelling requires the typical measurements and flight parameters of modelled species (i.e. Key Ornithological Receptors) to be known. Relevant data for Key Ornithological Receptors based on existing literature are detailed in Table 4 below. In line with SNH guidance, where flight speed data for a species was not available, published flight data for a similar species were used.

Table 4. Measurements and flight parameters for Key Ornithological Receptors

Species	Average body length (m)	Average wingspan (m)	Average flight speed (m/s)	Data sources
Buzzard	0.54	1.20	9.45	BTO BirdFacts (2022); Hawk & Owl Trust (2022); Robinson (2005); Snow & Perrins (1998); Bruderer & Boldt (2001)
Golden plover	0.28	0.72	17.9*	BTO BirdFacts (2022); Hawk & Owl Trust (2022); Alerstam *et al.* (2007)
Kestrel	0.34	0.76	9.95	BTO BirdFacts (2022); Hawk & Owl Trust (2022); Robinson (2005); Snow & Perrins (1998); Bruderer & Boldt (2001); Taylor *et al*. (2003)
Peregrine	0.42	1.02	12.1	BTO BirdFacts (2022); Alerstam *et al.* (2007)

Species	Average body length (m)	Average wingspan (m)	Average flight speed (m/s)	Data sources
Pomarine skua	0.42	1.13	15.0**	BTO BirdFacts (2022); Alerstam *et al.* (2007)
Whooper swan	1.52	2.30	17.3	BTO BirdFacts (2022); Alerstam *et al.* (2007)
* Taken as the flight speed for grey plover (*Pluvialis squatarola*) (Alerstam *et al*., 2007). ** Based on approximate flight speed quoted for skuas (Alerstam *et al*., 2007).				

3.4 Model selection

SNH has published two models for calculation of collision risk. These models are appropriate for different scenarios, depending on how Key Ornithological Receptors are using the WFA:

- The 'Airspace' Model applies where birds are typically recorded within the airspace of the WFA; for example, birds with breeding territories or observed foraging within the WFA.
- The 'Fly Through' Model applies where birds are typically recorded using regular commuting routes across the WFA.

Observations of four of the Key Ornithological Receptors from the VP surveys undertaken in 2020-2023 inclusive were typically of birds hunting, circling, soaring and perching within the WFA (for raptors) or circling or flying over the wind farm site (for golden plover). As such, the Airspace Model was selected as being most appropriate for collision risk modelling of buzzard, golden plover, kestrel and peregrine.

Airspace models are generated on the basis of bird occupancy within a 'flight risk volume' (vW); specifically the two-dimensional WFA multiplied by the turbine height. As such, bird occupancy is modelled using the number of birds observed within this volume multiplied by the time in seconds spent flying within this volume. Flight lines of birds outside of this volume, either based on flight heights above the turbine height, or lateral movement outside of the WFA, were excluded from the model (as described in Section 3.2).

The observations of two Key Ornithological Receptors, pomarine skua and whooper swan, were of birds flying directly through the WFA, potentially representing commuting or migration routes. As such, a Fly Through Model was selected as being most appropriate for collision risk modelling of pomarine skua and whooper swan. Rather than identifying a 'flight risk volume' (as for airspace models above), a 'risk window' equal to the width of the wind farm across the general flight direction observed for the species, and the maximum turbine height, is identified.

3.5 Avoidance rates

The third stage of collision risk modelling takes account of the understanding that birds will often take action to avoid collision with wind turbines, either by avoiding the wind farm entirely (i.e. displacement), by flying above or below operational turbines, or by performing 'emergency' maneuvers to avoid moving turbine blades.

Avoidance rates are generally derived by comparing data on actual observed collisions with the predicted no-avoidance collision estimate. SNH *Avoidance Rates for the onshore SNH Wind Farm Collision Risk Model* (SNH, 2018) collates species-specific estimates of avoidance rates from a range of information sources to determine estimates of avoidance that should be used for Key Ornithological Receptors.

Avoidance rates used are indicated in Table 5 below. As per SNH guidance, a default avoidance rate of 98% has been applied for species for which a specific avoidance rate is not specified (due to a lack of empirical evidence to the contrary).

Table 5. Avoidance rates for Key Ornithological Receptors (SNH, 2018)

Species	Avoidance rate
Buzzard	98% (default value)
Golden plover	98% (default value)
Kestrel	95%
Peregrine	98% (default value)
Pomarine skua	99.5% (as quoted for Arctic skua (*Stercorarius parasiticus*) and great skua (*Stercorarius skua*))
Whooper swan	99.5%

3.6 Limitations and assumptions

This report is based on field data collected during VP surveys undertaken at the wind farm site in 2020-2023. Limitations of these field data are discussed in the Ornithological Baseline Report (see Appendix 8.1 of the EIAR); notably limitations relating to VP survey effort, VP positioning and the use of overlapping viewsheds.

Regarding general assumptions within collision risk modelling, collision risk modelling assumes all nine turbines are turning constantly throughout the modelled period. In reality this will not be the case, as turbines will not be turning at certain times (e.g. at wind speeds below the minimum cut-in speed/above the maximum cut-out speed, or during maintenance periods). In addition, as stated in Section 3.1, collision risk modelling assumes all bird collisions with turbines will be fatal, which may not necessarily be the case. Based on these two assumptions, collision risk modelling is considered to represent a conservative scenario of collision fatalities.

As stated in Section 2.1, to account for potential errors when recording the precise locations of birds in flight, a 100m buffer was adopted around turbine bases (in addition to the turbine blade span of 75m) when generating the WFA. This is based on the typical proximity of surveyors to the birds recorded (due to the number of VP locations surveyed from), and the site topography, which included boundary features aiding precise mapping of flight lines. As such, this buffer is considered suitably precautionary to ensure all relevant flight lines were included in collision risk modelling.

The overlap of viewsheds provided by the different VP locations, as illustrated on Figure 8.1, means that the part of the WFA has been subject to duplication of effort (i.e. a greater number of effective hours were surveyed than is implied by the total number of hours of observation undertaken at each VP). However, rather than increasing the total number of survey hours modelled (and thus diluting the number of bird flight seconds recorded within the sampling period), the models presented in this report have been calculated on the basis of non-overlapping coverage of the WFA. In reality this means that the models are conservative estimates of collision risk.

The collision risk modelling assumes that the bird activity observed during the baseline surveys is suitably representative of the wind farm site, in the absence of the Project. It does not account for any displacement of birds which may result from the physical presence of the turbines and other associated infrastructure, which could in turn reduce the levels of bird activity within the WFA during the operational period. The models are therefore conservative estimates of collision risk.

4.0 RESULTS

Flight times for Key Ornithological Receptors within the flight risk volume (vW) were calculated as the number of birds observed within the WFA at collision risk height (see Section 3.2), during each observation, multiplied by the number of seconds spent in the air. For example, two birds flying at a height of 80m for 15 seconds would constitute 30 flight-seconds within the flight risk volume.

The following flight seconds for each Key Ornithological Receptor at collision risk height were recorded (flight activity data included in collision risk modelling is provided in Annex A):

- Buzzard: 6,776 seconds during the breeding season / 5,588 seconds during the non-breeding season.
- Golden plover: 850 seconds during the non-breeding season.
- Kestrel: 1,432 seconds during the breeding season / 991 seconds during the non-breeding season.
- Peregrine: 401 seconds during the non-breeding season.
- Pomarine skua: 60 seconds during the non-breeding season.
- Whooper swan: 35 seconds during the non-breeding season.

Species-specific collision risk models for each Key Ornithological Receptor are summarised below. Collision risk probability calculations are provided in Annex B. Collision risk modelling analysis is provided in Annex C.

4.1 Buzzard

Based on its status within Ireland, buzzard is considered to potentially be present within the WFA year-round. Risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Buzzard was recorded within the WFA at risk height during the non-breeding season in 2020/21 and 2022/23 and during the breeding season in 2021 and 2022. Considering the potential year-round presence of buzzard within the WFA, collision risk has been calculated based on a modelled period of one year (i.e. October 2020 to September 2021 inclusive, and October 2021 to September 2022 inclusive), with an additional calculation reflecting activity during the non-breeding season from October 2022 to March 2023 inclusive.

Based on the measurements and flight parameters for buzzard described in Table 4, and the turbine specifications described in Table 1, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 6.8%.

Therefore, in the absence of any avoiding actions, the estimated annual number of buzzard collision fatalities based on the 2020/21 survey data is 33.49 birds, whilst the estimated annual number of buzzard collision fatalities based on the 2021/22 survey data is 18.58 birds. The estimated number of buzzard collision fatalities during the non-breeding season based on the 2022/23 survey data is 2.48 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of buzzard collision fatalities based on the 2020/21 survey data is 0.67 birds (equating to 23.45 collision fatalities over the anticipated lifespan of the wind farm), whilst the estimated annual number of buzzard collision fatalities based on the 2021/22 survey data is 0.37 birds (equating to 13.01 collision fatalities over the anticipated lifespan of the wind farm). This therefore represents a mean annual collision rate of 0.52 birds (equating to 18.23 collision fatalities over the lifespan of the wind farm). Factoring in the avoidance rate, based on the 2022/23 survey data the number of collisions during the non-breeding season would be 0.05 birds (equating to 1.73 collision fatalities in the non-breeding season over the lifespan of the wind farm). Collision risk modelling for buzzard is summarised in Table 6 below.

Table 6. Buzzard airspace collision risk model summary

Survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020-September 2021	98% (default value)	0.670	23.446
October 2021-September 2022		0.372	13.010
Mean annual values		**0.521**	**18.228**
October 2022-March 2023		0.050	1.733

4.2 Golden plover

Based on its status within Ireland, golden plover is only considered to potentially be present within the WFA during the non-breeding season (i.e. October to March inclusive). Risk modelling for this species is therefore only appropriate for the non-breeding season.

Golden plover was only recorded within the WFA during the non-breeding season in 2020/21, during which 850 flight seconds were recorded within the WFA. Collision risk has been modelled for this period, based on possible golden plover presence within the WFA between October and March inclusive (i.e. a period of 182 days). It should therefore be noted that, based on survey data, this assessment of collision risk is likely to be precautionary, as during the non-breeding VP surveys undertaken in 2021/22 no golden plovers were recorded at risk height within the WFA.

Based on the measurements and flight parameters for golden plover described in Table 4, and the turbine specifications described in Table 1, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 4.5%.

Therefore, in the absence of any avoiding actions, the estimated annual number of golden plover collision fatalities, based on the 2020/21 survey data, is 6.99 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of golden plover collision fatalities is 0.14 birds. This would equate to an estimated 4.9 golden plover collision fatalities over the anticipated lifespan of the wind farm. Taking into consideration the absence of golden plover observations within the WFA during the 2021/22 and 2022/23 non-breeding seasons, the mean annual collision rate for golden plovers would be 0.005 birds (equating to 1.632 collision fatalities over the lifespan of the wind farm). Collision risk modelling for golden plover is summarised in Table 7 below.

Table 7. Golden plover airspace collision risk model summary

Survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020-March 2021	98% (default value)	0.140	4.897
October 2021-March 2022		0	0
October 2022-March 2023		0	0
Mean values		**0.005**	**1.632**

4.3 Kestrel

Based on its status within Ireland, kestrel is considered to potentially be present within the WFA year-round. Risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Kestrel was recorded within the WFA at risk height during the non-breeding season in 2020/21 and 2022/23 and during the breeding season in 2021 and 2022. Considering the potential year-round presence of kestrel within the WFA, collision risk has been calculated based on a modelled period of one year (i.e. October 2020 to September 2021 inclusive, and October 2021 to September 2022 inclusive), with an additional calculation reflecting the results of the 2022/23 non-breeding surveys.

Based on the measurements and flight parameters for kestrel described in Table 4, and the turbine specifications described in Table 1, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 5.5%.

Therefore, in the absence of any avoiding actions, the estimated annual number of kestrel collision fatalities based on the 2020/21 survey data is 6.46 birds, whilst the estimated number of kestrel collision fatalities based on the 2021/22 survey data is 3.90 birds. The estimated number of kestrel collision fatalities during the non-breeding season based on the 2022/23 survey data is 0.26 birds.

Taking into consideration an avoidance rate of 95% (in line with SNH guidance), the estimated annual number of kestrel collision fatalities based on the 2020/21 survey data is 0.32 birds (equating to 11.31 collision fatalities over the anticipated lifespan of the wind farm), whilst the estimated annual number of kestrel collision fatalities based on the 2021/22 survey data is 0.19 birds (equating to 6.82 collision fatalities over the anticipated lifespan of the wind farm). This therefore represents a mean annual collision rate of 0.26

birds (equating to 9.07 collision fatalities over the lifespan of the wind farm). Factoring in the avoidance rate, based on the 2022/23 survey data the number of collisions during the non-breeding season would be 0.013 birds (equating to 0.451 collision fatalities during the non-breeding season over the lifespan of the wind farm). Collision risk modelling for kestrel is summarised in Table 8 below.

Table 8. Kestrel airspace collision risk model summary

Survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020-September 2021	95%	0.323	11.312
October 2021-September 2022		0.195	6.824
Mean annual values		**0.259**	**9.068**
October 2022-March 2023		0.013	0.451

4.4 Peregrine

Based on its status within Ireland, peregrine is considered to potentially be present within the WFA year-round. Risk modelling for this species is therefore appropriate for both the breeding and non-breeding seasons.

Peregrine was only recorded within the WFA at risk height during the non-breeding season in 2020/21 and 2022/23 during which 205 and 36 flight seconds were recorded within the WFA respectively. Considering the potential year-round presence of peregrine within the WFA, collision risk has been calculated based on a modelled period of one year (i.e. October 2020 to September 2021 inclusive, and April 2022 to March 2023 inclusive). It should therefore be noted that, based on survey data, this assessment of collision risk is likely to be precautionary, as during the VP surveys undertaken from October 2021 to September 2022 inclusive no peregrines were recorded at risk height within the WFA.

Based on the measurements and flight parameters for peregrine described in Table 4, and the turbine specifications described in Table 1, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 5.6%.

Therefore, in the absence of any avoiding actions, the estimated annual number of peregrine collision fatalities based on the 2020/21 survey data is 1.81 birds, whilst the estimated annual number of peregrine fatalities based on the 2022/23 survey data is 0.23 birds.

Taking into consideration an avoidance rate of 98% (in line with SNH guidance), the estimated annual number of peregrine collision fatalities is 0.04 birds for 2020/21 and 0.005 birds for 2022/23. This would equate to an estimated 1.27 peregrine collision fatalities over the anticipated lifespan of the wind farm based on the 2020/21 data, and an estimated 0.16 peregrine collision fatalities over the anticipated lifespan of the wind farm based on the 2022/23 data. Based on an average of these two years of data there would be an estimated

0.72 peregrine collision fatalities over the anticipated lifespan of the wind farm. Collision risk modelling for peregrine is summarised in Table 9 below.

Table 9. Peregrine airspace collision risk model summary

Survey period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020-September 2021	98% (default value)	0.036	1.271
April 2022-March 2023		0.005	0.159
Mean annual values		**0.020**	**0.715**

4.5 Pomarine skua

A scarce passage migrant in Ireland, pomarine skua could potentially fly through the WFA during the breeding and non-breeding seasons. Risk modelling for this species is therefore undertaken for the entire year.

Pomarine skua was recorded within the WFA on a single occasion during the non-breeding season in 2022/23, during which 50 flight seconds were recorded within the WFA. Based on the possible presence of pomarine skua outside of the non-breeding season (particularly in April-May), collision risk has been modelled based on the year from April 2022 to March 2023 inclusive (i.e. a period of 365 days). It should therefore be noted that, based on survey data, this assessment of collision risk is likely to be precautionary, as during the surveys undertaken in October 2020 to September 2022 no pomarine skuas were recorded, and there are months within the modelled period within which presence of pomarine skua within the WFA is highly unlikely.

Based on the measurements and flight parameters for pomarine skua described in Table 4, and the turbine specifications described in Table 1, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 5.3%.

Therefore, in the absence of any avoiding actions, the estimated annual number of pomarine skua collision fatalities, based on the 2022/23 survey data, is 0.61 birds.

Taking into consideration an avoidance rate of 99.5% (in line with SNH guidance), the estimated annual number of pomarine skua collision fatalities is 0.003 birds. This would equate to an estimated 0.11 pomarine skua collision fatalities over the anticipated lifespan of the wind farm. Taking into consideration the absence of pomarine skua observations within the WFA in the preceding year (i.e. between April 2021 and March 2022 inclusive), the mean annual collision rate for this species would be 0.002 birds (equating to 0.05 collision fatalities over the lifespan of the wind farm). Collision risk modelling for pomarine skua is summarised in Table 11 below.

Table 10. Pomarine skua fly through collision risk model summary

Modelled period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
April 2021-March 2022	99.5%	0	0
April 2022-March 2023		0.003	0.106
Mean annual values		**0.002**	**0.053**

4.6 Whooper swan

Based on its status within Ireland, whooper swan is only considered to potentially be flying through the WFA during the non-breeding season (i.e. October to March inclusive). Risk modelling for this species is therefore only appropriate for the non-breeding season.

Whooper swan was only recorded within the WFA during the non-breeding season VP surveys in 2021/22, during which 35 flight seconds were recorded within the WFA. Collision risk has been modelled for this period, based on possible whooper swan flights through the WFA between October and March inclusive (i.e. a period of 182 days). It should therefore be noted that, based on survey data, this assessment of collision risk is likely to be precautionary, as during the non-breeding VP surveys undertaken in 2020/21 no whooper swans were recorded.

Based on the measurements and flight parameters for whooper swan described in Table 4, and the turbine specifications described in Table 1, the probability of a bird flying through an operational turbine resulting in a collision, in the absence of any avoiding actions, is 8.9%.

Therefore, in the absence of any avoiding actions, the estimated annual number of whooper swan collision fatalities, based on the 2021/22 survey data, is 0.92 birds.

Taking into consideration an avoidance rate of 99.5% (in line with SNH guidance), the estimated annual number of whooper swan collision fatalities is 0.005 birds. This would equate to an estimated 0.16 whooper swan collision fatalities over the anticipated lifespan of the wind farm. Taking into consideration the absence of whooper swan observations within the WFA during the 2020/21 and 2022/23 non-breeding seasons, the mean annual collision rate for this species would be 0.001 birds (equating to 0.05 collision fatalities over the lifespan of the wind farm). Collision risk modelling for whooper swan is summarised in Table 11 below.

Table 11. Whooper swan fly through collision risk model summary

Modelled period	Avoidance rate	Estimated collision fatalities	
		Per year	35 years
October 2020-March 2021	99.5%	0	0
October 2021-March 2022		0.005	0.161
October 2022-March 2023		0	0
Mean values		**0.001**	**0.053**

5.0 DISCUSSION

Based on the VP survey data recorded at the wind farm site between October 2020 and March 2023 inclusive, six Key Ornithological Receptors were identified as being potentially susceptible to collision impacts with new wind turbines: specifically buzzard, kestrel, peregrine and pomarine skua during the entire year, and golden plover and whooper swan during the non-breeding season only.

Estimated collision risk fatalities for these species as a result of the new turbines, both annually and for the anticipated operational lifespan of the development (35 years) are presented in Section 4.

It should be noted that, for the reasons specified in Section 3.6 and Section 4, these calculations represent a precautionary scenario of collision fatalities from the Project.

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FIGURES

- Figure 8.1 – Viewsheds and Transects;
- Figure 8.2 – Flight observations from VP surveys for target species during the breeding season 2021;
- Figure 8.3 – Flight observations from VP surveys for target species during the breeding season 2022;
- Figure 8.4 – Flight observations from VP surveys for target species during the non-breeding season 2020/21;
- Figure 8.5 – Flight observations from VP surveys for target species during the non-breeding season 2021/22; and
- Figure 8.6 – Flight observations from VP surveys for target species during the non-breeding season 2022/23.

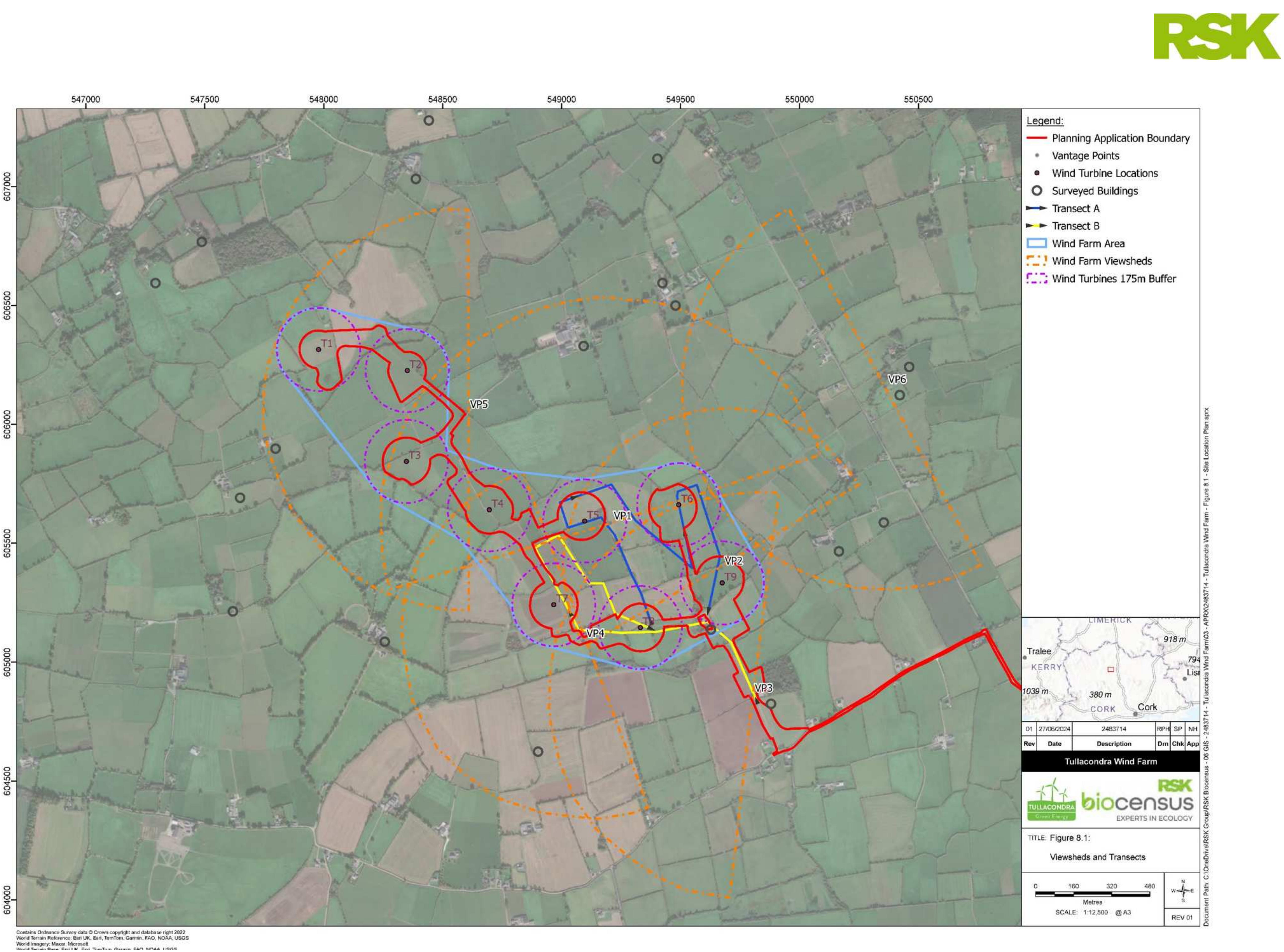


Figure 8.1 - Viewsheds and Transects

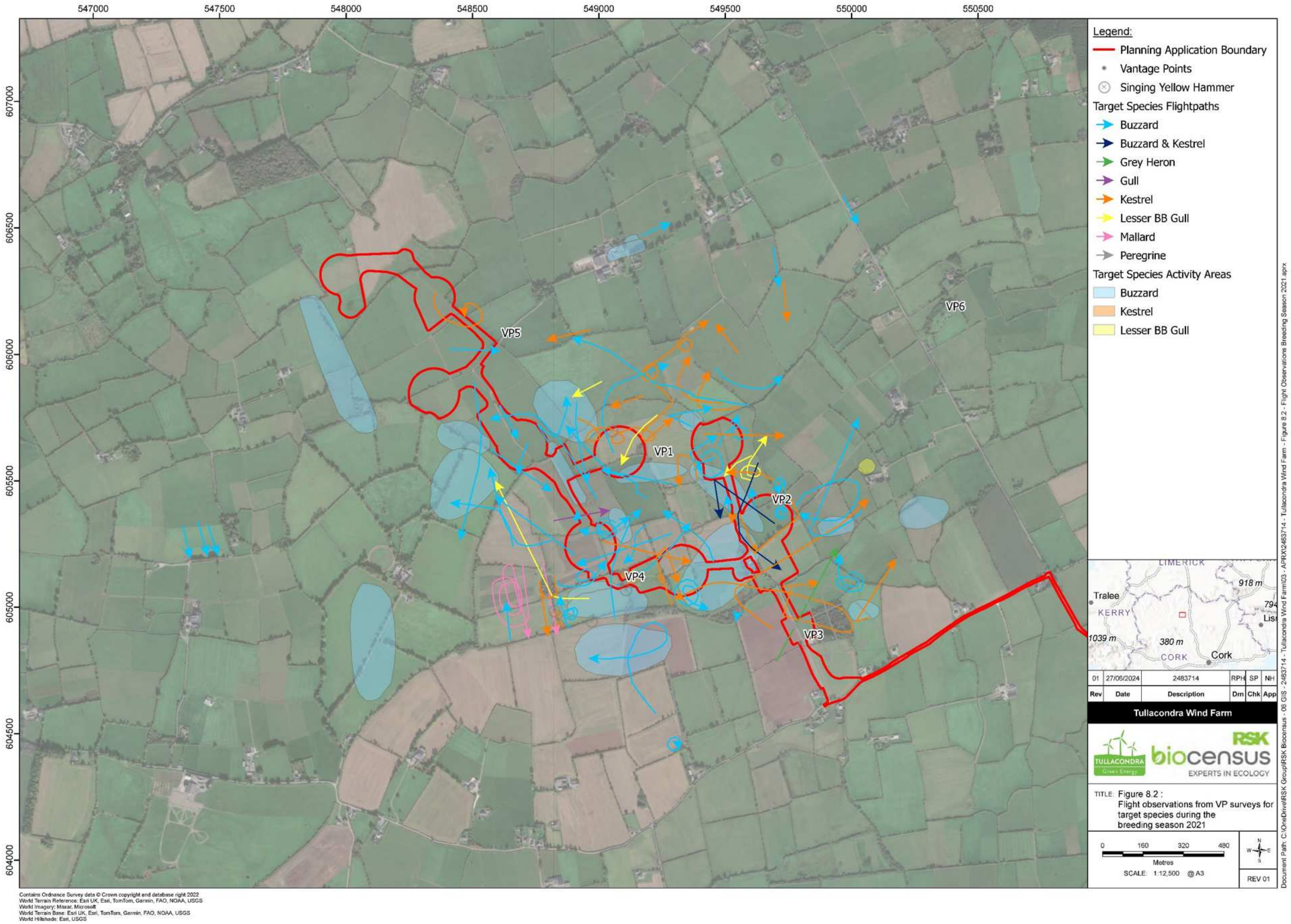


Figure 8.2 – Flight observations from VP surveys during the breeding season 2021

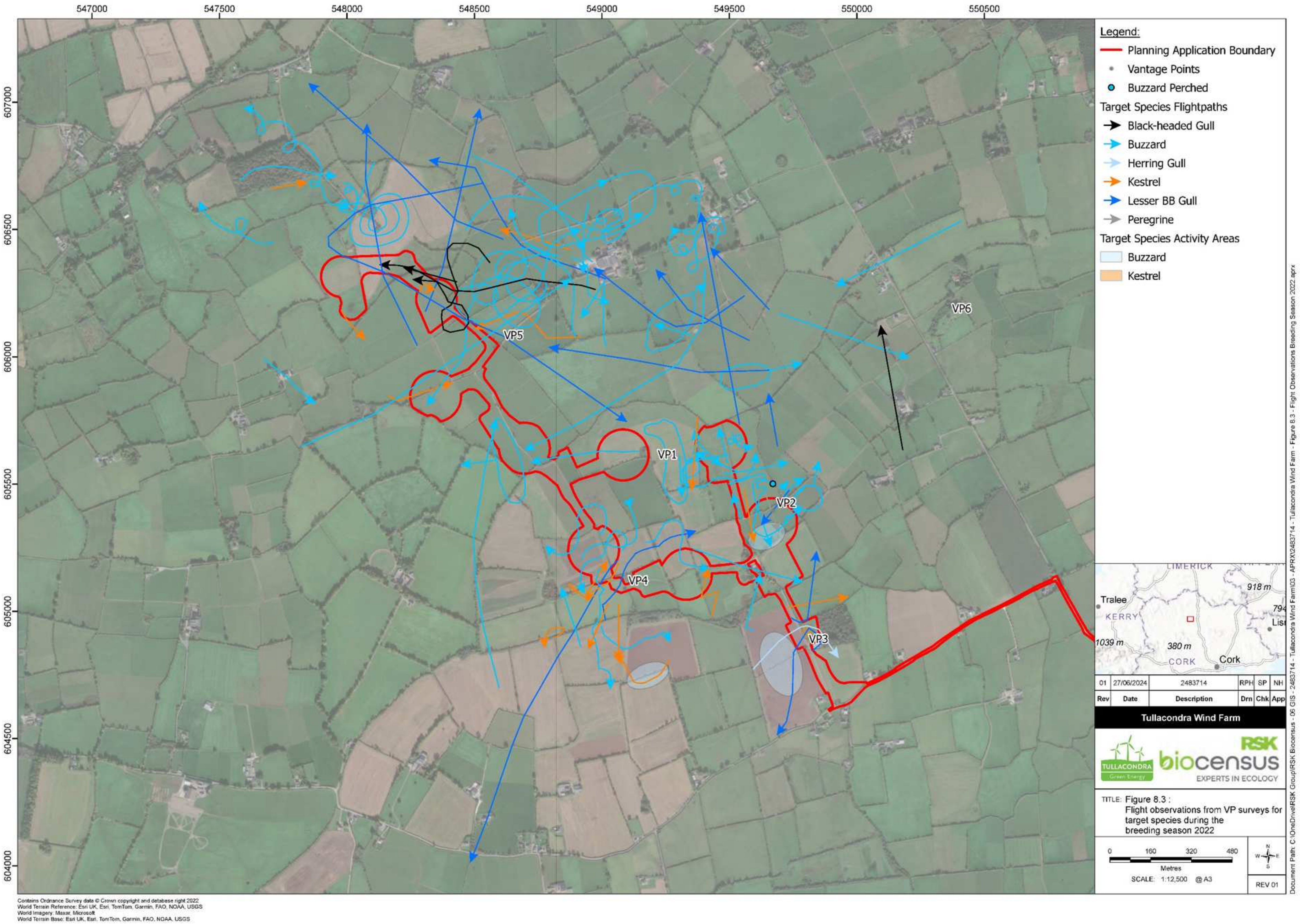


Figure 8.3 – Flight observations from VP surveys during the breeding season 2022

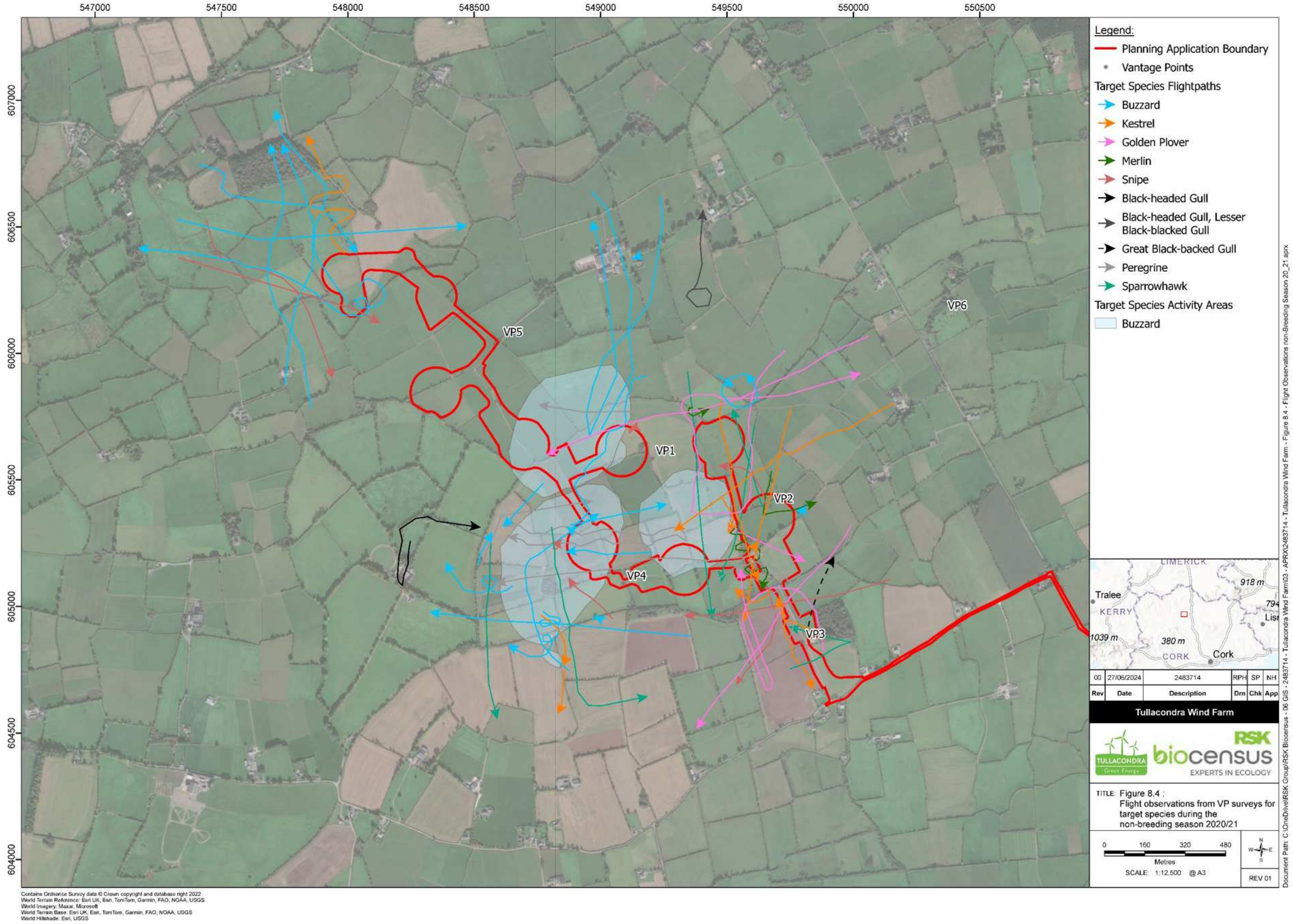
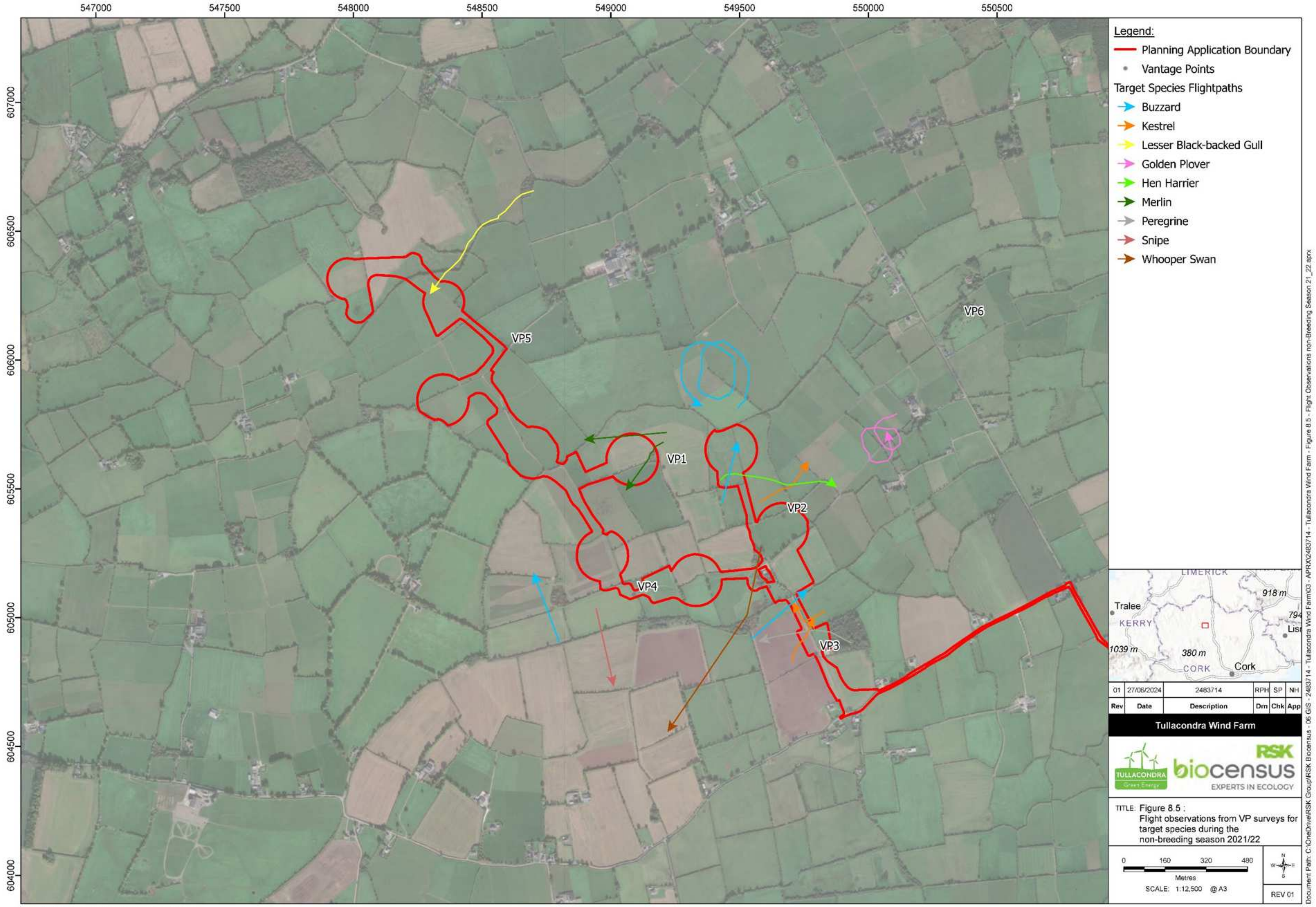


Figure 8.4 – Flight observations from VP surveys during the non-breeding season 2020/21



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World Imagery: Maxar, Microsoft
World Terrain Base: Esri UK, Esri, TomTom, Garmin, FAO, NOAA, USGS
World Hillshade: Esri, USGS

Figure 8.5 – Flight observations from VP surveys during the non-breeding season 2021/22

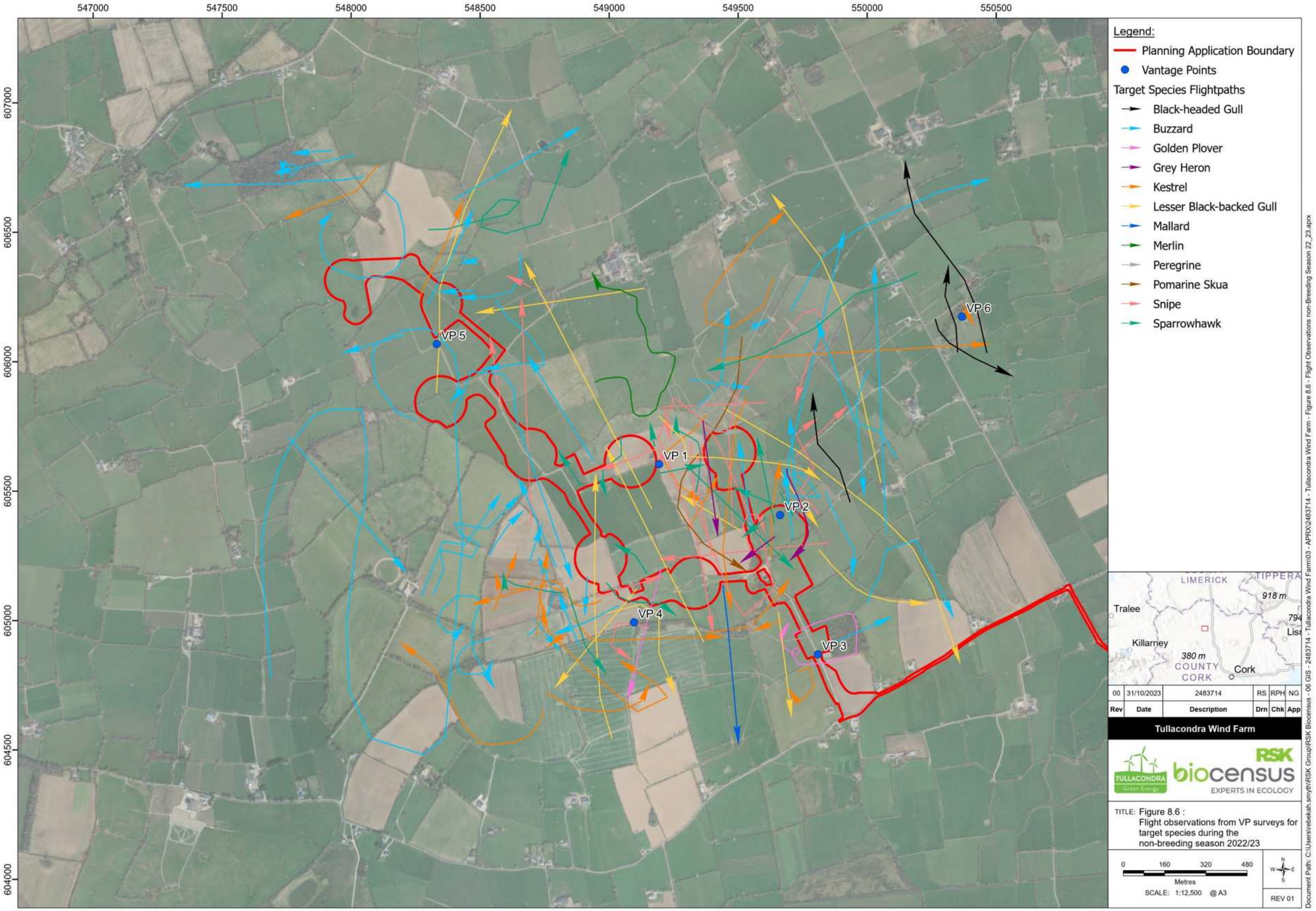

Figure 8.6 – Flight observations from VP surveys during the non-breeding season 2022/23

ANNEX A – FLIGHT ACTIVITY DATA

Flight activity by Key Ornithological Receptors within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Buzzard	B21	1	12/04/2021	1	11	30-40	11	4	4
Buzzard	B21	4	12/04/2021	1	183	100-130	183	183	183
Buzzard	B21	4	12/04/2021	1	20	70	20	20	20
Buzzard	B21	4	12/04/2021	1	165	30-200	135	100	100
Buzzard	B21	2	13/04/2021	2	30	60	30	6	12
Buzzard	B21	1	13/05/2021	2	15	30	15	15	30
Buzzard	B21	1	13/05/2021	1	4	20	4	2	2
Buzzard	B21	4	13/05/2021	1	35	25-40	35	35	35
Buzzard	B21	4	13/05/2021	1	17	30-40	17	12	12
Buzzard	B21	4	13/05/2021	2	420	30-40	420	420	840
Buzzard	B21	1	15/06/2021	1	26	15-20	13	13	13
Buzzard	B21	2	22/06/2021	1	32	140-180	32	32	32
Buzzard	B21	3	22/06/2021	2	45	25-40	45	45	90
Buzzard	B21	3	22/06/2021	1	10	100-110	10	10	10
Buzzard	B21	1	07/07/2021	2	120	30-80	120	120	240
Buzzard	B21	1	07/07/2021	1	214	5-100	189	165	165
Buzzard	B21	4	07/07/2021	1	165	30-50	165	124	124
Buzzard	B21	1	09/08/2021	1	200	40-60	200	120	120
Buzzard	B21	1	09/08/2021	1	68	5-30	60	52	52
Buzzard	B21	1	09/08/2021	1	45	60	45	45	45
Buzzard	B21	1	09/08/2021	2	30	30-40	30	30	60
Buzzard	B21	4	09/08/2021	1	195	40-80	195	195	195
Buzzard	B21	4	09/08/2021	2	60	35	60	15	30
Buzzard	B21	2	10/08/2021	1	135	20-50	135	135	135
Buzzard	B21	3	10/08/2021	1	420	40-150	420	30	30
Buzzard	**B21**				**Total**				**2579**
Buzzard	B22	1	25/04/2022	1	117	30-50	117	115	115
Buzzard	B22	5	25/04/2022	1	309	40-100	309	50	50
Buzzard	B22	4	29/04/2022	2	30	15-25	15	15	30
Buzzard	B22	4	29/04/2022	1	265	10-30	230	230	230
Buzzard	B22	4	29/04/2022	1	135	15-70	130	130	130
Buzzard	B22	4	29/04/2022	2	115	30-75	115	115	230
Buzzard	B22	4	29/04/2022	1	48	80	48	48	48
Buzzard	B22	4	19/05/2022	1	145	20-35	145	29	29
Buzzard	B22	2	25/05/2022	1	90	>180	0	0	0
Buzzard	B22	1	31/05/2022	1	174	20-100	174	174	174
Buzzard	B22	1	15/06/2022	1	180	150	180	180	180

Flight activity by Key Ornithological Receptors within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Buzzard	B22	2	15/06/2022	1	88	50-100	88	40	40
Buzzard	B22	1	11/07/2022	1	230	70-120	230	230	230
Buzzard	B22	1	11/07/2022	1	175	100	175	175	175
Buzzard	B22	1	11/07/2022	1	150	80-180	150	150	150
Buzzard	B22	5	21/07/2022	1	420	170-190	240	48	48
Buzzard	B22	5	21/07/2022	2	108	130-180	108	36	72
Buzzard	B22	4	25/07/2022	1	130	20-50	130	33	33
Buzzard	B22	2	26/07/2022	1	190	30	190	190	190
Buzzard	B22	1	09/08/2022	1	220	15-100	100	100	100
Buzzard	B22	1	09/08/2022	1	240	180	240	240	240
Buzzard	B22	3	03/09/2022	1	15	80	15	11	11
Buzzard	B22	5	22/09/2022	1	120	90-110	120	40	40
Buzzard	**B22**				**Total**				**2545**
Buzzard	NB20/21	1	25/10/2020	3	110	30-50	110	60	180
Buzzard	NB20/21	1	25/10/2020	1	100	20-90	100	20	20
Buzzard	NB20/21	1	25/10/2020	2	35	20-35	35	15	30
Buzzard	NB20/21	1	25/10/2020	2	45	90-140	45	10	20
Buzzard	NB20/21	1	25/10/2020	2	34	15-30	22	5	10
Buzzard	NB20/21	2	31/10/2020	3	175	60-90	175	60	180
Buzzard	NB20/21	2	31/10/2020	3	175	60-90	175	30	90
Buzzard	NB20/21	2	25/02/2021	2	120	100-180	120	120	240
Buzzard	NB20/21	4	25/02/2021	2	120	120	120	120	240
Buzzard	NB20/21	1	26/02/2021	2	300	20-40	300	200	400
Buzzard	**NB20/21**				**Total**				**1410**
Buzzard	NB22/23	5	14/10/2022	1	10	50-100	10	10	10
Buzzard	NB22/23	4	08/11/2022	1	480	20-50	480	160	160
Buzzard	NB22/23	5	08/11/2022	1	110	20-50	110	40	40
Buzzard	NB22/23	1	08/11/2022	1	120	0-50	60	5	5
Buzzard	NB22/23	6	08/11/2022	1	12	50-100	12	1	1
Buzzard	NB22/23	4	08/11/2022	1	60	20-50	60	15	15
Buzzard	NB22/23	6	18/01/2023	1	12	20-50	12	8	8
Buzzard	NB22/23	2	18/01/2023	1	10	20-50	10	10	10
Buzzard	NB22/23	5	14/02/2023	1	45	20-50	45	8	8
Buzzard	NB22/23	6	14/03/2023	3	63	50-100	63	35	105
Buzzard	NB22/23	5	14/03/2023	1	198	20-50	198	60	60
Buzzard	NB22/23	5	14/03/2023	1	124	20-50	124	124	124
Buzzard	NB22/23	3	14/03/2023	3	9	50-100	9	9	27
Buzzard	**NB22/23**				**Total**				**573**
Golden plover	NB20/21	2	30/10/2020	12	25	80	25	25	300

Flight activity by Key Ornithological Receptors within the flight risk volume (vW)									
Species	Season	VP	Date	No. birds	Total flight time	Flight height	Flight time at risk height	Flight time in vW	Bird flight seconds in vW
Golden plover	NB20/21	1	25/01/2021	14	60	30-40	60	35	490
Golden plover	NB20/21	3	16/02/2021	6	180	60	180	10	60
Golden plover	**NB20/21**				**Total**				**850**
Kestrel	B21	1	13/05/2021	1	14	20-30	10	10	10
Kestrel	B21	1	13/05/2021	1	360	45	360	180	180
Kestrel	B21	1	13/05/2021	1	120	40	120	120	120
Kestrel	B21	1	15/06/2021	1	8	25	8	4	4
Kestrel	B21	3	22/06/2021	1	628	15-120	608	200	200
Kestrel	B21	2	22/06/2021	1	30	60	30	30	30
Kestrel	B21	3	22/06/2021	1	59	100-140	59	40	40
Kestrel	B21	2	09/07/2021	2	15	25	15	15	30
Kestrel	B21	2	09/07/2021	1	180	20-50	180	180	180
Kestrel	B21	2	09/07/2021	1	5	25	5	5	5
Kestrel	**B21**				**Total**				**799**
Kestrel	B22	4	19/05/2022	1	17	50-60	17	17	17
Kestrel	B22	5	31/05/2022	1	20	35	20	20	20
Kestrel	B22	5	31/05/2022	1	460	40-80	460	460	460
Kestrel	B22	5	31/05/2022	1	60	30	60	60	60
Kestrel	B22	3	22/09/2022	1	70	30-50	70	70	70
Kestrel	**B22**				**Total**				**627**
Kestrel	NB20/21	1	25/10/2020	1	70	40-60	70	10	10
Kestrel	NB20/21	2	30/10/2020	1	45	25-40	45	45	45
Kestrel	NB20/21	2	26/01/2021	1	30	30	30	25	25
Kestrel	NB20/21	2	26/03/2021	1	40	30	40	25	25
Kestrel	**NB20/21**				**Total**				**105**
Kestrel	NB22/23	1	14/10/2022	1	70	20-50	70	70	70
Kestrel	**NB22/23**				**Total**				**70**
Peregrine	NB20/21	4	24/11/2020	1	180	30	180	40	40
Peregrine	NB20/21	4	24/11/2020	1	30	25	30	25	25
Peregrine	NB20/21	4	24/11/2020	2	60	30	60	50	100
Peregrine	NB20/21	4	18/12/2020	1	60	40	60	40	40
Peregrine	**NB20/21**				**Total**				**205**
Peregrine	NB22/23	1	08/11/2022	1	180	0-100	150	30	30
Peregrine	NB22/23	1	18/01/2023	1	18	0-50	9	6	6
Peregrine	NB22/23				**Total**				36
Pomarine skua	NB22/23	2	08/11/2022	1	60	50-100	60	50	50
Pomarine skua	NB22/23				**Total**				50

Flight activity by Key Ornithological Receptors within the flight risk volume (vW)									
Species	**Season**	**VP**	**Date**	**No. birds**	**Total flight time**	**Flight height**	**Flight time at risk height**	**Flight time in vW**	**Bird flight seconds in vW**
Whooper swan	NB21/22	3	03/11/2021	1	120	30	120	35	35
Whooper swan	**NB21/22**				**Total**				**35**

ANNEX B – COLLISION PROBABILITY CALCULATIONS

Buzzard

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 27/10/2022

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	4.2	m
Pitch (degrees)	6	
BirdLength	0.54	m
Wingspan	1.2	m
F: Flapping (0) or gliding (+1)	1	
Bird speed	9.45	m/sec
RotorDiam	150	m
RotationPeriod	5.00	sec
Bird aspect ratioo: β	0.45	

Calculation of alpha and p(collision) as a function of radius

			Upwind:			Downwind:		
r/R radius	c/C chord	α alpha	collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
0.025	0.575	4.01	12.95	0.82	0.00103	12.44	0.79	0.00099
0.075	0.575	1.34	4.48	0.28	0.00214	3.98	0.25	0.00190
0.125	0.702	0.80	3.27	0.21	0.00260	2.66	0.17	0.00211
0.175	0.860	0.57	2.87	0.18	0.00319	2.12	0.13	0.00235
0.225	0.994	0.45	2.83	0.18	0.00404	1.95	0.12	0.00279
0.275	0.947	0.36	2.40	0.15	0.00419	1.57	0.10	0.00273
0.325	0.899	0.31	2.09	0.13	0.00432	1.30	0.08	0.00269
0.375	0.851	0.27	1.86	0.12	0.00444	1.12	0.07	0.00266
0.425	0.804	0.24	1.68	0.11	0.00455	0.98	0.06	0.00264
0.475	0.756	0.21	1.54	0.10	0.00464	0.87	0.06	0.00264
0.525	0.708	0.19	1.42	0.09	0.00472	0.79	0.05	0.00265
0.575	0.660	0.17	1.31	0.08	0.00479	0.73	0.05	0.00267
0.625	0.613	0.16	1.22	0.08	0.00484	0.68	0.04	0.00270
0.675	0.565	0.15	1.14	0.07	0.00488	0.64	0.04	0.00275
0.725	0.517	0.14	1.07	0.07	0.00491	0.61	0.04	0.00282
0.775	0.470	0.13	1.00	0.06	0.00492	0.59	0.04	0.00289
0.825	0.422	0.12	0.94	0.06	0.00492	0.57	0.04	0.00298
0.875	0.374	0.11	0.88	0.06	0.00491	0.55	0.04	0.00308
0.925	0.327	0.11	0.83	0.05	0.00488	0.54	0.03	0.00320
0.975	0.279	0.10	0.78	0.05	0.00484	0.54	0.03	0.00336

Overall p(collision) = **Upwind** **8.4%** **Downwind** **5.3%**

Average **6.8%**

Golden plover

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 27/10/2022

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	4.2	m
Pitch (degrees)	6	
BirdLength	0.28	m
Wingspan	0.72	m
F: Flapping (0) or gliding (+1)	0	
Bird speed	17.9	m/sec
RotorDiam	150	m
RotationPeriod	5.00	sec
Bird aspect ratioo: β	0.39	

Calculation of alpha and p(collision) as a function of radius

			Upwind:			Downwind:		
r/R radius	c/C chord	α alpha	collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
0.025	0.575	7.60	23.97	0.80	0.00100	23.46	0.79	0.00098
0.075	0.575	2.53	8.16	0.27	0.00205	7.65	0.26	0.00192
0.125	0.702	1.52	5.85	0.20	0.00245	5.24	0.18	0.00219
0.175	0.860	1.09	5.06	0.17	0.00297	4.30	0.14	0.00252
0.225	0.994	0.84	4.55	0.15	0.00343	3.68	0.12	0.00277
0.275	0.947	0.69	3.64	0.12	0.00336	2.81	0.09	0.00259
0.325	0.899	0.58	3.01	0.10	0.00328	2.22	0.07	0.00242
0.375	0.851	0.51	2.54	0.09	0.00319	1.79	0.06	0.00225
0.425	0.804	0.45	2.17	0.07	0.00310	1.47	0.05	0.00209
0.475	0.756	0.40	1.88	0.06	0.00300	1.22	0.04	0.00194
0.525	0.708	0.36	1.66	0.06	0.00292	1.04	0.03	0.00183
0.575	0.660	0.33	1.48	0.05	0.00285	0.90	0.03	0.00174
0.625	0.613	0.30	1.33	0.04	0.00278	0.79	0.03	0.00165
0.675	0.565	0.28	1.19	0.04	0.00270	0.70	0.02	0.00157
0.725	0.517	0.26	1.07	0.04	0.00261	0.62	0.02	0.00150
0.775	0.470	0.25	0.97	0.03	0.00251	0.55	0.02	0.00144
0.825	0.422	0.23	0.87	0.03	0.00241	0.50	0.02	0.00138
0.875	0.374	0.22	0.78	0.03	0.00230	0.46	0.02	0.00133
0.925	0.327	0.21	0.70	0.02	0.00218	0.42	0.01	0.00129
0.975	0.279	0.19	0.63	0.02	0.00206	0.38	0.01	0.00126
	Overall p(collision) =			**Upwind**	**5.3%**		**Downwind**	**3.7%**
					Average	**4.5%**		

Kestrel

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 27/10/2022

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	4.2	m
Pitch (degrees)	6	
BirdLength	0.34	m
Wingspan	0.76	m
F: Flapping (0) or gliding (+1)	0	
Bird speed	9.95	m/sec
RotorDiam	150	m
RotationPeriod	5.00	sec
Bird aspect ratioo: β	0.45	

Calculation of alpha and p(collision) as a function of radius

r/R radius	c/C chord	α alpha	Upwind: collide length	Upwind: p(collision)	Upwind: contribution from radius r	Downwind: collide length	Downwind: p(collision)	Downwind: contribution from radius r
0.025	0.575	4.22	13.60	0.82	0.00103	13.10	0.79	0.00099
0.075	0.575	1.41	4.70	0.28	0.00213	4.20	0.25	0.00190
0.125	0.702	0.84	3.42	0.21	0.00258	2.81	0.17	0.00212
0.175	0.860	0.60	3.00	0.18	0.00317	2.25	0.14	0.00237
0.225	0.994	0.47	2.74	0.17	0.00372	1.87	0.11	0.00254
0.275	0.947	0.38	2.27	0.14	0.00377	1.44	0.09	0.00239
0.325	0.899	0.32	1.95	0.12	0.00383	1.17	0.07	0.00228
0.375	0.851	0.28	1.71	0.10	0.00388	0.97	0.06	0.00219
0.425	0.804	0.25	1.53	0.09	0.00391	0.82	0.05	0.00210
0.475	0.756	0.22	1.37	0.08	0.00393	0.71	0.04	0.00203
0.525	0.708	0.20	1.25	0.08	0.00394	0.62	0.04	0.00198
0.575	0.660	0.18	1.14	0.07	0.00394	0.56	0.03	0.00193
0.625	0.613	0.17	1.04	0.06	0.00392	0.50	0.03	0.00190
0.675	0.565	0.16	0.96	0.06	0.00390	0.46	0.03	0.00188
0.725	0.517	0.15	0.88	0.05	0.00386	0.43	0.03	0.00187
0.775	0.470	0.14	0.81	0.05	0.00380	0.40	0.02	0.00187
0.825	0.422	0.13	0.75	0.05	0.00374	0.38	0.02	0.00189
0.875	0.374	0.12	0.69	0.04	0.00366	0.36	0.02	0.00192
0.925	0.327	0.11	0.64	0.04	0.00356	0.35	0.02	0.00197
0.975	0.279	0.11	0.59	0.04	0.00346	0.34	0.02	0.00202

Overall p(collision) = **Upwind** **7.0%** **Downwind** **4.0%**

Average **5.5%**

Peregrine

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 27/10/2022

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	4.2	m
Pitch (degrees)	6	
BirdLength	0.42	m
Wingspan	1.02	m
F: Flapping (0) or gliding (+1)	0	
Bird speed	12.1	m/sec
RotorDiam	150	m
RotationPeriod	5.00	sec
Bird aspect ratioo: β	0.41	

Calculation of alpha and p(collision) as a function of radius

r/R radius	c/C chord	α alpha	Upwind: collide length	Upwind: p(collision)	Upwind: contribution from radius r	Downwind: collide length	Downwind: p(collision)	Downwind: contribution from radius r
0.025	0.575	5.14	17.82	0.88	0.00110	17.32	0.86	0.00107
0.075	0.575	1.71	6.11	0.30	0.00227	5.60	0.28	0.00208
0.125	0.702	1.03	4.37	0.22	0.00271	3.75	0.19	0.00232
0.175	0.860	0.73	3.76	0.19	0.00326	3.01	0.15	0.00261
0.225	0.994	0.57	3.39	0.17	0.00378	2.52	0.12	0.00281
0.275	0.947	0.47	2.74	0.14	0.00373	1.91	0.09	0.00260
0.325	0.899	0.40	2.30	0.11	0.00370	1.51	0.07	0.00243
0.375	0.851	0.34	2.01	0.10	0.00374	1.26	0.06	0.00235
0.425	0.804	0.30	1.79	0.09	0.00377	1.08	0.05	0.00228
0.475	0.756	0.27	1.61	0.08	0.00378	0.94	0.05	0.00222
0.525	0.708	0.24	1.45	0.07	0.00379	0.83	0.04	0.00217
0.575	0.660	0.22	1.33	0.07	0.00378	0.75	0.04	0.00213
0.625	0.613	0.21	1.21	0.06	0.00376	0.68	0.03	0.00210
0.675	0.565	0.19	1.12	0.06	0.00374	0.62	0.03	0.00208
0.725	0.517	0.18	1.03	0.05	0.00370	0.58	0.03	0.00207
0.775	0.470	0.17	0.95	0.05	0.00366	0.54	0.03	0.00207
0.825	0.422	0.16	0.88	0.04	0.00360	0.51	0.03	0.00208
0.875	0.374	0.15	0.81	0.04	0.00353	0.49	0.02	0.00210
0.925	0.327	0.14	0.75	0.04	0.00345	0.47	0.02	0.00214
0.975	0.279	0.13	0.70	0.03	0.00336	0.45	0.02	0.00218

Overall p(collision) = **Upwind** **6.8%** **Downwind** **4.4%**

Average **5.6%**

Pomarine skua

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 16/05/2023

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	4.2	m
Pitch (degrees)	6	
BirdLength	0.42	m
Wingspan	1.13	m
F: Flapping (0) or gliding (+1)	0	
Bird speed	15	m/sec
RotorDiam	150	m
RotationPeriod	5.00	sec
Bird aspect ratioo: β	0.37	

Calculation of alpha and p(collision) as a function of radius

			Upwind:			Downwind:		
r/R radius	c/C chord	α alpha	collide length	p(collision)	contribution from radius r	collide length	p(collision)	contribution from radius r
0.025	0.575	6.37	22.74	0.91	0.00114	22.23	0.89	0.00111
0.075	0.575	2.12	7.75	0.31	0.00232	7.24	0.29	0.00217
0.125	0.702	1.27	5.48	0.22	0.00274	4.86	0.19	0.00243
0.175	0.860	0.91	4.67	0.19	0.00327	3.92	0.16	0.00274
0.225	0.994	0.71	4.17	0.17	0.00376	3.30	0.13	0.00297
0.275	0.947	0.58	3.36	0.13	0.00369	2.53	0.10	0.00278
0.325	0.899	0.49	2.79	0.11	0.00362	2.00	0.08	0.00260
0.375	0.851	0.42	2.36	0.09	0.00354	1.61	0.06	0.00242
0.425	0.804	0.37	2.03	0.08	0.00346	1.33	0.05	0.00226
0.475	0.756	0.34	1.81	0.07	0.00344	1.15	0.05	0.00218
0.525	0.708	0.30	1.63	0.07	0.00342	1.01	0.04	0.00211
0.575	0.660	0.28	1.47	0.06	0.00339	0.89	0.04	0.00206
0.625	0.613	0.25	1.34	0.05	0.00335	0.80	0.03	0.00201
0.675	0.565	0.24	1.22	0.05	0.00331	0.73	0.03	0.00197
0.725	0.517	0.22	1.12	0.04	0.00325	0.67	0.03	0.00194
0.775	0.470	0.21	1.03	0.04	0.00319	0.62	0.02	0.00191
0.825	0.422	0.19	0.95	0.04	0.00312	0.57	0.02	0.00190
0.875	0.374	0.18	0.87	0.03	0.00304	0.54	0.02	0.00189
0.925	0.327	0.17	0.80	0.03	0.00295	0.51	0.02	0.00189
0.975	0.279	0.16	0.73	0.03	0.00286	0.49	0.02	0.00190

Overall p(collision) = **Upwind** **6.3%** **Downwind** **4.3%**

Average **5.3%**

Whooper swan

CALCULATION OF COLLISION RISK FOR BIRD PASSING THROUGH ROTOR AREA

Only enter input parameters in blue

W Band 27/10/2022

K: [1D or [3D] (0 or 1)	1	
NoBlades	3	
MaxChord	4.2	m
Pitch (degrees)	6	
BirdLength	1.52	m
Wingspan	2.3	m
F: Flapping (0) or gliding (+1)	0	
Bird speed	17.3	m/sec
RotorDiam	150	m
RotationPeriod	5.00	sec
Bird aspect ratioo: β	0.66	

Calculation of alpha and p(collision) as a function of radius

r/R radius	c/C chord	α alpha	Upwind: collide length	Upwind: p(collision)	Upwind: contribution from radius r	Downwind: collide length	Downwind: p(collision)	Downwind: contribution from radius r
0.025	0.575	7.34	34.77	1.00	0.00125	34.27	1.00	0.00125
0.075	0.575	2.45	11.76	0.41	0.00306	11.25	0.39	0.00293
0.125	0.702	1.47	7.99	0.28	0.00346	7.37	0.26	0.00320
0.175	0.860	1.05	6.56	0.23	0.00398	5.80	0.20	0.00352
0.225	0.994	0.82	5.70	0.20	0.00445	4.83	0.17	0.00377
0.275	0.947	0.67	4.59	0.16	0.00438	3.76	0.13	0.00359
0.325	0.899	0.56	4.04	0.14	0.00455	3.25	0.11	0.00366
0.375	0.851	0.49	3.63	0.13	0.00473	2.89	0.10	0.00375
0.425	0.804	0.43	3.32	0.12	0.00490	2.62	0.09	0.00386
0.475	0.756	0.39	3.07	0.11	0.00506	2.41	0.08	0.00397
0.525	0.708	0.35	2.87	0.10	0.00522	2.24	0.08	0.00408
0.575	0.660	0.32	2.69	0.09	0.00537	2.11	0.07	0.00421
0.625	0.613	0.29	2.54	0.09	0.00551	2.00	0.07	0.00434
0.675	0.565	0.27	2.41	0.08	0.00564	1.91	0.07	0.00448
0.725	0.517	0.25	2.29	0.08	0.00577	1.84	0.06	0.00463
0.775	0.470	0.24	2.19	0.08	0.00589	1.78	0.06	0.00478
0.825	0.422	0.22	2.10	0.07	0.00600	1.73	0.06	0.00494
0.875	0.374	0.21	2.01	0.07	0.00611	1.68	0.06	0.00511
0.925	0.327	0.20	1.93	0.07	0.00620	1.65	0.06	0.00528
0.975	0.279	0.19	1.86	0.06	0.00630	1.62	0.06	0.00547

Overall p(collision) = **Upwind** **9.8%** **Downwind** **8.1%**

Average **8.9%**

ANNEX C – COLLISION RISK MODELLING ANALYSIS

Buzzard

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	Year October 2020-September 2021	Year October 2021-September 2022	October 2022-March 2023
Number of turbines	9	9	9
WFA	1266232.843	1266232.843	1266232.843
Rotor diameter, inc. hub (m)	150	150	150
Rotor swept area (RSA) (m^2)	17,671.46	17,671.46	17,671.46
Rotor depth (m)	4.29	4.29	4.29
Bird length (m)	0.54	0.54	0.54
(Vw) Flight risk volume (m^3)	189,934,926.45	189,934,926.45	189,934,926.45
(Vr) Combined vol swept by blades (m^3)	768,178.31	768,178.31	768,178.31
(Vr) as % of (Vw) (%)	0.404443%	0.404443%	0.404443%

STAGE 2 (Birds flying through turbine area)

Detail	Year October 2020-September 2021	Year October 2021-September 2022	October 2022-March 2023
VP survey hours	287.00	330.00	216.00
Bird flight seconds within (Vw)	3989	2545	573
Average Day length (over period)	12.27	12.27	9.58
Season days	365	365	181
Bird speed (m/sec)	9.45	9.45	9.45
Probability of collision (p) [model]	6.8%	6.8%	6.8%
Flight Seconds/survey hour (bird secs)	13.89895	7.71212	2.65278
Flight Seconds/season day (bird secs)	170.54017	94.62773	25.41361
Flight Seconds/season (bird secs)	62247.16359	34539.12045	4599.86361
n x (Vr/Vw)	251.75423	139.69102	18.60382
Bird transit time through turbine (t)	0.51111	0.51111	0.51111
No. of transits through rotor swept vol	492.56262	273.30851	36.39878
No. of birds hit by blades/season	33.49426	18.58498	2.47512

STAGE 3 (Avoidance)

Detail	Year October 2020-September 2021	Year October 2021-September 2022	October 2022-March 2023
Avoidance rate (SNH 2018)	98%	98%	98%
No. of birds hit by blades/season	0.669885164	0.371699577	0.049502342
Estimated casualties over 35 yrs	23.446	13.009	1.733

RESULTS SUMMARY

Period	Year	Estimated annual bird flights through turbine swept volume	Estimated casualties (assuming 98% avoidance) Per year	Over 35 years
Year	October 2020-September 2021	492.56	0.6699	23.4460
Year	October 2021-September 2022	273.31	0.3717	13.0095
Year	**Average (year)**	**382.94**	**0.5208**	**18.2277**
Non-breeding season	October 2022-March 2023	36.40	0.0495	1.7326

Golden plover

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	Winter 2020/21
Number of turbines	9
WFA (m^2)	1266232.843
Rotor diameter, inc. hub (m)	150
Rotor swept area (RSA) (m^2)	17,671.46
Rotor depth (m)	4.29
Bird length (m)	0.28
(Vw) Flight risk volume (m^3)	189,934,926.45
(Vr) Combined vol swept by blades (m^3)	726,349.97
(Vr) as % of (Vw) (%)	0.382420%

STAGE 2 (Birds flying through turbine area)

Detail	Winter 2020/21
VP survey hours	143.00
Bird flight seconds within (Vw)	850
Average Day length (over period)	9.59
Season days	182
Bird speed (m/sec)	17.9
Probability of collision (p) [model]	4.5%
Flight Seconds/survey hour (bird secs)	5.94406
Flight Seconds/season day (bird secs)	56.99161
Flight Seconds/season (bird secs)	10372.47273
n x (Vr/Vw)	39.66645
Bird transit time through turbine (t)	0.25514
No. of transits through rotor swept vol	155.46957
No. of birds hit by blades/season	6.99613

STAGE 3 (Avoidance)

Detail	Winter 2020/21
Avoidance rate (SNH 2018)	98.0%
No. of birds hit by blades/season	0.139922617
Estimated casualties over 35 yrs	4.897

RESULTS SUMMARY TABLE

Period	Year	Estimated annual bird flights through turbine swept volume	Estimated casualties (assuming 98% avoidance) Per year	Over 35 years
Winter	2020/21	155.47	0.140	4.897
Winter	2021/22	0.00	0.000	0.000
Winter	2022/23	0.00	0.000	0.000
Winter	**Average (winter)**	**51.82**	**0.05**	**1.63**

Kestrel

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	Year October 2020-September 2021	Year October 2021-September 2022	October 2022-March 2023
Number of turbines	9	9	9
WFA	1266232.843	1266232.843	1266232.843
Rotor diameter, inc. hub (m)	150	150	150
Rotor swept area (RSA) (m^2)	17,671.46	17,671.46	17,671.46
Rotor depth (m)	4.29	4.29	4.29
Bird length (m)	0.34	0.34	0.34
(Vw) Flight risk volume (m^3)	189,934,926.45	189,934,926.45	189,934,926.45
(Vr) Combined vol swept by blades (m^3)	736,369.68	736,369.68	736,369.68
(Vr) as % of (Vw) (%)	0.387696%	0.387696%	0.387696%

STAGE 2 (Birds flying through turbine area)

Detail	Year October 2020-September 2021	Year October 2021-September 2022	October 2022-March 2023
VP survey hours	287.00	330.00	216.00
Bird flight seconds within (Vw)	904	627	70
Average Day length (over period)	12.27	12.27	9.58
Season days	365	365	181
Bird speed (m/sec)	9.95	9.95	9.95
Probability of collision (p) [model]	5.5%	5.5%	5.5%
Flight Seconds/survey hour (bird secs)	3.14983	1.90000	0.32407
Flight Seconds/season day (bird secs)	38.64836	23.31300	3.10463
Flight Seconds/season (bird secs)	14106.65226	8509.24500	561.93796
n x (Vr/Vw)	54.69089	32.98998	2.17861
Bird transit time through turbine (t)	0.46533	0.46533	0.46533
No. of transits through rotor swept vol	117.53227	70.89640	4.68189
No. of birds hit by blades/season	6.46427	3.89930	0.25750

STAGE 3 (Avoidance)

Detail	Year October 2020-September 2021	Year October 2021-September 2022	October 2022-March 2023
Avoidance rate (SNH 2018)	95%	95%	95%
No. of birds hit by blades/season	0.323213738	0.194965101	0.012875207
Estimated casualties over 35 yrs	11.312	6.824	0.451

RESULTS SUMMARY

Period	Year	Estimated annual bird flights through turbine swept volume	Estimated casualties (assuming 95% avoidance) Per year	Over 35 years
Year	October 2020-September 2021	117.532	0.323	11.312
Year	October 2021-September 2022	70.896	0.195	6.824
Year	**Average (year)**	**94.214**	**0.259**	**9.068**
Non-breeding season	October 2022-March 2023	4.682	0.013	0.451

Peregrine

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	October 2020-September 2021	April 2022-March 2023
Number of turbines	9	9
WFA (m^2)	1266232.843	1266232.843
Rotor diameter, inc. hub (m)	150	150
Rotor swept area (RSA) (m^2)	17,671.46	17,671.46
Rotor depth (m)	4.29	4.29
Bird length (m)	0.42	0.42
(Vw) Flight risk volume (m^3)	189,934,926.45	189,934,926.45
(Vr) Combined vol swept by blades (m^3)	748,616.00	748,616.00
(Vr) as % of (Vw) (%)	0.394143%	0.394143%

STAGE 2 (Birds flying through turbine area)

Detail	October 2020-September 2021	April 2022-March 2023
VP survey hours	287.00	402.00
Bird flight seconds within (Vw)	205	36
Average Day length (over period)	12.27	12.27
Season days	365	365
Bird speed (m/sec)	12.1	12.1
Probability of collision (p) [model]	5.6%	5.6%
Flight Seconds/survey hour (bird secs)	0.71429	0.08955
Flight Seconds/season day (bird secs)	8.76429	1.09881
Flight Seconds/season (bird secs)	3198.96429	401.06418
n x (Vr/Vw)	12.60851	1.58077
Bird transit time through turbine (t)	0.38901	0.38901
No. of transits through rotor swept vol	32.41193	4.06358
No. of birds hit by blades/season	1.81507	0.22756

STAGE 3 (Avoidance)

Detail	October 2020-September 2021	April 2022-March 2023
Avoidance rate (SNH 2018)	98.0%	98.0%
No. of birds hit by blades/season	0.036301357	0.004551215
Estimated casualties over 35 yrs	1.271	0.159

RESULTS SUMMARY

Period	Year	Estimated annual bird flights through turbine swept volume	Estimated casualties (assuming 98% avoidance) Per year	Estimated casualties (assuming 98% avoidance) Over 35 years
Year	October 2020-September 2021	32.412	0.036	1.271
Year	April 2022-March 2023	4.064	0.005	0.159
Year	**Average (year)**	**18.238**	**0.020**	**0.715**

Pomarine skua

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	Year 2022/2023
Number of turbines	9
Length of risk window inc. buffer (m)	885.00
Turbine height (m)	175.00
Rotor swept area (RSA) (m^2)	17,671.46
Area of the risk window (m2) [W]	154,875.00
Rotor swept area (m2) [A]	159,043.14
(Vr) as % of (Vw) (%)	102.69%

STAGE 2 (Birds flying through turbine area)

Detail	Year 2022/2023
Birds within the turbine footprint	**1**
Survey hours	402.00
Average Day length (over period)	12.27
Season days	365
Probability of collision (p) [model]	5.3%
Bird flights within the rotor swept area: n x (A/W)	1.03
Bird flights/hour	0.00
Bird flights/day	0.03
Bird flights/survey period	11.44
No. of birds hit by blades	0.61

STAGE 3 (Avoidance)

Detail	Year 2022/2023
Avoidance rate (SNH 2010)	99.5%
No. of birds hit by blades/season	0.003031732
Estimated casualties over 35 yrs	0.106

RESULTS SUMMARY

Period	Year	Bird flights per survey period	Estimated casualties (assuming 99.5% avoidance) Per year	Over 35 years
Year	April 2021-March 2022	0.00	0.00	0.00
Year	April 2022-March 2023	11.44	0.003	0.106
Year	**Average (year)**	**5.72**	**0.002**	**0.053**

Whooper swan

STAGE 1 (Probability of birds being hit by a turbine blade)

Detail	Winter 2021/22
Number of turbines	9
Length of risk window inc. buffer (m)	885.00
Turbine height (m)	175.00
Rotor swept area (RSA) (m^2)	17,671.46
Area of the risk window (m2) [W]	154,875.00
Rotor swept area (m2) [A]	159,043.14
(Vr) as % of (Vw) (%)	102.69%

STAGE 2 (Birds flying through turbine area)

Detail	Winter 2021/22
Birds within the turbine footprint	**1**
Survey hours	144.00
Average Day length (over period)	9.59
Season days	151
Probability of collision (p) [model]	8.9%
Bird flights within the rotor swept area: n x (A/W)	1.03
Bird flights/hour	0.01
Bird flights/day	0.07
Bird flights/survey period	10.33
No. of birds hit by blades	0.92

STAGE 3 (Avoidance)

Detail	Winter 2021/22
Avoidance rate (SNH 2010)	99.5%
No. of birds hit by blades/season	0.004595436
Estimated casualties over 35 yrs	0.161

RESULTS SUMMARY

Period	Year	Bird flights per survey period	Estimated casualties (assuming 99.5% avoidance) Per season	Over 35 years
Winter	2021/22	10.33	0.005	0.161
Winter	2020/21	0.00	0.00	0.00
Winter	**Average (winter)**	5.16	**0.002**	**0.080**

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CHAPTER 9 – HYDROLOGY AND HYDROGEOLOGY

Appendix 9.1: Guidance Documents

APPENDIX 9.1 – LEGISLATION

Legislation

This study has been prepared using the following environmental legislation relevant to hydrological and hydrogeological aspects of the environment were referred to:

- Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption, European Union
- European Union (Drinking Water) Regulations 2023, S.I. No. 99/2023[1].
- SI No. 293 of 1988: Quality of Salmonid Waters Regulations (replaced by the Water Framework Directive)
- SI No. 258 of 1998: Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorus) Regulations, 1998 as amended The Water Framework Directive (2000/60/EC) and daughter regulations:
- Water Quality (Dangerous Substances) Regulations, 2001, SI No. 12 of 2001. as amended.
- European Communities (Protection of Waters Against Pollution from Agricultural Sources) Regulations, 2003[2], SI No. 213 of 2003, as amended.
- European Communities (Water Policy) Regulations, 2003-22.
- European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009) as amended
- European Union (Water Policy) (Abstractions Registration) Regulations 2018 SI No. 261 of 2018[3] as amended
- European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010) as amended
- European Communities (Technical Specifications for the Chemical Analysis and Monitoring of Water Status) Regulations, 2011 (S.I. No. 489 of 2011) as amended

Guidance Documents

This study has been prepared using the following guidance documents, which take account the current legislation and policy:

- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- CIRIA (2015) Environmental Good Practice on Site (fourth edition) (C741)
- Enterprise Ireland (n.d.) “Best Practice Guide (BPGCS005) Oil Storage Guidelines”

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[1] https://www.irishstatutebook.ie/eli/2023/si/99/made/en/print
[2] SI No. 213 of 2003
[3] SI No. 261 of 2018

- Environmental Protection Agency (EPA) (2014) “Guidance on the Authorisation of Direct Discharges to Groundwater”.
- EPA (2015) Advice Notes for Preparing Environmental effect Statements – DRAFT September 2015 (Supersedes 2003 version)
- EPA (2022) Guidelines on the Information to be Contained in Environmental effect Assessment Reports EPA (2022) (Supersedes 1997 and 2002 versions)
- Exploration & Mining Division, Minerals Ireland, Dept. of Communications, Climate Action & Environment (2019) “Exploration Drilling – Guidance on Discharge to Surface and Groundwater”.
- Inland Fisheries Ireland (IFI) (2016) “Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters” *Inland Fisheries Ireland*
- Institute of Geologists of Ireland (IGI) (2002) Geology in Environmental effect Statements – A guide
- IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental effect Statements
- Irish Wind Energy Association (IWEA) (2012) Best Practice Guidelines for the Irish Wind Energy Industry
- Law, C. and D'Aleo, S. (2016) Environmental Good Practice on Site Pocket Book. (C762) 4th edition. CIRIA
- Masters-Williams, H. et al. (2001) “Control of Water Pollution from Construction Sites. Guidance for Consultants and Contractors (C532)
- Murnane, E., A. Heap, A. and Swain, A. (2006) “Control of Water Pollution from Linear Construction Projects, Technical guidance (C648)” CIRIA
- Murnane, E., A. Heap, A. and Swain, A. (2006) “Control of Water Pollution from Linear Construction Projects, Site Guide (C649) CIRIA
- Murphy, D. (2004) “Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites” Eastern Regional Fisheries Board
- National Roads Authority (NRA) (2008) "Guidelines on Procedures for the Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes”
- NRA (2008) “Environmental effect Assessment of National Road Schemes” – A Practical Guide – Rev 1
- NRA (2008) “Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes”
- Office of Public Works (2009) “The Planning System and Flood Risk Management, Guidelines for Planning Authorities”
- Office of Public Works (OPW) (2013) “Construction, Replacement or Alteration of Bridges and Culverts” Office of Public Works
- Scottish Environment Protection Agency (SEPA) (2010) “Engineering in the Water Environment: Good Practice Guide – River Crossings” *Scottish Environment Protection Agency*

- Scottish National Heritage (SNH) (2018) Environmental effect Assessment Handbook – Version 5
- Transport Infrastructure Ireland (TII) (2014) “Drainage Design for National Road Schemes - Sustainable Drainage Options”.

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CHAPTER 9 – HYDROLOGY AND HYDROGEOLOGY

Appendix 9.10: Silt Management Brochure

How to manage silt on construction sites

Avoid silt pollution when working in or near water,
the risk of fines & protect the environment with our low cost, versatile solutions

100%

100% committed to providing you with an effective solution. All of our products work in isolation or together depending on your project

Full technical support & specification advice

Our offering is scalable, meaning our solutions can be designed to suit any size of works or project

Low cost, reliable solutions from our UK depot

SiltMat™

- 100% biodegradable mat that captures & prevents sediment resuspension
- Dry weight 12kg, each mat captures ≤ 40kg of silt
- Versatile function - used in ditches, rivers, streams

Why choose SiltMat™? A thick, high quality & durable solution with a greater capacity compared with others on the market.

Read More

FlocMat™

Read More

- 100% biodegradable water treatment & silt capture mat
- A cost effective way of treating water in ditches & channels, without the need for pumps – saving energy & CO_2

Why choose FlocMat™? Mat fibres are treated with patented gel flocculant which means it can be used for treating and trapping very fine particles such as clay before it enters a watercourse.

Silt Wattle

- Used in ditches & rivers to reduce the speed of water & aid natural sediment deposition
- Available in 20cm, 30cm or 45cm diameter

Why choose Silt Wattle? The naturally treated woodchip interior makes it highly durable, it retains its structure and moulds to the shape of any ditch or riverbed.

Read More

Gel Flocculant

Read More

- Low cost option for treating clay water, no need for pumps
- Opportunity for long term low carbon water treatment or silt tanks (4 different blends available depending on soil chemistry)

Why choose Gel Flocculant? A highly effective, non-hazardous flocculant with a patented design. The blocks are very slow release, lasting up to 120 days.

We are passionate about sharing knowledge and helping our customers to protect our environment

Silt control training & free CPD 'lunch & learn'

Increase your knowledge or become a Silt Control Champion with our range of training and CPD options

- **Half-day on-site** or **online training** available where you can build your expertise in preventing silt pollution and achieving compliance.
- Improve your knowledge and awareness of silt pollution with our **free 1 hour 'lunch & learn'** online CPD sessions delivered by one of our experienced Technical Team.

Contact

frogenvironmental.co.uk

info@frogenvironmental.co.uk

0345 057 4040

frog-environmental

Product sales | Technical support | CPD & training

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CHAPTER 9 – HYDROLOGY AND HYDROGEOLOGY

Appendix 9.11: Safety Material Datasheet

Section 1 - Identification of The Material and Supplier

Clearbore Pty Ltd	**AUS Freecall 1800 013 210**
62 Mt Tootie Rd	**AUS Fax (02) 4567 0122**
Bilpin, NSW 2758	**NZ Freecall 0800 443 537**
AUSTRALIA	**NZ Freefax 0800 443 538**

Chemical nature:	Organic acid with indicator dye.
Trade Name:	**Clearbore**
Product Use:	Bore water pump cleaner.
Creation Date:	**February, 2009**
This version issued:	**January 2019** and is valid for 5 years from this date.

Section 2 - Hazards Identification

Statement of Hazardous Nature

This product is classified as: Xn, Harmful. Xi, Irritating. Hazardous according to the criteria of SWA.

Not a Dangerous Good according to the Australian Dangerous Goods (ADG) Code.

Risk Phrases: R36, R21/22. Irritating to eyes. Harmful in contact with skin and if swallowed.
Safety Phrases: S2, S20, S22, S45, S24/25, S36/39. Keep out of reach of children. When using, do not eat or drink. Do not breathe dust. In case of accident or if you feel unwell, contact a doctor or Poisons Information Centre immediately (show this MSDS where possible). Avoid contact with skin and eyes. Wear suitable protective clothing and eye/face protection.
SUSMP Classification: S6
ADG Classification: None allocated. Not a Dangerous Good under the ADG Code.
UN Number: None allocated

GHS Signal word: WARNING.

HAZARD STATEMENT:

- H302: Harmful if swallowed.
- H312: Harmful in contact with skin.
- H320: Causes eye irritation.

PREVENTION

- P102: Keep out of reach of children.
- P264: Wash contacted areas thoroughly after handling.
- P280: Wear protective gloves, protective clothing and eye or face protection.
- P281: Use personal protective equipment as required.

RESPONSE

- P311: If swallowed, call a POISON CENTER or doctor.
- P337: If eye irritation persists: seek medical attention.
- P353: Rinse skin or shower with water.
- P301+P330+P331: IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
- P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
- P337+P313: If eye irritation persists: Get medical advice.
- P370+P378: Not Combustible. Use extinguishing media suited to burning materials.

DISPOSAL

- P501: Dispose of contents and containers to landfill.

Emergency Overview

Physical Description & Colour: Blue crystalline solid.
Odour: No odour.
Major Health Hazards: harmful in contact with skin, and if swallowed, eye irritant.

Potential Health Effects

Inhalation:
Short Term Exposure: Available data indicates that this product is not harmful. However product may be mildly irritating, although unlikely to cause anything more than mild transient discomfort.
Long Term Exposure: No data for health effects associated with long term inhalation.

Skin Contact:
Short Term Exposure: Available data shows that this product is harmful, but symptoms are not available. In addition product may be irritating, but is unlikely to cause anything more than mild transient discomfort.
Long Term Exposure: No data for health effects associated with long term skin exposure.

Eye Contact:
Short Term Exposure: This product is an eye irritant. Symptoms may include stinging and reddening of eyes and watering which may become copious. Other symptoms may also become evident. If exposure is brief, symptoms should disappear once exposure has ceased. However, lengthy exposure or delayed treatment may cause permanent damage.
Long Term Exposure: No data for health effects associated with long term eye exposure.

Ingestion:
Short Term Exposure: Significant oral exposure is considered to be unlikely. Available data shows that this product is harmful, but symptoms are not available. However, this product is an oral irritant. Symptoms may include burning sensation and reddening of skin in mouth and throat. Other symptoms may also become evident, but all should disappear once exposure has ceased.
Long Term Exposure: No data for health effects associated with long term ingestion.

Carcinogen Status:
SWA: No significant ingredient is classified as carcinogenic by SWA.
NTP: No significant ingredient is classified as carcinogenic by NTP.
IARC: No significant ingredient is classified as carcinogenic by IARC.

Section 3 - Composition/Information on Ingredients

Ingredients	CAS No	Conc,%	TWA (mg/m^3)	STEL (mg/m^3)
Oxalic acid	144-62-7	>60	1	2
Other non hazardous ingredients	secret	to 100	not set	not set

This is a commercial product whose exact ratio of components may vary slightly. Minor quantities of other non hazardous ingredients are also possible.

The SWA TWA exposure value is the average airborne concentration of a particular substance when calculated over a normal 8 hour working day for a 5 day working week. The STEL (Short Term Exposure Limit) is an exposure value that may be equalled (but should not be exceeded) for no longer than 15 minutes and should not be repeated more than 4 times per day. There should be at least 60 minutes between successive exposures at the STEL. The term "peak "is used when the TWA limit, because of the rapid action of the substance, should never be exceeded, even briefly.

Section 4 - First Aid Measures

General Information:
You should call The Poisons Information Centre if you feel that you may have been poisoned, burned or irritated by this product. The number is 13 1126 from anywhere in Australia (0800 764 766 in New Zealand) and is available at all times. Have this MSDS with you when you call.

Inhalation: No first aid measures normally required. However, if inhalation has occurred, and irritation has developed, remove to fresh air and observe until recovered. If irritation becomes painful or persists more than about 30 minutes, seek medical advice.
Skin Contact: Quickly and gently brush away excess solids. Wash gently and thoroughly with warm water (use non-abrasive soap if necessary) for 10-20 minutes or until product is removed. Under running water, remove contaminated clothing, shoes and leather goods (e.g. watchbands and belts) and completely decontaminate them before reuse or discard.
Eye Contact: Quickly and gently brush particles from eyes. Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 20 minutes or until the product is removed, while holding the eyelid(s) open. Take care not to rinse contaminated water into the unaffected eye or onto the face. Obtain medical attention immediately. Take special care if exposed person is wearing contact lenses.
Ingestion: If swallowed, do NOT induce vomiting. Wash mouth with water and contact a Poisons Information Centre, or call a doctor.

Section 5 - Fire Fighting Measures

Fire and Explosion Hazards: There is no risk of an explosion from this product under normal circumstances if it is involved in a fire. Violent steam generation or eruption may occur upon application of direct water stream on hot liquids.
Fire decomposition products from this product may be toxic if inhaled. Take appropriate protective measures.
Extinguishing Media: Not Combustible. Use extinguishing media suited to burning materials.
Fire Fighting: If a significant quantity of this product is involved in a fire, call the fire brigade.

Flash point:	Combustible solid.
Upper Flammability Limit:	No data.
Lower Flammability Limit:	No data.
Autoignition temperature:	No data.
Flammability Class:	Combustible solid.

Section 6 - Accidental Release Measures

Accidental release: In the event of a major spill, prevent spillage from entering drains or water courses. Wear full protective clothing including eye/face protection. All skin areas should be covered. See below under Personal Protection regarding Australian Standards relating to personal protective equipment. Suitable materials for protective clothing include rubber, Nitrile, butyl rubber, neoprene. Eye/face protective equipment should comprise as a minimum, protective goggles. If there is a significant chance that dusts are likely to build up in cleanup area, we recommend that you use a suitable Dust Mask. Use a P1 mask, designed for use against mechanically generated particles eg silica & asbestos. Otherwise, not normally necessary.
Stop leak if safe to do so, and contain spill. Sweep up and shovel or collect recoverable product into labelled containers for recycling or salvage, and dispose of promptly. Consider vacuuming if appropriate. Recycle containers wherever possible after careful cleaning. After spills, wash area preventing runoff from entering drains. If a significant quantity of material enters drains, advise emergency services. This material may be suitable for approved landfill. Ensure legality of disposal by consulting regulations prior to disposal. Thoroughly launder protective clothing before storage or re-use. Advise laundry of nature of contamination when sending contaminated clothing to laundry.

Section 7 - Handling and Storage

Handling: Keep exposure to this product to a minimum, and minimise the quantities kept in work areas. Check Section 8 of this MSDS for details of personal protective measures, and make sure that those measures are followed. The measures detailed below under "Storage" should be followed during handling in order to minimise risks to persons using the product in the workplace. Also, avoid contact or contamination of product with incompatible materials listed in Section 10.
Storage: This product is a Scheduled Poison. Observe all relevant regulations regarding sale, transport and storage of this schedule of poison. Store packages of this product in a cool place. Make sure that containers of this product are kept tightly closed. Keep containers dry and away from water. Make sure that the product does not come into contact with substances listed under "Incompatibilities" in Section 10. Check packaging - there may be further storage instructions on the label.

Section 8 - Exposure Controls and Personal Protection

The following Australian Standards will provide general advice regarding safety clothing and equipment:

Respiratory equipment: **AS/NZS 1715**, Protective Gloves: **AS 2161**, Occupational Protective Clothing: AS/NZS 4501 set 2008, Industrial Eye Protection: **AS1336** and **AS/NZS 1337**, Occupational Protective Footwear: **AS/NZS2210**.

SWA Exposure Limits	**TWA (mg/m^3)**	**STEL (mg/m^3)**
Oxalic acid	1	2

No special equipment is usually needed when occasionally handling small quantities. The following instructions are for bulk handling or where regular exposure in an occupational setting occurs without proper containment systems.
Ventilation: This product should only be used in a well ventilated area. If natural ventilation is inadequate, use of a fan is suggested.
Eye Protection: Protective glasses or goggles should be worn when this product is being used. Failure to protect your eyes may cause them harm. Emergency eye wash facilities are also recommended in an area close to where this product is being used.
Skin Protection: Prevent skin contact by wearing impervious gloves, clothes and, preferably, apron. Make sure that all skin areas are covered. See below for suitable material types.
Protective Material Types: We suggest that protective clothing be made from the following materials: rubber, nitrile, butyl rubber, neoprene.

Respirator: If there is a significant chance that dusts are likely to build up in the area where this product is being used, we recommend that you use a suitable Dust Mask. Otherwise, not normally necessary.
Eyebaths or eyewash stations and safety deluge showers should be provided near to where this product is being used.

Section 9 - Physical and Chemical Properties:

Physical Description & colour:	Blue crystalline solid.
Odour:	No odour.
Boiling Point:	No specific data. Expected to decompose before boiling.
Freezing/Melting Point:	187°C
Volatiles:	No specific data. Expected to be low at 100°C.
Vapour Pressure:	Negligible at normal ambient temperatures.
Vapour Density:	No data.
Specific Gravity:	1.65 at 20°C
Water Solubility:	Soluble.
pH:	2 approx (concentration not given)
Volatility:	Negligible at normal ambient temperatures.
Odour Threshold:	No data.
Evaporation Rate:	No data.
Coeff Oil/water Distribution:	No data
Autoignition temp:	No data.

Section 10 - Stability and Reactivity

Reactivity: This product is unlikely to react or decompose under normal storage conditions. However, if you have any doubts, contact the supplier for advice on shelf life properties.
Conditions to Avoid: This product should be kept in a cool place, preferably below 30°C. Keep containers tightly closed. Containers should be kept dry.
Incompatibilities: strong oxidising agents, zinc, tin, aluminium and their alloys.
Fire Decomposition: Carbon dioxide, and if combustion is incomplete, carbon monoxide and smoke. Water. Carbon monoxide poisoning produces headache, weakness, nausea, dizziness, confusion, dimness of vision, disturbance of judgment, and unconsciousness followed by coma and death.
Polymerisation: This product will not undergo polymerisation reactions.

Section 11 - Toxicological Information

Local Effects:
Target Organs: There is no data to hand indicating any particular target organs.

Classification of Hazardous Ingredients

Ingredient	Risk Phrases
Oxalic Acid	Conc>=5%: Xn; R21/22

Section 12 - Ecological Information

This product is biodegradable. It will not accumulate in the soil or water or cause long term problems. This product is unlikely to accumulate in body tissues.

Section 13 - Disposal Considerations

Disposal: This product may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use. If it has been contaminated, it may be possible to reclaim the product by filtration, distillation or some other means. If neither of these options is suitable, consider controlled incineration, or landfill.

Section 14 - Transport Information

ADG Code: This product is not classified as a Dangerous Good. No special transport conditions are necessary unless required by other regulations.

Section 15 - Regulatory Information

AICS: All of the significant ingredients in this formulation are compliant with NICNAS regulations.
The following ingredient: Oxalic acid, is mentioned in the SUSMP.

Section 16 - Other Information

This MSDS contains only safety-related information. For other data see product literature.

Acronyms:

ADG Code	Australian Code for the Transport of Dangerous Goods by Road and Rail (7th edition)
AICS	Australian Inventory of Chemical Substances
SWA	Safe Work Australia, formerly ASCC and NOHSC
CAS number	Chemical Abstracts Service Registry Number
IARC	International Agency for Research on Cancer
NTP	National Toxicology Program (USA)
R-Phrase	Risk Phrase
SUSMP	Standard for the Uniform Scheduling of Medicines & Poisons
UN Number	United Nations Number

THIS MSDS SUMMARISES OUR BEST KNOWLEDGE OF THE HEALTH AND SAFETY HAZARD INFORMATION OF THE PRODUCT AND HOW TO SAFELY HANDLE AND USE THE PRODUCT IN THE WORKPLACE. EACH USER MUST REVIEW THIS MSDS IN THE CONTEXT OF HOW THE PRODUCT WILL BE HANDLED AND USED IN THE WORKPLACE.

IF CLARIFICATION OR FURTHER INFORMATION IS NEEDED TO ENSURE THAT AN APPROPRIATE RISK ASSESSMENT CAN BE MADE, THE USER SHOULD CONTACT THIS COMPANY SO WE CAN ATTEMPT TO OBTAIN ADDITIONAL INFORMATION FROM OUR SUPPLIERS

OUR RESPONSIBILITY FOR PRODUCTS SOLD IS SUBJECT TO OUR STANDARD TERMS AND CONDITIONS, A COPY OF WHICH IS SENT TO OUR CUSTOMERS AND IS ALSO AVAILABLE ON REQUEST.

Please read all labels carefully before using product.

This MSDS is prepared in accord with the SWA document “Preparation of Safety Data Sheets for Hazardous Chemicals - Code of Practice” (December 2011)

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CHAPTER 9 – HYDROLOGY AND HYDROGEOLOGY

Appendix 9.12: Project Monitoring and Emergency Response

APPENDIX 9.12 – PROJECT MONITORING AND EMERGENCY RESPONSE

Monitoring - Wind Farm Site

To ensure effective implementation of mitigation measures, environmental auditing, and monitoring of environmental obligations of the developer, an Environmental Clerk of Works (EnvCoW) will be assigned by the developer to carry out monitoring at the site during the construction and operational phases of the development. The role of the EnvCoW will be responsible for the active and continuous monitoring of site conditions and advise on environmental issues and monitoring compliance, and will not be responsible for implementing measures, the due duty of implementing measures will be held by the developer/contracted construction operator. The EnvCoW will have the authority to temporarily stop works in a particular area of the site to ensure corrective measures are implemented and adverse environmental effects are minimised if not avoided.

The following wind farm site monitoring recommendations will be undertaken by the EnvCoW assigned by the developer to mitigate against potential effects on the surface water and groundwater receiving environment:

- Monitoring site pollution prevention plan.
- Water quality monitoring.
- Advising on required pollution prevention measures (as described in this EIAR) and monitoring their effectiveness.
- Liaison with local authorities in relation to pollution instances if applicable.
- Considering the EnvCoW will be responsible for monitoring a broad range of environmental factors at the site, technical monitoring and advice will be sought such as from specialist consultants as the need arises.

The following measures will be implemented for site monitoring in relation to the hydrological and hydrogeological effects:

- The baseline monitoring undertaken at the site as part of this study will be repeated periodically before, during and after the construction phase of the development to monitor any deviations from baseline water quality that occur at the site. This monitoring along with the detailed monitoring outlined below will ensure that the mitigation measures that are in place to protect water quality are working. Specifically, a construction period and post construction monitoring programme for the site will include the following:
- During the construction phase, daily inspection of silt traps, buffered outfalls and drainage channels and daily measurement of total suspended solids, electrical conductivity, pH, and turbidity at selected water monitoring locations on the site (locations close to active working zones) will be carried out. Monitoring of same during times when excavations are being dewatered (likely high in solids) will be done by the EnvCoW. Physiochemical properties will be monitored at baseline sampling locations and thresholds established in line with water quality reference concentrations/limits which will be set using relevant

instruments for example, Surface Water Quality Regulations, <25mg/l Total Suspended Solids (TSS).

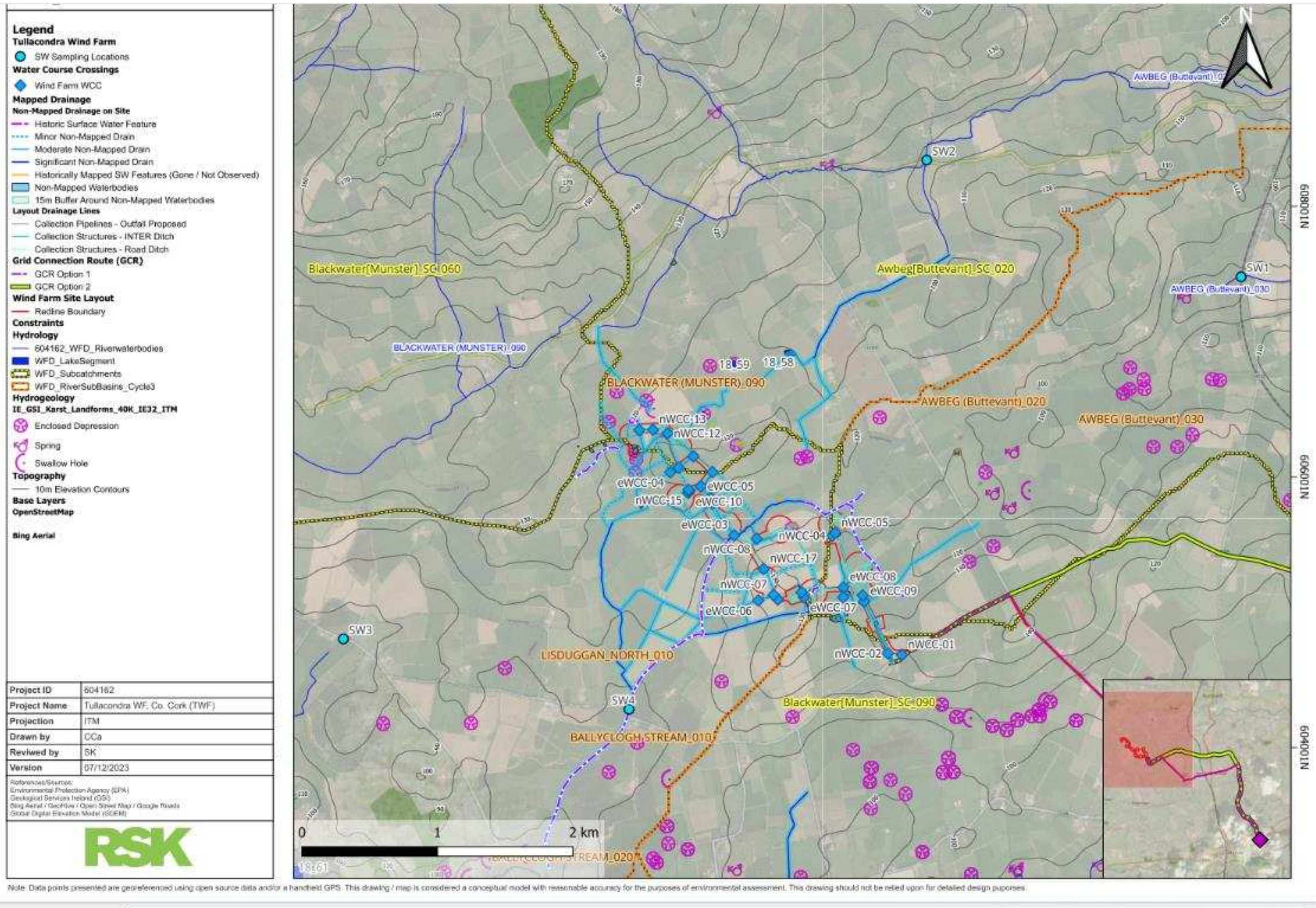
- Continuous Monitoring will be carried out as part of Active Management of construction water management and treatment. These monitoring systems will travel with the active construction areas / remain with the Active Management infrastructure. The purpose of this is to recycle water if quality is unfavourable and adjust the dewatering and treatment train accordingly until discharge quality is observed to be acceptable. A small degree of tolerance (e.g an outlier or single occurrence high reading) above reference concentrations is acceptable but only if the discharge from the Active Management train discharges to another Passive Management system or to a non-sensitive vegetated area. Where discharging within sensitive areas or buffer zones the quality of discharge from the Active Management train will be in line with prescribed reference limits for good water quality discussed previously.
- Continuous monitoring at downstream baseline Surface Water (SW) monitoring locations (**Plate 1**) will be carried out by the EnvCoW during the construction phase. Triggering of the threshold at these locations (during excavation days or earthworks of any kind upstream taking place) will trigger emergency response and escalation of measures including immediate full site inspection to ascertain to the potential unknown source (bearing in mind that the quality of managed runoff at the site will be known by means of handheld meters). Continuous monitoring at baseline SW monitoring locations will continue into the operational phase until stable conditions are observed e.g., stable conditions in line with baseline conditions for 6 months.
- Post construction: inspection of silt traps, buffered outfalls and drainage channels, measurement of total suspended solids, electrical conductivity, and pH at selected water monitoring locations at the site will be carried out at a reasonable frequency (weekly initially gradually reduced based on observed stability of conditions) and will also be scheduled following extreme metrological events. During the operational phase of the Project the stilling ponds and buffered outfalls will be periodically inspected e.g., weekly during maintenance visits to the site initially and gradually reduced based on observed stability of conditions.
- During the construction phase of the Project, the development areas will be monitored daily for evidence of groundwater seepage, which presents as water ponding and wetting of previously dry spots, and visual monitoring of the effectiveness of the constructed drainage and attenuation system so that it does not become blocked, eroded or damaged during the construction process. This monitoring will continue at a reasonable frequency (weekly initially gradually reduced to fortnightly, monthly then every 2 months, based on observed stability of conditions) during the operational phase of the development, however it is envisaged that any potential issues in this regard will be identified and rectified during the construction phase.
- A programme of water quality monitoring outlining the selected parameters and monitoring frequency will be agreed with Inland Fisheries Ireland and Cork County Council prior to the commencement of construction. During the construction phase of the Project, the development areas and adjacent receiving drainage systems will be monitored daily for evidence of erosion and other adverse effects to natural drainage channels and existing degraded areas whereby soils/subsoils are exposed and prone to enhanced degradation. This monitoring will continue at a reasonable frequency during the operational phase of

the development; however it is envisaged that any potential issues in this regard will be identified and rectified during the construction phase.

- During both the construction and operational phases of the Project watercourse crossings will be monitored frequently (daily during construction and intermittently during operational phase i.e., weekly/monthly inspections initially and reduced gradually in line with observed stability and confidence in longer term data obtained. The water course crossings will be monitored in terms of structural integrity and in terms of their effect on respective watercourses.
- A detailed inspection and monitoring regime, including frequency will be specified in the Construction Environmental Management Plan (CEMP). This includes an environmental risk register e.g., constraints linked to the development construction schedule, routine reporting on the performance and effectiveness of drainage and attenuation infrastructure, and any actions taken to rectify or enhance the system.
- Site water runoff quality at all surface water monitoring locations will be monitored on a continuous basis during the construction phase of the development. Monitoring will continue into the operational phase until such time that the site and water quality have stabilised (stable conditions in line with baseline conditions for e.g., 8 consecutive quarterly monitoring events). This monitoring will be carried out at the proposed downstream surface water baseline sampling location (**Plate 1**).
- Rainfall will be monitored (one rainfall gauge required). This unit will be connected with and displayed with other site water quality data.
- Surface water runoff control infrastructure will be checked and maintained on an ongoing basis, and stilling ponds and check dams will be maintained (de-sludge / settle solids removed) on an ongoing basis, particularly during the construction phase of the development. It is important to minimise the agitation of solids during these works, otherwise it will likely lead to an acute significant loading of suspended solids in the drainage network. This will be achieved by temporarily reducing or blocking inkling flow and vacuum extracting settled solids or sludge. Where the drainage feature possesses relatively significant flow rates, isolating and over pumping will be undertaken.
- All details in relation to monitoring will be included in the outline Surface Water Management Plan (SWMP as part of the CEMP; EIAR **Volume III, Appendix 5.1**).
- Monitoring of potential hydrological effect of the development, particularly during the operational phase will be inherently linked to the ecological health of the site (as a functioning ecosystem) and therefore both hydrology and ecology will be considered and monitored in tandem. For example, effects to the hydrological regime at the site can potentially effect on the ecological health or characterisation of the site, and vice versa. Ecological indicators can potentially provide useful data in relation to the long-term effect of changes to the hydrological regime at the site. However, changes to the management of runoff and in turn the hydrological regime at the site will lead to a positive effect overall when compared to the baseline conditions associated with the site e.g. introduction of intermittent buffered outfalls along the length of the drainage network is in contrast to baseline, this will promote a more even distribution runoff, attenuate runoff and reduce the hydrological response to rainfall, enhanced potential for recharge to ground, and in various areas of biodiversity enhancement.

- Agricultural use of the lands within the red line boundary will cease on the commencement of the construction phase and recommence in the operational phase.

Plate 1: Surface Water Monitoring locations(SW1 - SW4)



Monitoring - Grid Connection Route

Monitoring will be carried out at each significant construction location (HDD, any excavation >2.0m) and at significant environmental receptors including the following Environmental Monitoring Locations;

- Upstream and downstream of surface water crossings on mapped rivers.
- Dewatering excavation points within buffer zones (mapped wells, source protection areas, and/or associated Regionally Important Karst Aquifer)
- Monitoring proposed will be specified relative to the particular activity and associated risk at respective locations outlined in **Plate 1**.

At construction areas requiring drilling (HDD) and/or significant excavations (launch pits, cable joint bays), and in the management of general excavations, arisings will be managed carefully with a view to containing and treating all drained water and runoff which will likely be laden with suspended solids. Active continuous monitoring will be required at these locations in line with the conceptual model presented in Plate 2. The monitoring location will be at the outfall or discharge point of the treatment train at any respective location. Continuous monitoring will include telemetry.

Continuous Monitoring Locations or Telemetric Monitoring Stations (TMS) will use probes to monitor the following parameters:

- Electrical Conductivity
- Turbidity (Data obtained can be equated to estimated Total Suspended Solids (TSS) through calibration)
- pH
- Temperature
- Capacity for additional probes.
- TMSs will be self-powered and will be comprised of the following components at a minimum:
- Remote Telemetry Unit (RTU) – Modem / data hub and transmission.
- Solar panel
- Sensor – pH
- Sensor – Turbidity
- Sensor – Electrical Conductivity
- Sensor Cleaning Device (SCD)(Turbidity probe)
- Power Management Unit (PMU)
- Power Bank (PB)
- Website – presenting data trends over time.
- Metal stand / frame and protective fencing.
- The TMS will have capacity for additional parameters.

- Telemetric continuous monitoring sampling frequency is generally set at one data point per 15 minutes, however considering the intensive nature of the proposed works, particularly drilling activities, if possible, sampling frequency is set at 5 minutes or less with a view to escalating responses to potential discharge quality issues in good time. Data is transmitted to the Project website which will display data trends over time. Access to the website can be gained and shared via a website link.
- Telemetric Monitoring Systems will be used a key part of Active Management of runoff and construction water at the site.
- A handheld turbidity meter will be available and used to accurately measure the quality of water discharging from the site at any particular location. The meter will be maintained and calibrated frequently (per the particular unit's calibration requirements / user manual) and will also be used to check and calibrate remote sensors if they are employed. Quality thresholds have been established for the purposes of escalating water quality issues as they arise as presented in EIAR **Volume III, Appendix 9.6**.

Routine Surface Water Monitoring

Similar to the wind farm site baseline monitoring, baseline surface water samples will be obtained at upstream and downstream sampling locations at each significant construction location over mapped rivers. Baseline surface water samples will be obtained at accessible locations such as existing bridges on public roads. Where upstream access is poor, the upstream baseline sampling location will be directly/immediately upstream of the construction location (e.g., existing bridge / culvert).

Continuous Monitoring of Active Construction Water Management and Discharge

At construction areas requiring drilling (HDD) and/or significant excavations (launch pits, cable joint bays), and in the management of general excavations, arisings will be managed carefully with a view to containing and treating all drained water and runoff which will likely be laden with suspended solids. Active continuous monitoring will be required at these locations in line with the conceptual model presented in Plate 2. The monitoring location will be at the outfall or discharge point of the treatment train at any respective location.

Active Monitoring on Site

Handheld meters (Turbidity/Total Suspended Solids (TSS)) will used by the EnvCoW / competent operators during construction works. This will be done with a view to managing water treatment and anticipating potential surcharges in water or TSS loading within the treatment train. Handheld probes will be checked and calibrated regularly.

Emergency Response

Emergency response procedures to potential contamination incidents will be prepared as part of the site-specific CEMP and will be implemented at the site prior to the commencement of the construction phase. The following is a non-exhaustive list of potential emergency scenarios where corrective action may be required, and proposed corrective mitigation measures are presented in **Table 1**.

Table 1: Emergency Responses to Potential Issues on Site

Potential issue	Proposed measure
Elevated concentrations of suspended solids in runoff during excavation activities during an unforeseen or low probability storm event, for example a 1 in 100-year event.	Cover exposed stockpiles in plastic sheeting and placement of straw bales and silt fences in associated drainage channels.
Failure or degradation of stone check dam during a storm event with associated elevated runoff volumes.	Introduction of straw bales and silt fences in order to regain attenuation capacity of the drainage channel until the maintenance can be completed, EIAR **Volume III, Appendix 9.4 – Tile 15.**
Localised stability issue leading to deposit of soils/subsoils within an active drainage channel.	Introduction of straw bales and silt fences directly downstream, of the area in order to attenuate gross solids isolate the area and over pump until remedial works and maintenance can be completed, divert all runoff from the area to Active Management area of the treatment train (EIAR **Volume III**, **Appendix 9.4 – Tiles 8 to 9**).
Management of unexpected runoff patterns leading to excessive drying or wetting in a particular area, potentially leading to enhanced erosion.	This type of issue will require assessment on a case by case basis. Solutions include; decommission, modification, introduction or relocation of buffered outfall, or diversion of runoff volumes to or away from the area. In regard to the potential for erosion and similar physical processes, any such issues will become apparent through monitoring relatively rapidly, whereas effects to ecological sensitivities will become apparent relatively slowly in comparison. It is noted that much of the Site is affected as part of baseline in this regard e.g. existing artificial drainage networks.
Hydrocarbon spill or leak	Hydrocarbon contamination incidents will be dealt with immediately as they arise. Hydrocarbon spill kits will be prepared and kept in vehicles associated with the construction phase of the proposed development. Spill kits will also be established at proposed construction areas, for example, a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable

	receptacles for hydrocarbon contaminated materials will also be at hand.
Significant hydrocarbon spill or leak	In the event of a significant hydrocarbon spillage, emergency responses will be escalated accordingly. Escalation will include measures such as installation of temporary sumps, drains or dykes to control the flow or migration of hydrocarbons and contaminated runoff will be contained, managed and pumped to a controlled area in line with active management including treatment or taken off site to be processed through a suitably equipped treatment tank and Granular Activate Carbon (GAC) vessels. This process will be managed by the EnvCoW in conjunction with a preidentified consultant (ECoW) specialist register) in regard to effective remediation, treatment and removal of hydrocarbon contaminated water and soils excavation and appropriate disposal of contaminated soils will be required in this instance.
Cementitious material spills/incidents	Cement / concrete contamination incidents will be dealt with immediately as they arise. Spill kits will also be established at proposed construction areas, for example a spill kit will be established and mobilised as part of the turbine erection materials and equipment. Suitable receptacles for cementitious materials will also be at hand.

Prior to commencement of construction, the EnvCoW will prepare a register of corrective action and emergency response sub-contractors that can be called upon in the event of an environmental incident, and/or to give training on escalating incident where useful, including e.g., specialist hydrocarbon spill response, specialist hydrological and/or water quality response.

Mitigations measures as outlined in the previous sections will reduce the potential for contamination of waters during the construction phase of the proposed development, however, there remains the risk of accidental spillages and or leaks of contaminants, and excessive loading of surface water mitigation infrastructure.

Emergency responses to potential contamination incidents will be established and form part of the CEMP. Potential emergencies and respective emergency responses include:

If a significant hydrocarbon spillage does occur, the contractor on behalf of the developer will have an approved and certified clean-up consultancy available on 24-hour notice to contain and clean-up the spill. The faster the containment or clean-up starts, the greater the success rate, the lower the damage caused and the lower the cost for the clean-up.

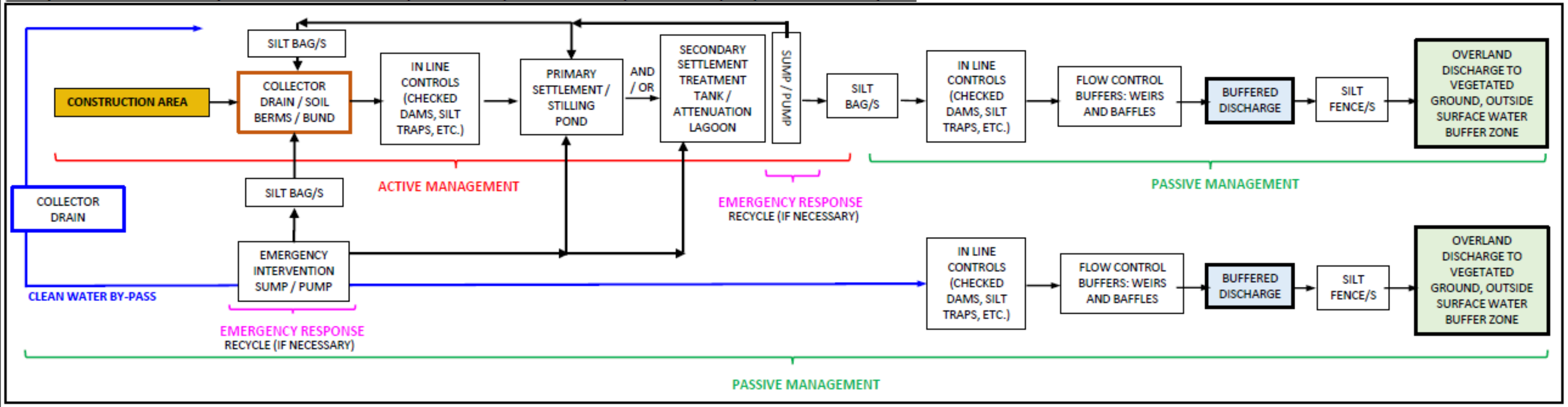
In the event of a significant contamination or polluting incident legislation requires that the relevant authorities will be informed immediately.

Managing & Reporting Environmental Incidents

Environmental incidents including accidental spillages on soils (e.g., fuel), breeches of licence limits if applicable (discharge of trade effluent), and significant environmental incidents will be reported to the Local Authority as part of emergency responses to such incidents. Incident notification will be escalated to relevant third parties where relevant e.g., Inland Fisheries Ireland (IFI) if surface water receptors are intercepted.

Plate 2: Water Treatment Train

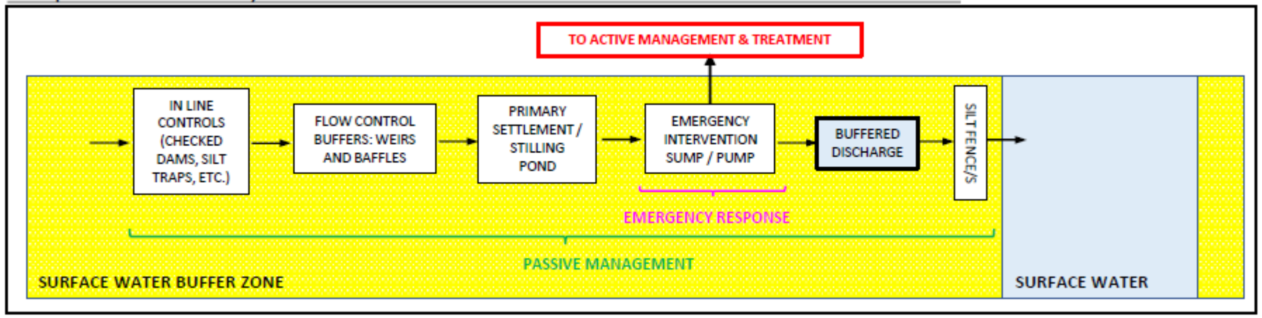
Conceptual Treatment Train Layout for Construction Areas (Access Tracks, Hardstand Areas, Turbine Base, etc.) & Clean Water By-Pass



NOTES:

- Wherever possible, outfalls will be positioned outside of Surface Water Buffer Zones.
- For areas of the development footprint within Surface Water Buffer Zones, in line measures such as silt screens will be over specified e.g. double / triple silt screens, and access to emergency intervention sump / pumps will be facilitated through design and/or emergency response.
- Quality of runoff entering buffer zones will be good i.e. suspended solids <25mg/l. Where runoff quality is poor, emergency response will be to use an intervention sump / pump and pump divert runoff to an area of the drainage network where it will be treated before redistribution and discharge.

Conceptual Treatment Train Layout for Construction Areas & Associated Infrastructure within Surface Water Buffer Zones



Site Name: Tullacondra Green Energy Project, Co. Cork	Project No.	604162	Drawn By:	Sven Klinkenbergh Principal Environmental Consultant
	Client:	Tullacondra Green Energy Ltd		
Figure Name: Appendix 9.4 – Conceptual & Information Graphics – Tile 8 Water Treatment Train Layouts	Date:	18/11/2022	Reviewed By:	SK
	Revision:	00 DRAFT		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

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CHAPTER 9 – HYDROLOGY AND HYDROGEOLOGY

Appendix 9.2: Assessment of Likely Effects and Mitigated Residual Effects

Effect	Receptor	Secondary / indirect effect	Sensitivity of receptor (Table 9.2)	Reason / Comment	Probability	Beneficial / Adverse / Neutral	Extent	Direct / Indirect	Duration	Reversible	Magnitude of effect (Table 9.3 & 9.4)	Significance of likely, unmitigated Effects (Table 9.6)	Proposed Mitigation	Significance of Residual Effects (Table 9.6)	Significant / Not significant
Construction Phase															
Increased Runoff	Surface water drains, then mapped SW Rivers, downstream flood risk areas.	Release of Suspended solids, Nutrients, Decrease in Water Quality, Exacerbate downstream flood impacts.	High	Net increase in runoff likely relatively small however must be considered as part of cumulative effect at catchment scale re. flood risk.	Likely	Adverse	Development footprint; localised	Direct & Indirect	Temporary	Reversible through remediation or natural attenuation	Small adverse	Moderate	SuDS	Not Significant / Beneficial	Not Significant
Potential effects on Local Groundwater Supplies	Downstream 'goes to groundwater' & Locally / Regionally important Aquifer s	Release of Suspended solids, Nutrients, Decrease in Water Quality	Medium	Shallow excavations	Likely	Adverse	Localised	Indirect	Temporary	Reversible through remediation or natural attenuation	Small adverse	Slight	SuDS	Not Significant	Not Significant
Release of Suspended solids	Surface water drains, then mapped SW Rivers	Release of Nutrients, Decrease in Water Quality	Medium	Relatively long pathways to mapped surface waters	Likely	Adverse	Development footprint; localised	Direct & Indirect	Temporary	Reversible through remediation or natural attenuation	Large Adverse	Significant	The above measures, buffer zones, constructed drainage, check dams, two-stage stilling ponds design for attenuation, buffered outfalls are referred to as The Treatment Train. Silt fences, Erosion protection, Routine inspections and silt removal, Monitoring, Flocculant 'gel blocks' are available and can be placed in drainage channels upstream of stilling ponds.	Slight	Not Significant
	Downstream 'goes to groundwater' & Locally important Aquifer	Release of Nutrients, Decrease in Water Quality	Medium		Likely	Adverse	Localised	Indirect	Temporary	Reversible through remediation or natural attenuation	Moderate adverse	Moderate		Not Significant	Not Significant
Release of Nutrients	Surface water drains, then mapped SW Rivers	Eutrophication, Decrease in Water Quality	Medium	Relatively long pathways to mapped surface waters. Low concentrations / loading, no direct nutrient loading. In line with baseline i.e. agri.	Likely	Adverse	Development footprint; localised	Direct & Indirect	Temporary	Reversible through remediation or natural attenuation	Large Adverse	Significant	The above measures, buffer zones, constructed drainage, check dams, two-stage stilling ponds design for attenuation, buffered outfalls are referred to as The Treatment Train. Silt fences, Erosion protection, Routine inspections and silt removal, Monitoring, Flocculant 'gel blocks' are available and can be placed in drainage channels upstream of stilling ponds.	Slight	Not Significant
	Downstream 'goes to groundwater' & Locally important Aquifer	Contaminated Drinking water, Decrease in Water Quality	Medium	Low concentrations / loading, no direct nutrient loading. In line with baseline i.e. agri.	Likely	Adverse	Localised	Indirect	Temporary	Reversible through remediation or natural attenuation	Moderate adverse	Moderate		Not Significant	Not Significant
Release of Hydrocarbons and Storage	Surface water drains	Decrease in Water Quality	Medium	Low likelihood of accidental release, small volumes. Relatively long pathways to mapped surface waters.	Likely	Adverse	Development footprint	Direct	Short-term	Reversible through remediation	Small adverse	Slight	Refuelling of vehicles will be carried out off site, The designated refuelling area will be located a minimum distance of 50m from any surface water or site drainage features, The designated refuelling area will be bunded to 110% volume capacity of fuels, The bunded area will be drained by an oil interceptor that will be controlled by a penstock valve, Oil absorbent booms and spill kits Oil absorbent booms and spill kits.	Slight	Not Significant
	Downstream 'goes to groundwater' & Locally / Regionally important Aquifer s	Contaminated Drinking water, Decrease in Water Quality	High	Short pathways to high sensitivity receptors.	Possible	Adverse	Localised	Indirect	Short-term to Long Term	Potentially irreversible	Small adverse	Moderate		Not Significant	Not Significant
Release of HDD Materials, drilling Fluids, drill arisings	Surface water drains, then mapped SW Rivers	Decrease in Water Quality	High	Close proximity to surface waters	Likely	Adverse	Localised	Direct	Short-term	Reversible through remediation	Moderate adverse	Moderate / Significant	Drilling fluids such as Bentonite or Clearbore will be used. Clearbore is an environmentally friendly substance. In the case of a spill, the leak will be stopped, contained and prevented from entering drains or water courses. Drill mud containing spoil can be treated in one of two ways. It can either be transferred off-site to an approved and authorized EPA license facility (in accordance with the Waste Management Act 1996 as amended) to be properly disposed of.	Slight	Not Significant
	Downstream 'goes to groundwater' & Regionally important Aquifer	Contaminated Drinking water, Decrease in Water Quality	High	Drilling in Regionally Important Aquifer	Possible	Adverse	Localised	Indirect	Short-term to Long Term	Potentially irreversible	Moderate adverse	Moderate / Significant		Slight	Not Significant
Release of Wastewater Sanitation Contaminants	Surface water drains, then mapped SW Rivers	Release of Nutrients	Medium		Possible	Adverse	Development footprint; localised	Direct & Indirect	Short-term	Reversible through remediation	Small adverse	Slight	The wastewater/sewerage will be collected and held in a sealed storage holding tank, fitted with a high-level alarm. The high-level alarm is a device installed in the storage tank that is capable of sounding an alarm during a filling operation when the liquid level nears the top of the tank. All wastewaters will be emptied periodically and tankered off-site by a licensed waste collector to an authorised wastewater sanitation plant for treatment. There will be no onsite treatment of wastewater.	Slight	Not Significant
	Downstream 'goes to groundwater' & Locally important Aquifer	Release of Nutrients	Medium		Possible	Adverse	Localised	Indirect	Short-term to Long Term	Potentially irreversible	Small adverse	Slight		Slight	Not Significant

Effect	Receptor	Secondary / indirect effect	Sensitivity of receptor (Table 9.2)	Reason / Comment	Probability	Beneficial / Adverse / Neutral	Extent	Direct / Indirect	Duration	Reversible	Magnitude of effect (Table 9.3 & 9.4)	Significance of likely, unmitigated Effects (Table 9.6)	Proposed Mitigation	Significance of Residual Effects (Table 9.6)	Significant / Not significant
Release of Construction or Cementitious Material	Surface water drains, then mapped SW Rivers	Release of Nutrients	Medium		Possible	Adverse	Development footprint; localised	Direct & Indirect	Short-term	Reversible through remediation	Moderate adverse	Moderate	The procurement, transport and use of any cement or concrete will be planned fully in advance of commencing works by the contractor's Environmental Manager. Concrete will be poured during metrological dry periods/seasons. Vehicles transporting cement or concrete to the site will exit the site pass through a designated wash out station. Minimising quantities on site, planning delivery routes and washout stations. Accidental spillages will be intercepted by drainage and precast concrete will be used wherever possible.	Slight	Not Significant
	Downstream 'goes to groundwater' & Locally important Aquifer	Release of Nutrients	Medium		Possible	Adverse	Localised	Indirect	Short-term to Long Term	Potentially irreversible	Small adverse	Slight		Slight	Not Significant
Constructed Drainage, Diversion or Enhancement of drainage	Surface water drains	Release of Suspended solids	Medium		Likely	Adverse	Development footprint	Direct	Short-term to Long Term	Reversible through reinstatement	Small adverse	Slight	Similar mitigation measures as outlined for runoff and suspended solids. Works along the GCR, locations in the flood zones, works will be carried out outside of heavy rainfall or flood events, by monitoring the meteorological forecast.	Not Significant	Not Significant
Watercourse Crossings	Surface water drains	Release of Suspended solids, Nutrients	Medium		Likely	Adverse	Development footprint	Direct	Short-term to Long Term	Reversible through reinstatement	Small adverse	Slight	Runoff and erosion control within the construction area will be treated with similar mitigations as above. The construction area will be isolated, this means; the water feature (streams/ drains) will be temporarily dammed upstream of the watercourse crossing and flow will be diverted by means of a flume / pipe by gravity or pumped.	Not Significant	Not Significant
Potential effects on Local Surface water Supplies	Surface water Supplies near wind farm	Release of Suspended solids, Nutrients	High	High Sensitivity - based on "All public drinking water supplies, including drinking water rivers, lakes, GSI Public – Source protection areas and NFGWS Group Scheme Source Protection Areas."	Possible	Adverse	Localised	Indirect	Temporary	Reversible through remediation or natural attenuation	Small adverse	Slight	Prevention and reduction of increased Runoff, suspended solids, wastewater and sanitation, HDD materials, Hydrocarbons, construction and cementitious materials, excavation dewatering and construction water mitigation measures applies.	Slight	Not Significant
	Surface water Supplies near GCR	Release of Suspended solids, Nutrients	High		Possible	Adverse	Localised	Indirect	Temporary	Reversible through remediation or natural attenuation	Large Adverse	Very Significant / Significant		Slight	Not Significant
Potential effects on Local Groundwater Supplies	Groundwater Supplies	reduction in water table	High		Possible	Adverse	Regional	Indirect	Temporary	Reversible through remediation or natural attenuation	Small adverse	Slight	No abstractions on site, minimising water required, prevention and reduction of increased Runoff, suspended solids, wastewater and sanitation, HDD materials, Hydrocarbons, construction and cementitious materials, excavation dewatering and construction water mitigation measures applies.	Not Significant	Not Significant
Operational Phase															
Increased Runoff	Surface water drains, then mapped SW Rivers	Release of Suspended solids, Nutrients, Decrease in Water Quality	High	Net increase in runoff likely relatively small however must be considered as part of cumulative effect at catchment scale re. flood risk.	Likely	Adverse	Development footprint; localised	Direct & Indirect	Temporary	Reversible through remediation or natural attenuation	Negligible - based on Calculated risk of serious pollution incident <0.5% annually	Not Significant	check dams, stilling ponds, attenuation lagoons etc.) are based on the control and management of runoff discharge rates and maintaining the natural hydrological regime. Collector drains, buffered outfalls, similar mitigation measures to reduce increase in runoff to the construction phase.	Not Significant	Not Significant
	Downstream 'goes to groundwater'	Release of Suspended solids, Nutrients, Decrease in Water Quality	Medium	Medium Sensitivity - based on fact that "Locally" important aquifer below.	Likely	Adverse	Localised	Indirect	Temporary	Reversible through remediation or natural attenuation	Negligible	Not Significant		Not Significant	Not Significant

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Appendix 9.3: Site Photographs

Tullacondra Green Energy Project, Co. Cork

Photographs

Surface Water Sampling R1 07/09/2022 (Dry)

Surface Water Sampling R1 07/09/2022 (Wet)

Surface Water Sampling R2 11/10/2022 (Dry)

Surface Water Sampling R1 07/092022 (Wet)

Surface Water Sampling R1 07/092022 (Dry)

Appendix 9.3 – Photographs
Subject: Baseline Surface Water Monitoring Location – SW3
(File Ref. 604162 R2 (01))

Surface Water Sampling R1 07/09/2022 (Wet)

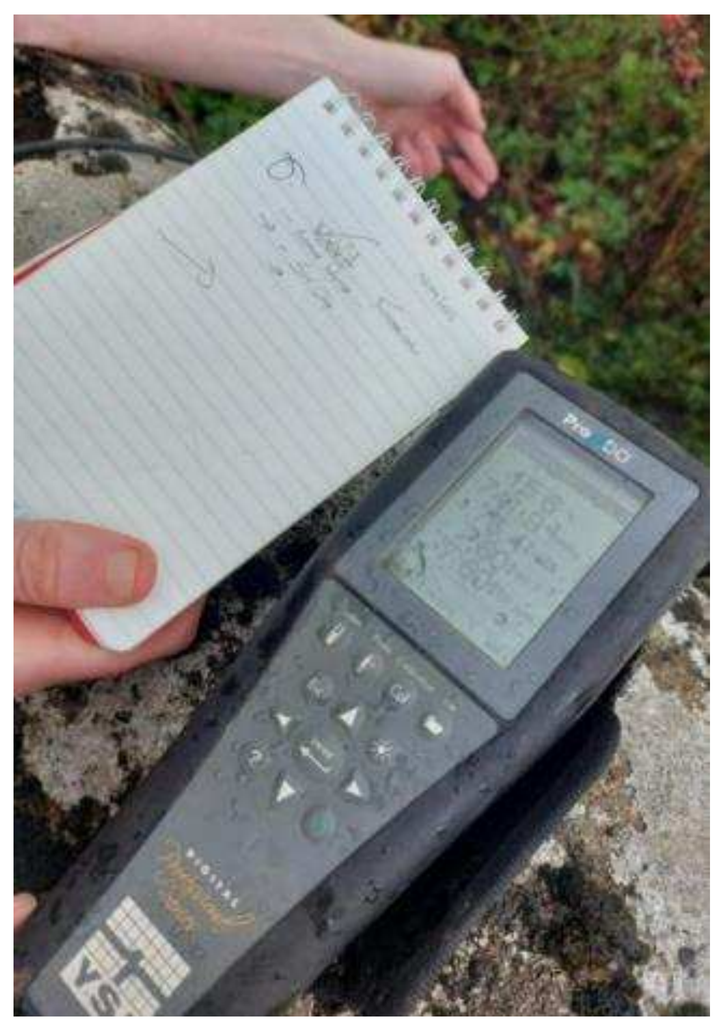
Surface Water Sampling R1 07/09/2022 (Wet)

Surface Water Sampling R1 07/09/2022 (Wet)

Surface Water Sampling R1 07/09/2022 (Wet)

Surface Water Sampling R1 07/09/2022 (Wet)

Surface Water Sampling R1 07/09/2022 (Wet)



Dry drain observed during site survey 11/10/2022.

Dry drain observed during site survey 11/10/2022.

Non mapped standing water bodies observed 07/09/2022.

Flooded roadway observed 07/09/2022.

Dry field drains, enclosed depression located in tree ahead observed 01/06/2022.

Potential areas of Karst in trees behind material (enclosed depression) 01/06/2022.

Shot from in the trees drain and observed (Enclosed depression) 01/06/2022.

Potential areas of Karst observed 01/06/2022.

Potential areas of Karst observed (swallow hole) 01/06/2022.

Potential areas of Karst observed (swallow hole) 01/06/2022.

Drain leading to observed (swallow hole) 01/06/2022.

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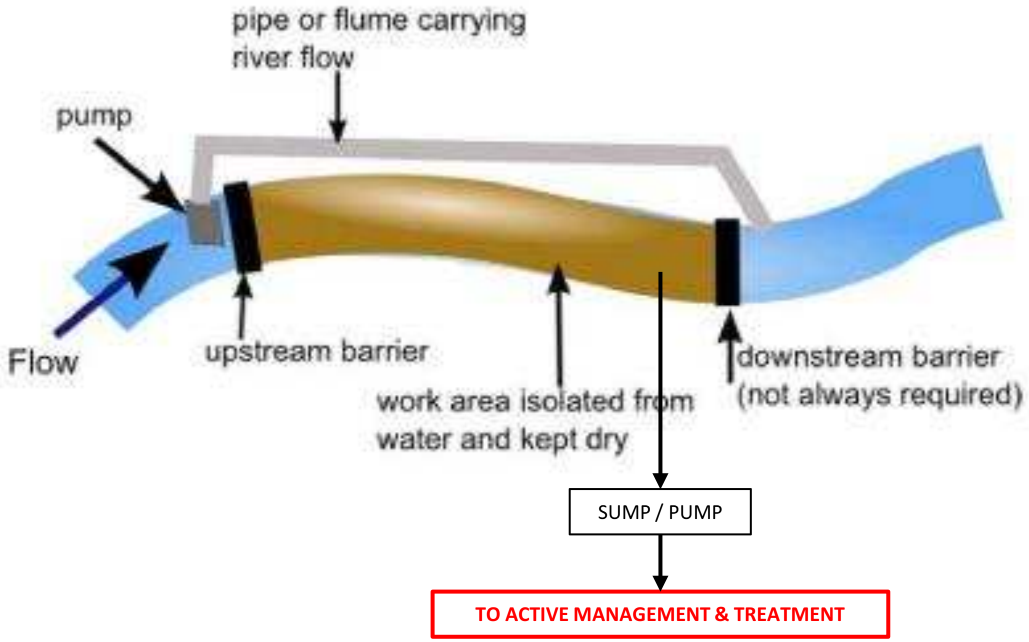
CHAPTER 9 – HYDROLOGY AND HYDROGEOLOGY

Appendix 9.4: Conceptual and Information Graphics

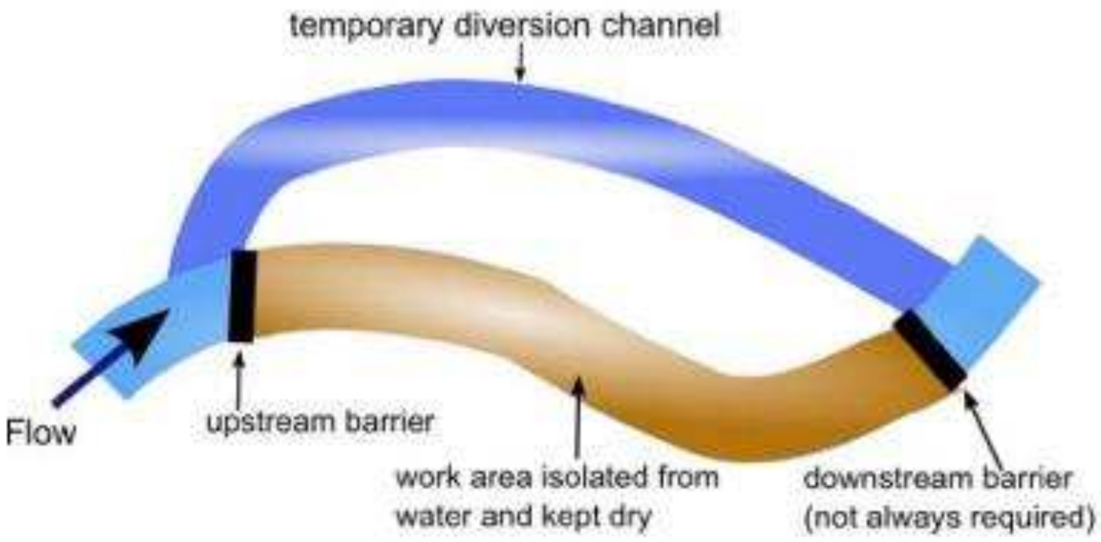
Full Isolation Over Pumping – Plan



NOTES:

- Full isolation over pumping / siphon. A whole section of the channel is isolated using barriers that span the full width of the river. This keeps a stretch of the river dry and the water is transferred downstream of the works area by mechanical assistance (pumping or siphon). The pump and associated pipework need not be located in the isolated area.
- This method is the preferred method for channel diversion during instream works , for example, during watercourse crossing / culvert construction. However, the pumping equipment deployed must be capable of the surface water feature discharge rate, including back up equipment and fail safe protocols.

Full Isolation by Diversion – Plan



NOTES:

- Full isolation temporary diversion channel. A whole section of the channel is isolated and kept dry, and the water is transferred downstream of the works area by excavating a temporary open channel.
- This is the less preferred method due to the destructive nature of constructing temporary diversion channels. However, in some instances where discharge rates are high, this method will negate the requirement for large volume pumping and associated inherent risks.

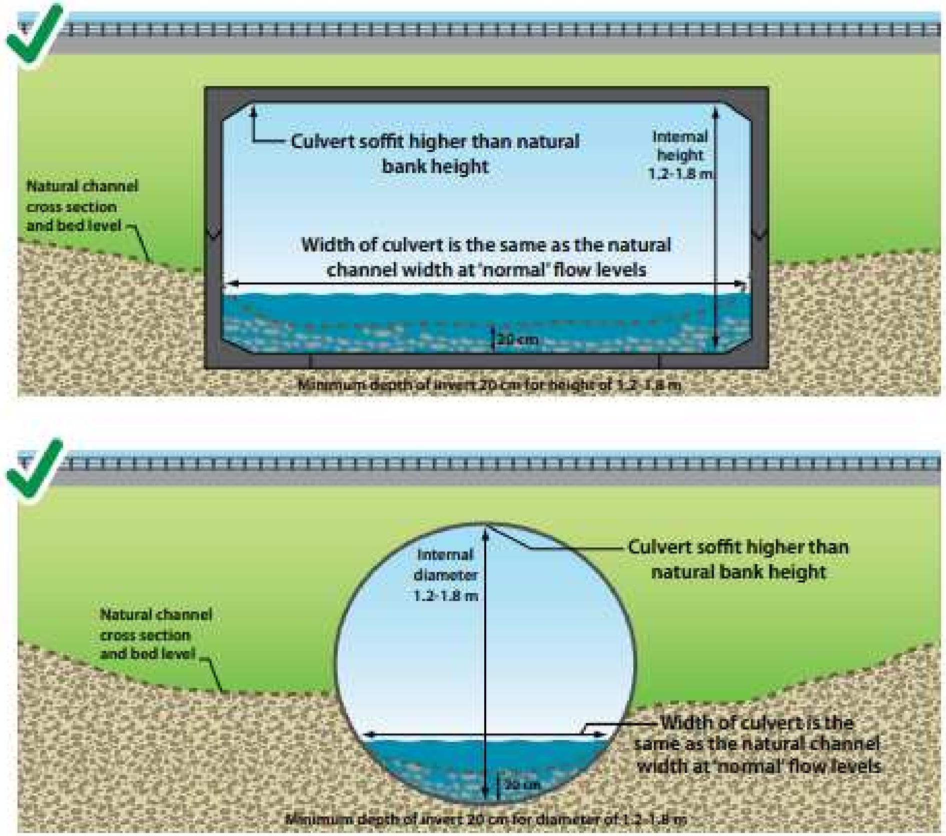
SEPA (2009) Engineering in the Water Environment Good Practice Guide – Temporary Construction Methods.

Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4– Conceptual & Information Graphics – Tile 1** **Isolation and Over Pumping of Watercourses– General Considerations**	**Date:**	18/11/2022	**Reviewed By:**	SK
	Revision:	00 DRAFT		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Closed Culvert Good Practice Design Considerations – Section

Figure 40: Good practice, culverts showing invert buried below bed level allowing the natural bed level, slope and material to be maintained. Culvert also maintains natural channel width.



SEPA (2010) Engineering in the Water Environment Good Practice Guide – River Crossings .

Closed Culvert Good & Bad Examples – Section

Figure 41: Good practice, use a single large culvert for crossings that maintains the natural channel width.

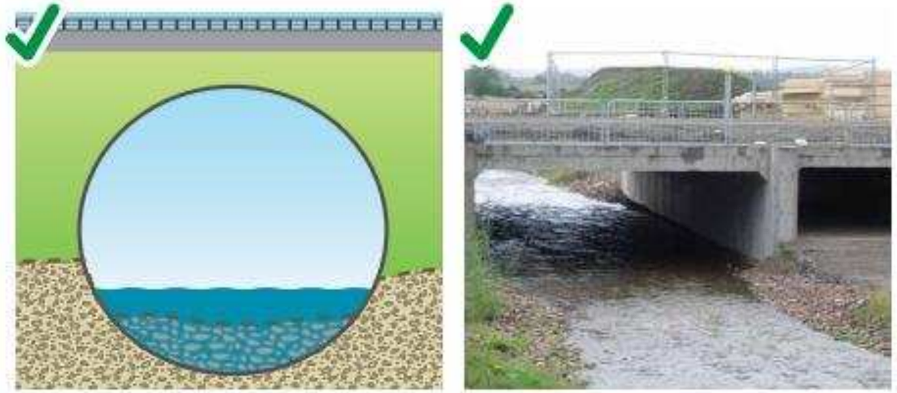


Figure 42: Poor practice, do not use smaller multiple pipes; they can create a barrier to fish passage.

SEPA (2010) Engineering in the Water Environment Good Practice Guide – River Crossings .

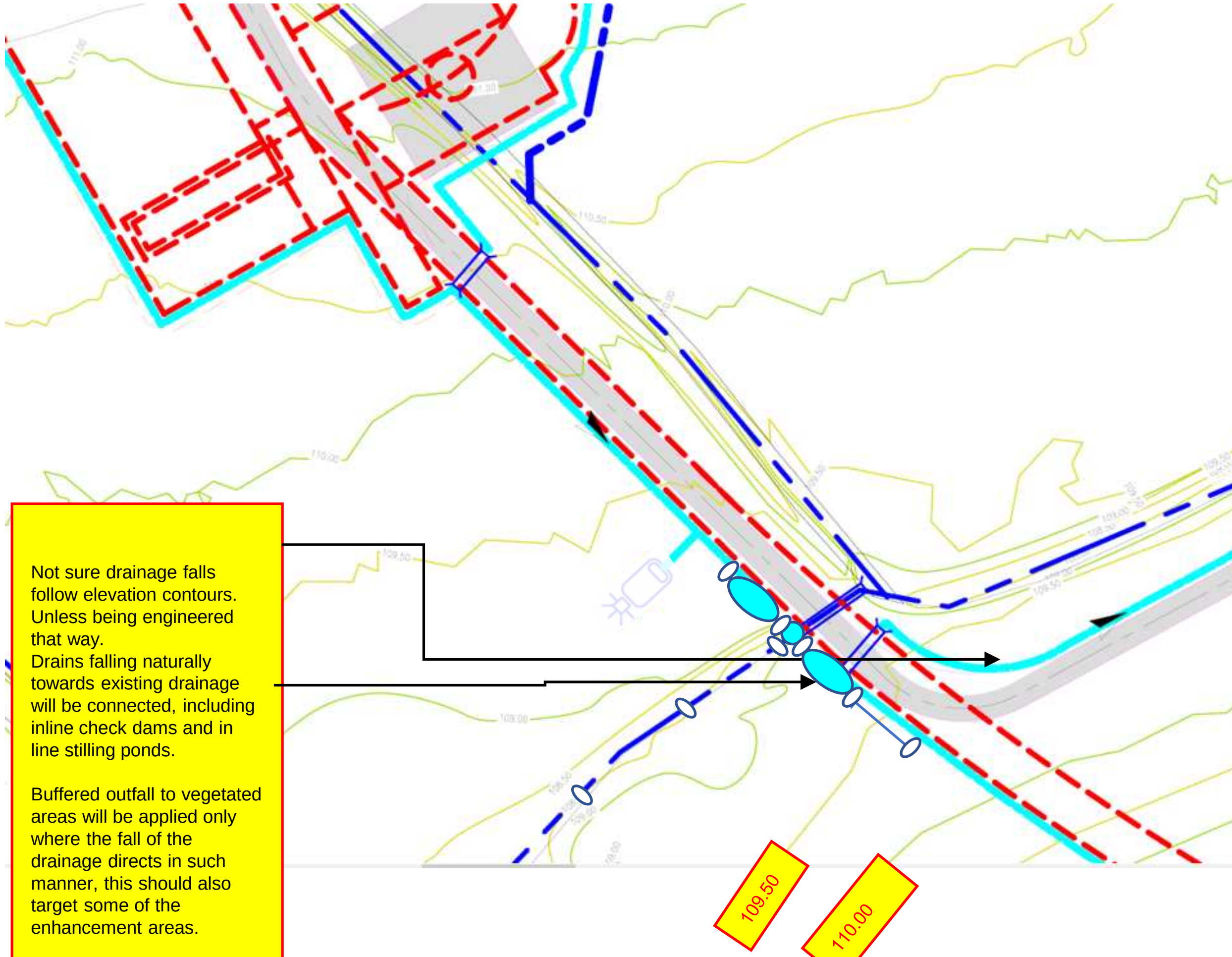
TrueNorth Steel (2021)

NOTE: Coarse aggregate has been used for erosion control. Silt fencing has been used to mitigate against the entrainment and mobilisation of solids during the construction process

Roadex Network (https://www.roadex.org/e-learning/lessons/drainage-of-low-volume-roads/components-of-road-drainage-system/)

Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.** 604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant
	Client: Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 2 Culverting – General Considerations**	**Date:** 18/11/2022	**Reviewed By:**	SK
	Revision: 00 DRAFT		

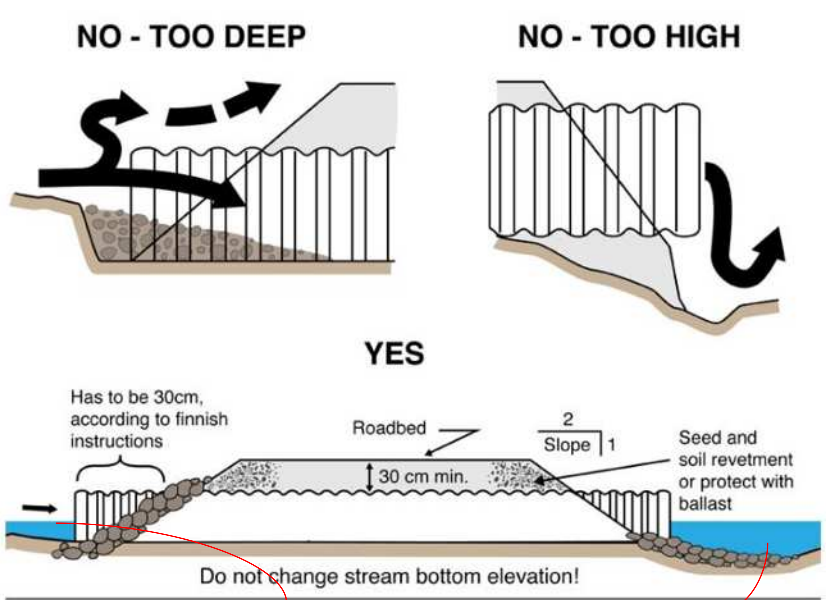
Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.



Not sure drainage falls follow elevation contours. Unless being engineered that way.
Drains falling naturally towards existing drainage will be connected, including inline check dams and in line stilling ponds.

Buffered outfall to vegetated areas will be applied only where the fall of the drainage directs in such manner, this should also target some of the enhancement areas.

Existing Culvert



Examples of poorly performing (above) and well built and maintained culverts (below).

Example of a well designed, built and maintained main road culvert built in relatively steep hill slope in Scotland

NOTE: Coarse aggregate will be used for erosion control. These areas at the openings of the culvert will also be designed to reduce velocity / discharge rate in turn further controlling erosion and providing additional beneficial impacts such increased attenuation time, increased recharge to ground etc.

In line with mitigation measures – It is suggesting to install this.

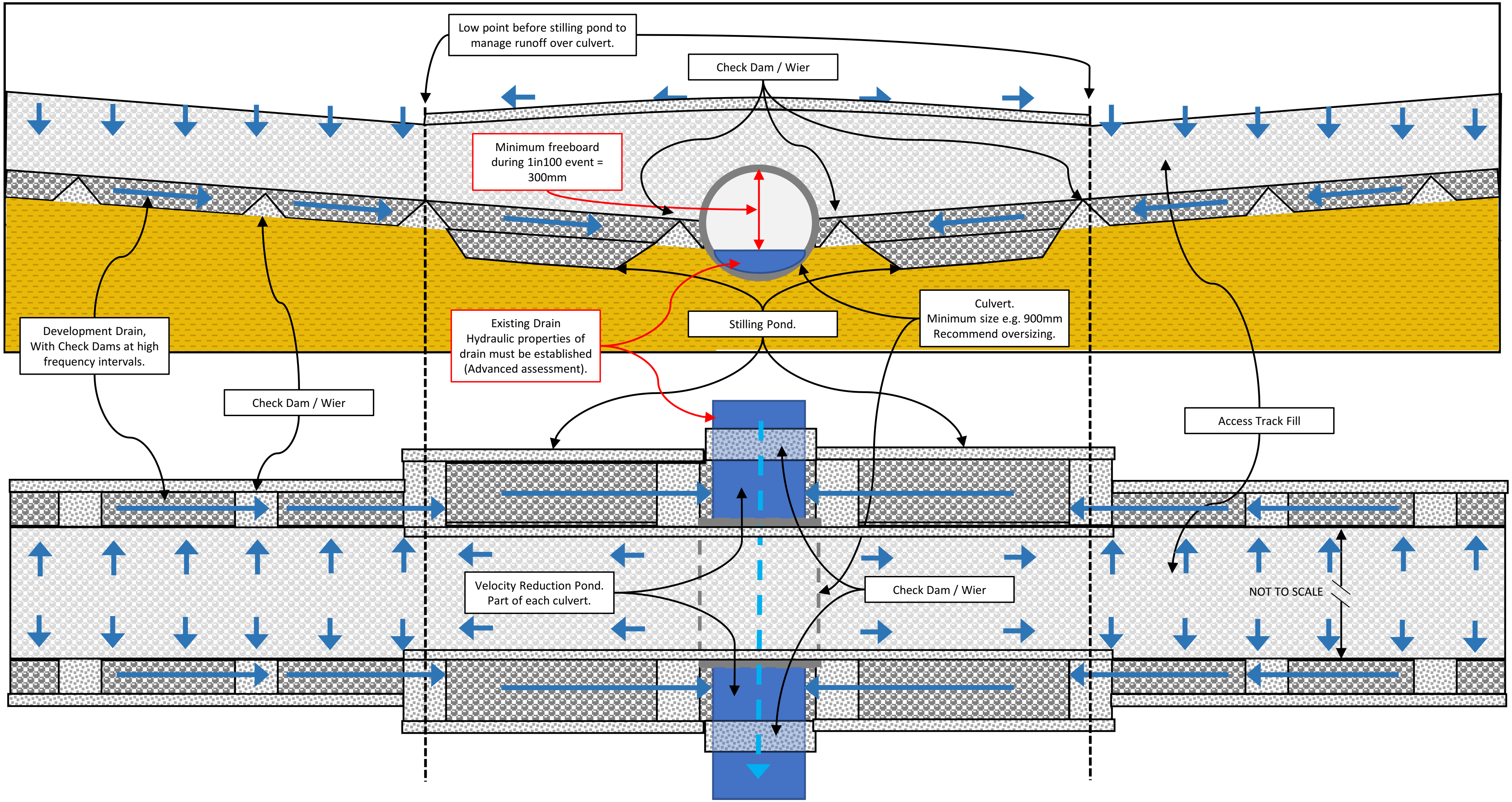
Site Name: **Tullacondra WF, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant Jayne Stephens
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 3a** **Example of Culvert to be installed**	**Date:**	31/03/2023	**Reviewed By:**	SK
	Revision:	00 DRAFT		

RSK

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

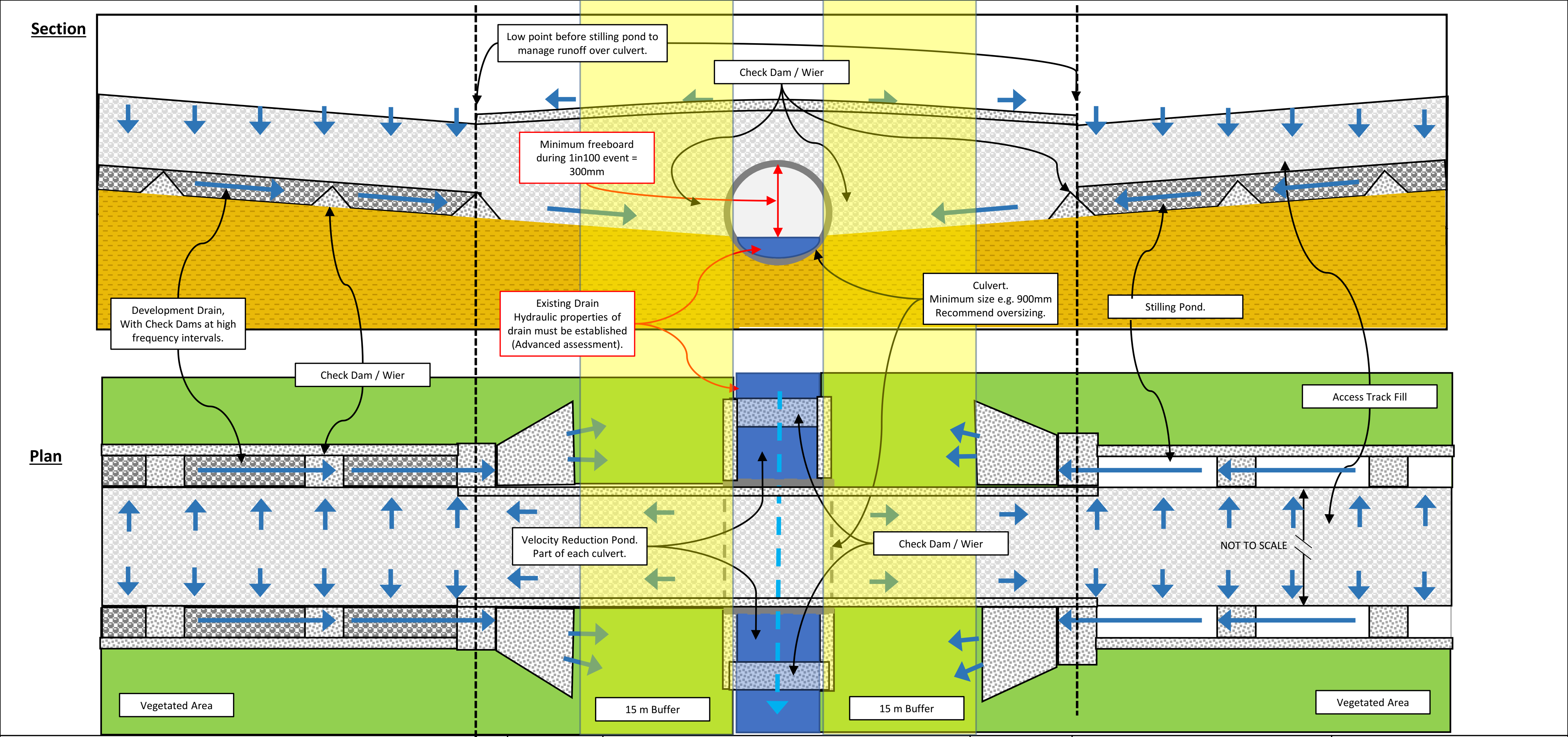
Section

Plan



Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 3b** **Design Considerations for Culvert & Drainage Connection**	**Date:**	14/11/2023	**Reviewed By:**	SK
	Revision:	00 DRAFT		

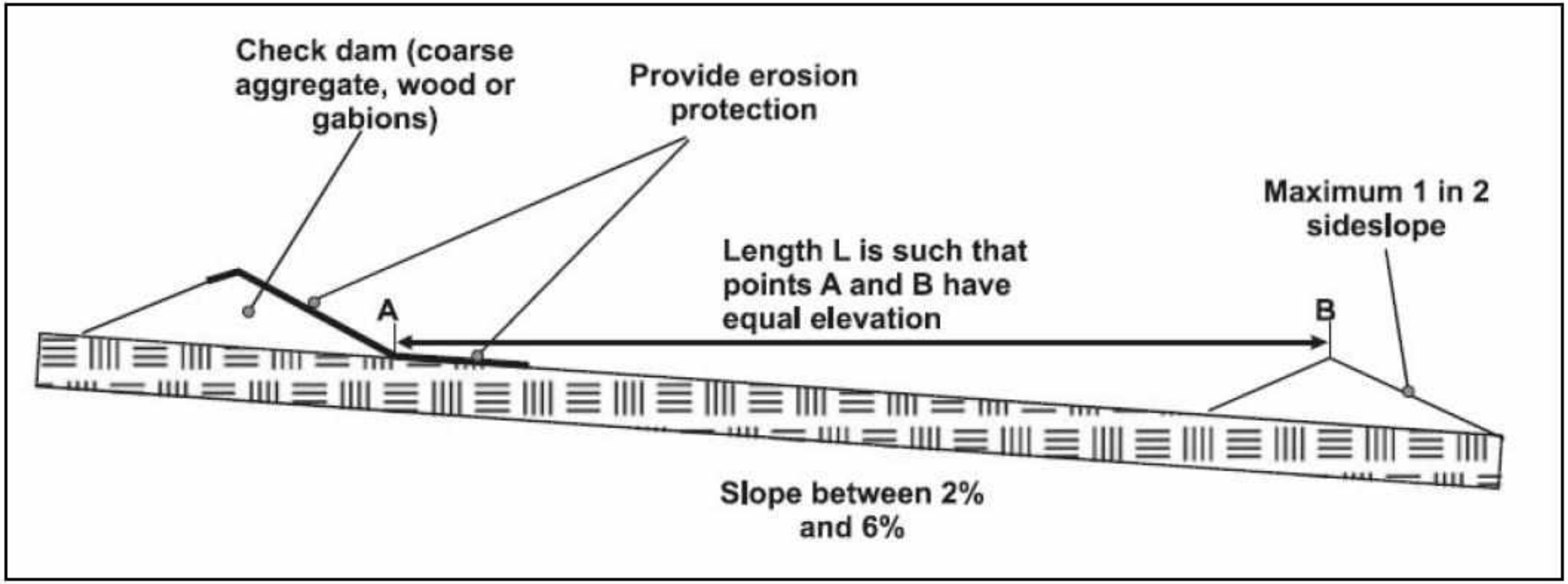
Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.



Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 3c** **Design Considerations for Culvert & Drainage Connection**	**Date:**	14/11/2023	**Reviewed By:**	SK
	Revision:	00 DRAFT		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Constructed Drain and Check Dams – Section



Check Dam Design Consideration (CIRIA, 2004)

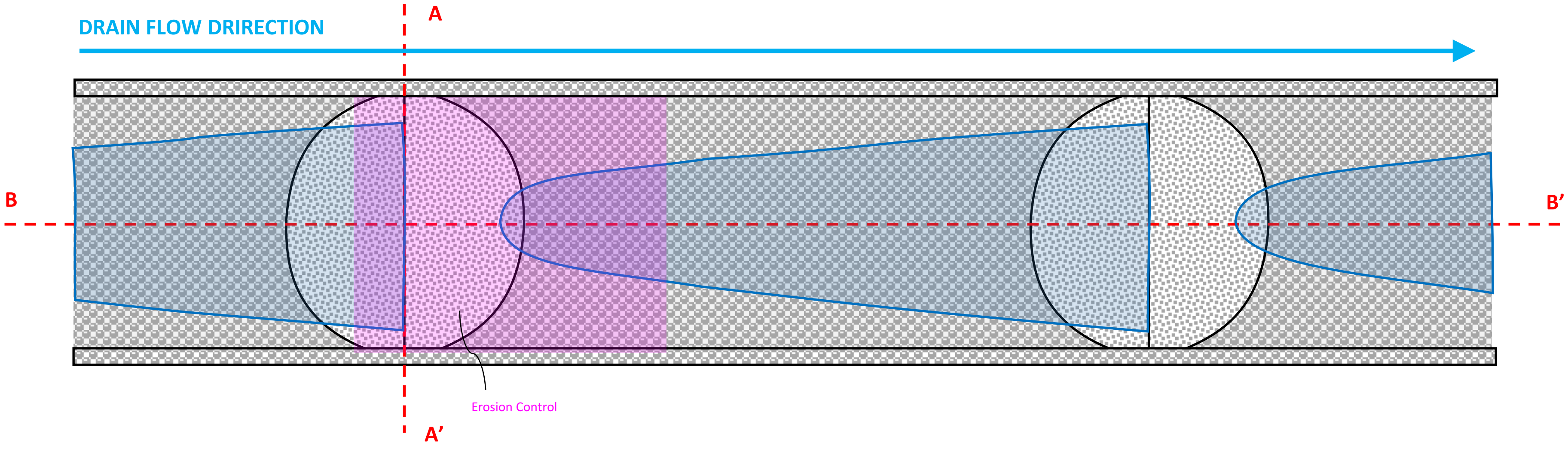
Site Name: Tullacondra Green Energy Project, Co. Cork	Project No.	604162	Drawn By:	Sven Klinkenbergh Principal Environmental Consultant
	Client:	Tullacondra Green Energy Ltd		
Figure Name: Appendix 9.4 – Conceptual & Information Graphics – Tile 4 Check Dams – General Considerations	Date:	18/11/2022	Reviewed By:	SK
	Revision:	00 DRAFT		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

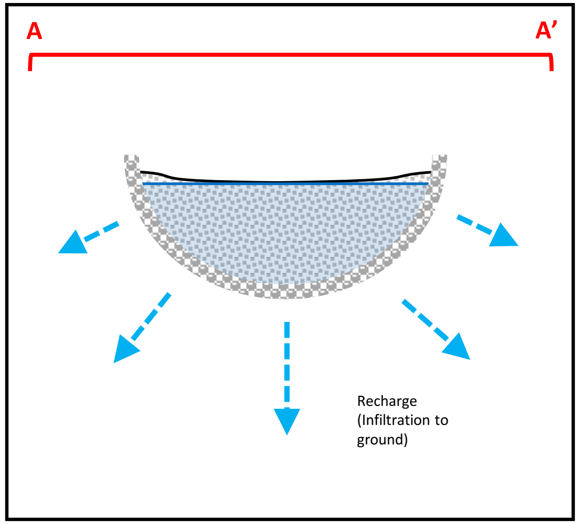
NOTES:

- The extensive use of check dams is recommended for the following reasons:
  - Management of runoff in terms of reducing flow velocity and minimising in channel erosion, or erosion at drainage outfalls.
  - Maximise attenuation of runoff with a view to enhancing runoff quality i.e. settlement of suspended solids.
  - Maximise attenuation of runoff with a view to reducing the hydrological response to rain fall at the site.
  - Maintain or improve the site hydrological/ hydrogeological regime with a view to maximising recharge to ground and increasing groundwater levels locally. This is particularly relevant for peatland areas.
- Check dams will be constructed with the following features and specifications:
  - A low flow pipe or small orifice to allow for low flows through the check dam.
  - Check dams will be permanent (life of development) and will be constructed with crushed rock with appropriate geo-chemistry (local) for example; coarse aggregate (100-600 mm). Wooden boards, gabions can also be used.
  - Erosion protection and energy dissipaters (cobbles / boulder 100-150mm diameter) which will extend approximately 1.2 – 1.8m downgradient of the dam and applied to both the base and side walls of the drain / swale.
  - Erosion control can be enhanced with the in-combination use of geotextile base layers (but consider low flow through).
  - It is recommended that the drainage channels / swales are entirely lined with coarse aggregate / erosion control. This will enhance mitigation in terms of attenuation, erosion control, and recharge to ground. Alternatively, allowing drains / swales to vegetate will achieve similar effects.

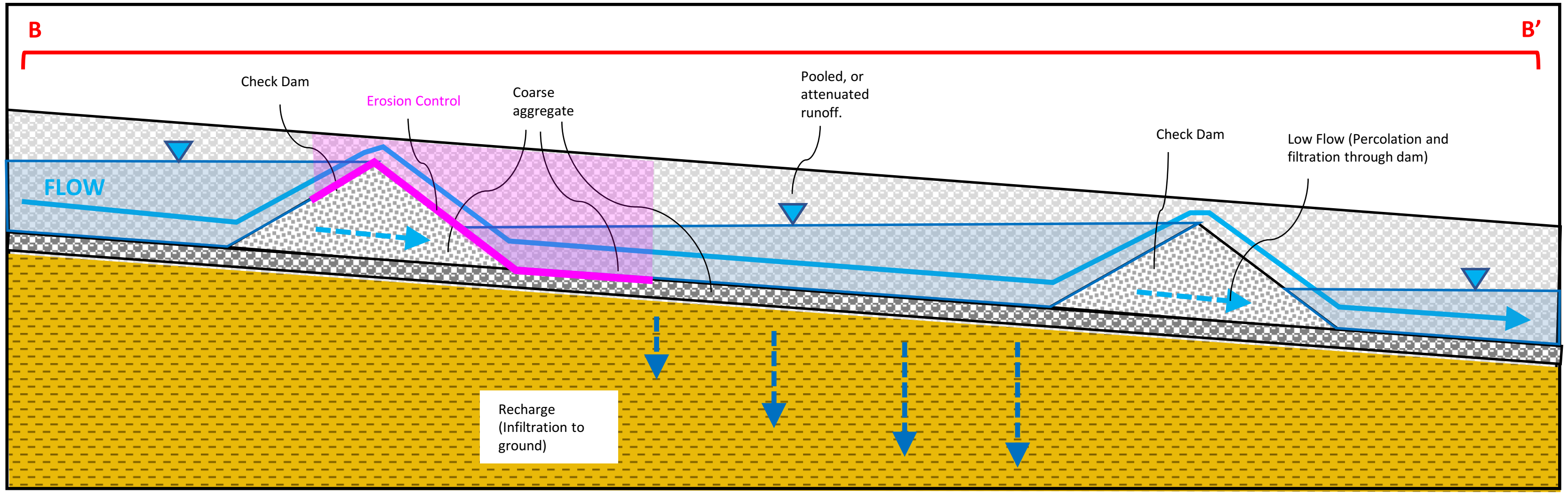
Constructed Drain and Check Dams – Plan View



Constructed Drain and Check Dams – Section A-A'



Constructed Drain and Check Dams – Section B-B'



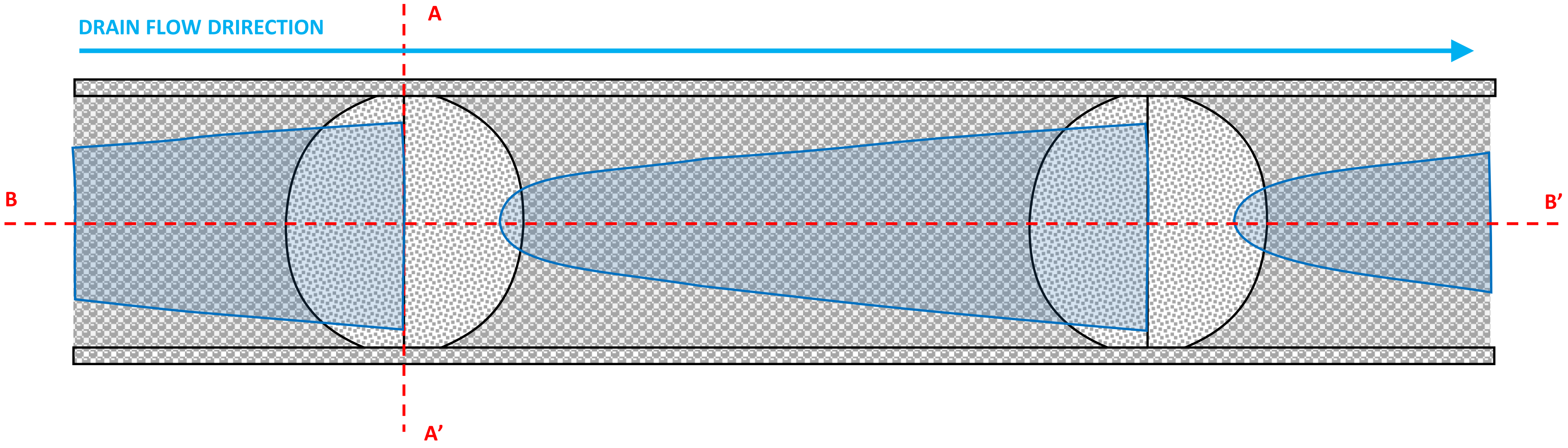
Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 5 Check Dams – General Considerations**	**Date:**	18/11/2022	**Reviewed By:**	SK
	Revision:	00 DRAFT		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

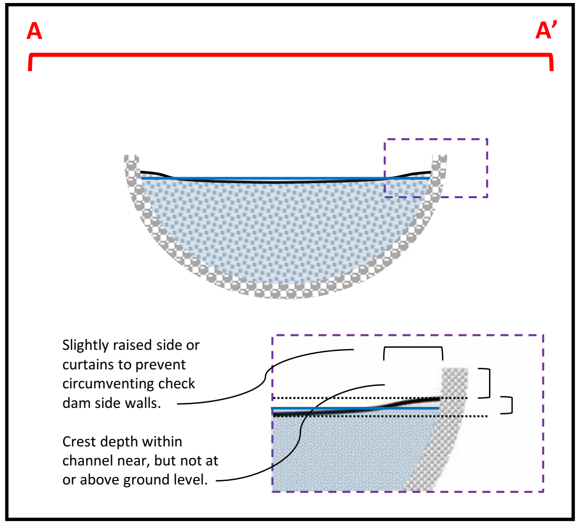
NOTES:

- It is recommended to align the elevation of the upgradient toe and downgradient crest. Therefore the spacing (L) of check dams will be dependent on the on the slope angle of a particular length (L) of drainage, whereby; on shallow slopes check dams will have larger spacing and on steeper slopes (up to 15 degrees *) spacing will be smaller.
- The purpose of aligning the toe and crest of respective check dams is recommended with a view to maximising pooling, or attenuation capacity of the drainage channel. The conceptual section presented here is designed with the downgradient crest (A) higher than the upgradient toe, as opposed to the crest (B) which is aligned with the toe. The purpose of this is to further enhance attenuation capacity at the dam, and to maximise hydraulic head ** and infiltration / percolation of runoff to ground water (recharge). However, this approach has limitations including for the potential to adversely impact undermine the integrity of the upgradient dam through erosion etc. or the downgradient dam through loading / excess weight. Mitigation measures including material selection, erosion control, and variable flow (V-notch) *** will be used where relevant to mitigate such impacts.
- (*) Check dams are recommended for drainage channels with slope angle up to 15 degrees. Drainage and runoff on steeper slopes (>15 degrees) will require different drainage velocity control features, for example; rock ripraps.
- (**) Attenuation of runoff in drainage channels is an opportunity to enhance recharge and reduce the hydrological response to rainfall at the site. However, detailed design will consider environmental and geological constraints, for example; enhanced recharge is not recommended in areas of elevated or high landslide susceptibility or risk.
- (***) V-Notch weirs discussed Conceptual Design – Drainage Infrastructure Check Dams – With Variable Flow Rate / V – Notch Weirs

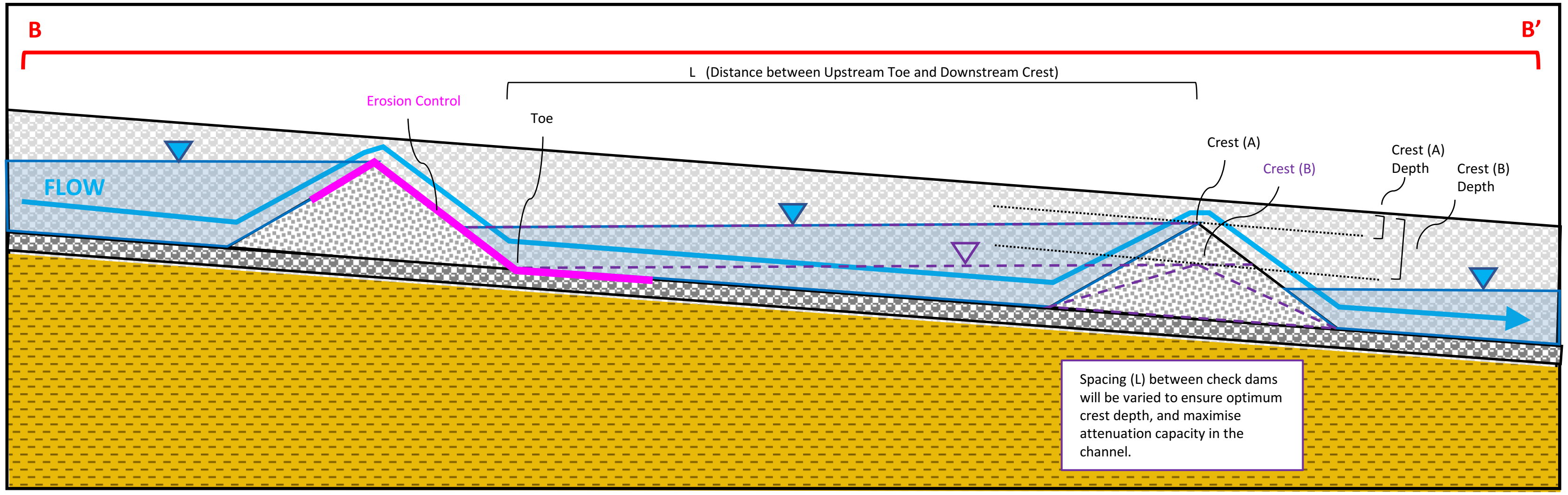
Constructed Drain and Check Dams – Plan View



Constructed Drain and Check Dams – Section A-A’



Constructed Drain and Check Dams – Section B-B’



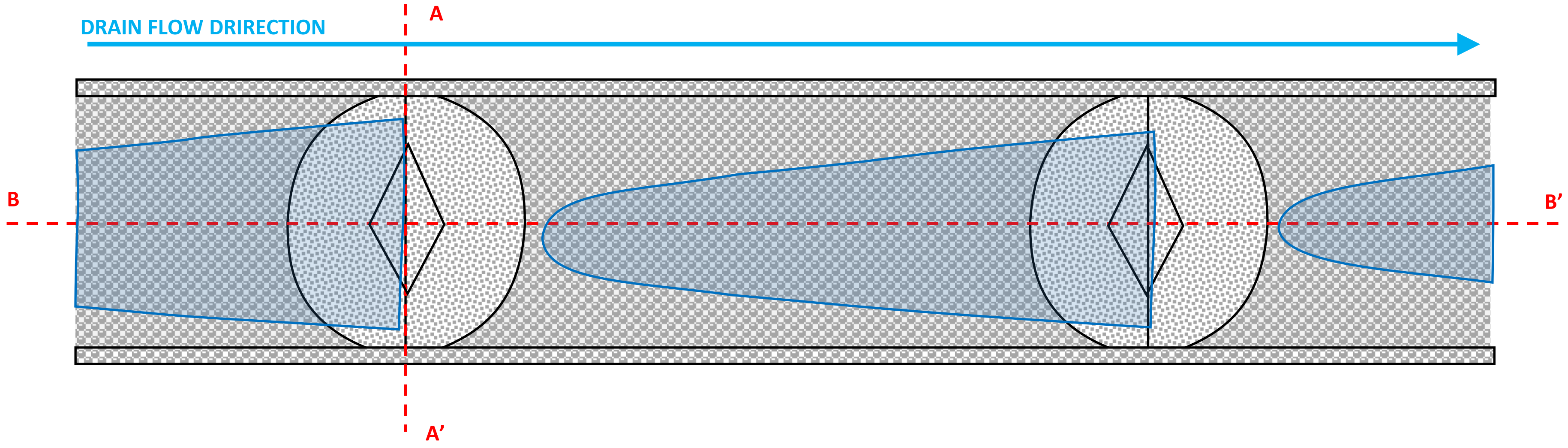
Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 6** **Check Dams – Design Specifications and Considerations**	**Date:**	18/112022	**Reviewed By:**	SK
	Revision:	00 DRAFT		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

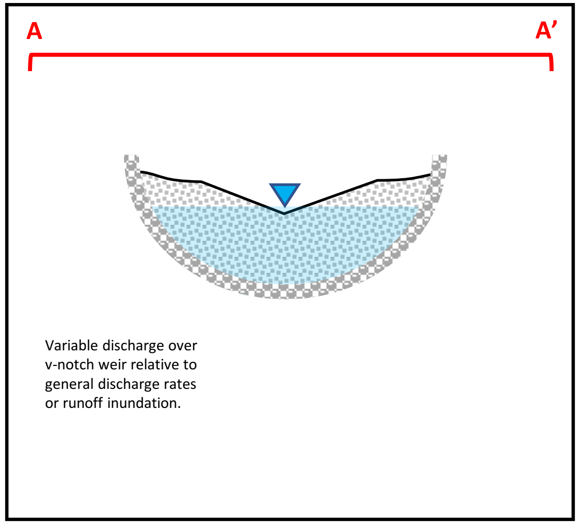
NOTES:

- V-Notch weirs can be included in designs as a control to mitigate against variable or peak flows / drainage discharge rates.
- V-Notch can also be employed to correct the elevation differential (between Toe and Crest) of respective in line check dams.

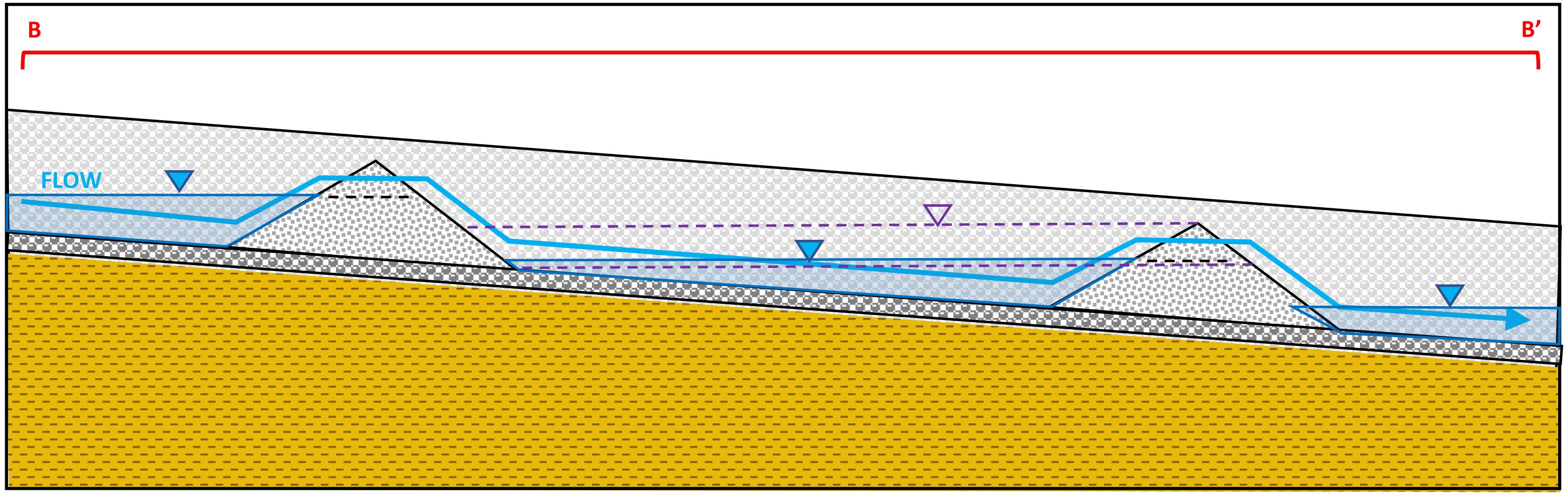
Constructed Drain and Check Dams – Plan View



Constructed Drain and Check Dams – Section A-A'



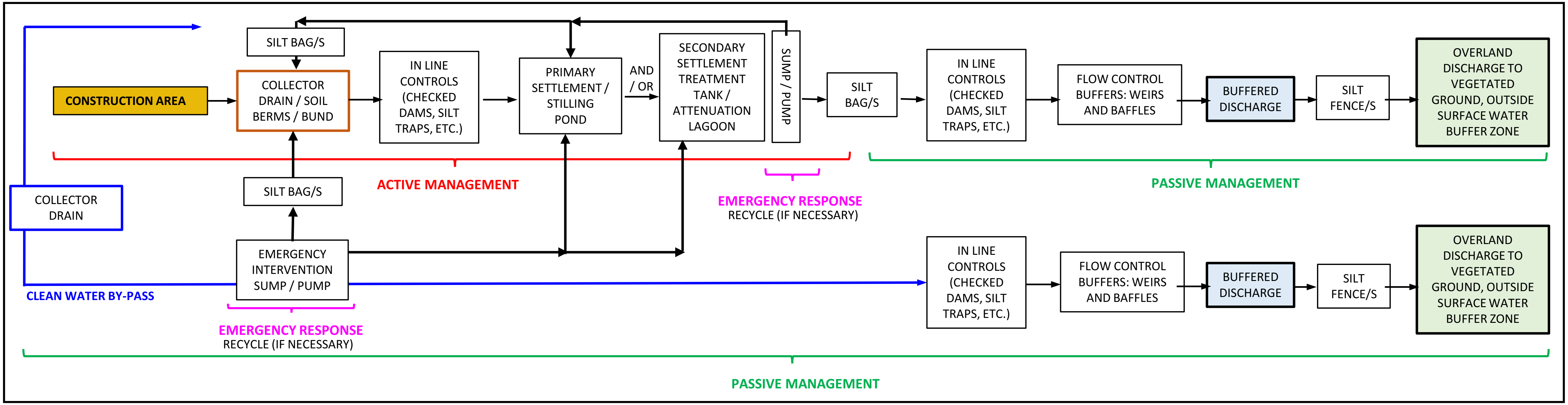
Constructed Drain and Check Dams – Section B-B'



Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 7 Check Dams – With Variable Flow Rate / V – Notch Weirs**	**Date:**	18/11/2022	**Reviewed By:**	SK	
	Revision:	00 DRAFT			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

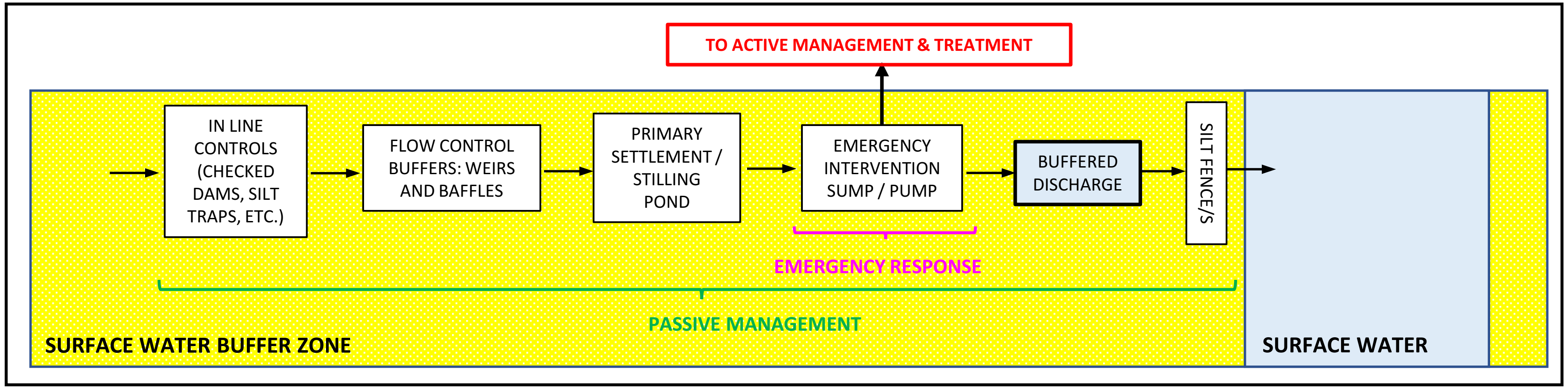
Conceptual Treatment Train Layout for Construction Areas (Access Tracks, Hardstand Areas, Turbine Base, etc.) & Clean Water By-Pass



NOTES:

- Wherever possible, outfalls will be positioned outside of Surface Water Buffer Zones.
- For areas of the development footprint within Surface Water Buffer Zones, in line measures such as silt screens will be over specified e.g. double / triple silt screens, and access to emergency intervention sump / pumps will be facilitated through design and/or emergency response.
- Quality of runoff entering buffer zones will be good i.e. suspended solids <25mg/l. Where runoff quality is poor, emergency response will be to use an intervention sump / pump and pump divert runoff to an area of the drainage network where it will be treated before redistribution and discharge.

Conceptual Treatment Train Layout for Construction Areas & Associated Infrastructure within Surface Water Buffer Zones



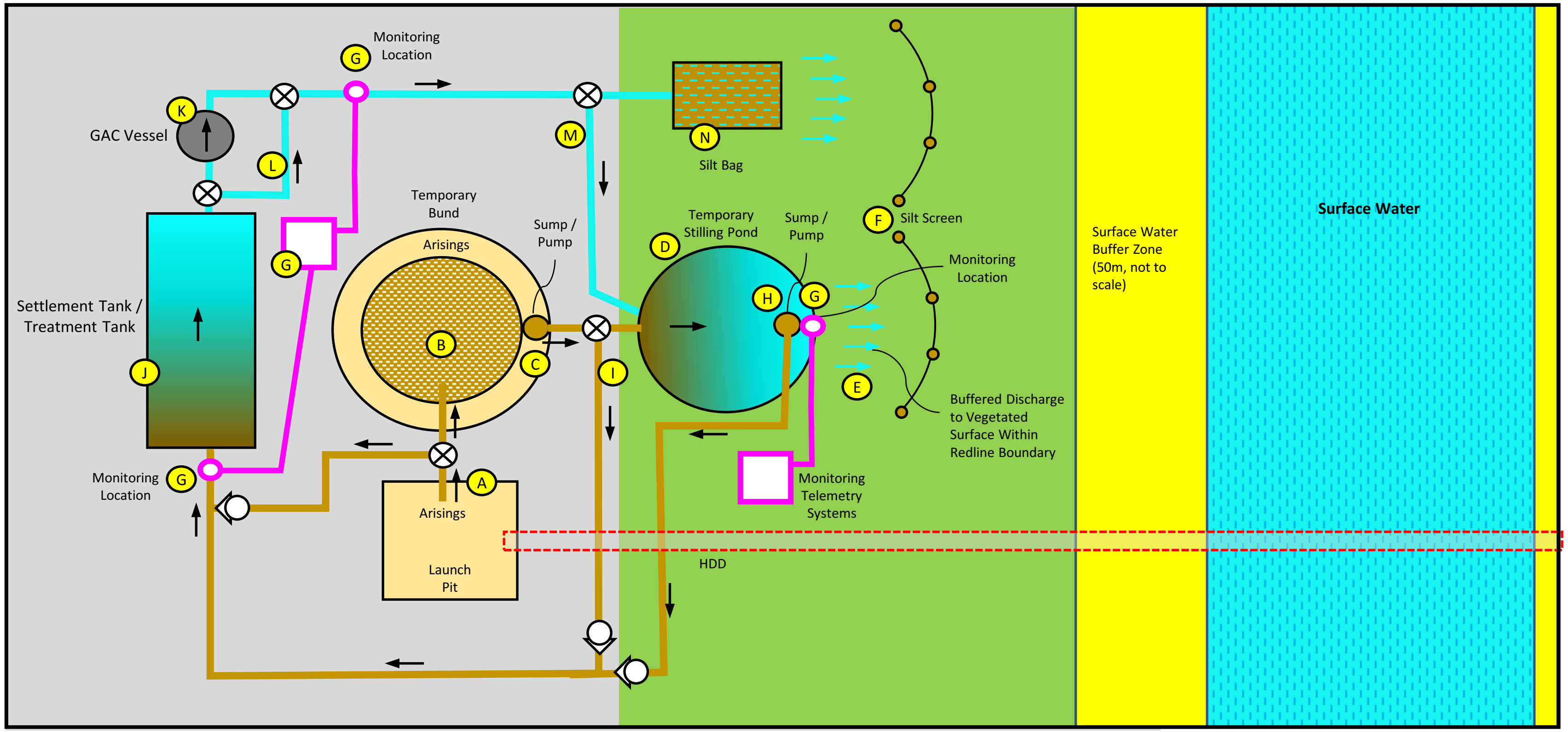
Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 8 Water Treatment Train Layouts**	**Date:**	18/11/2022	**Reviewed By:**	SK
	Revision:	00 DRAFT		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

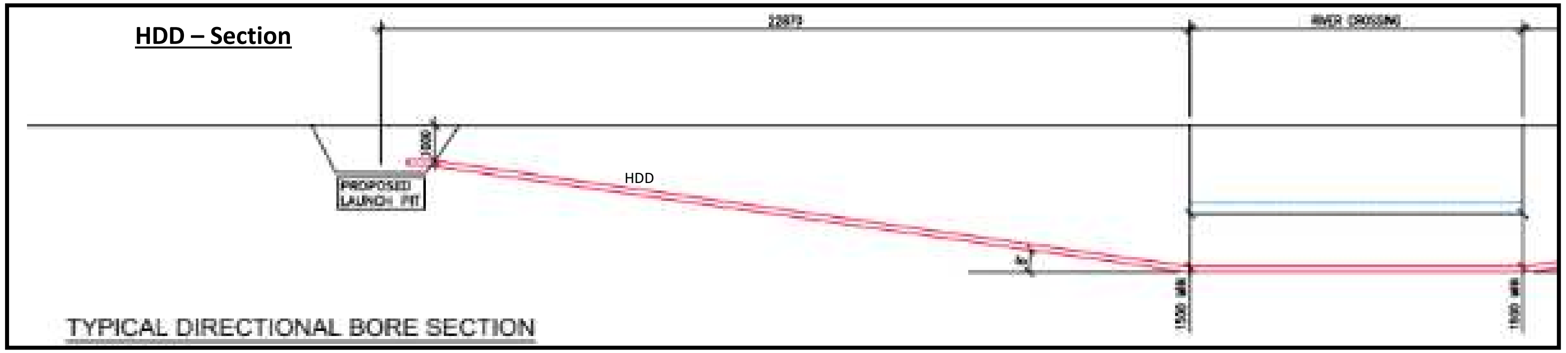
NOTES:

- This methodology and example scenario is designed with a view to managing Horizontal Drilling arisings, but can be applied to all scenarios whereby active dewatering, treatment, or management of construction waters is required.
- Contaminated water arising from construction works, namely; excavations, drilling and temporary stockpiling, will be contained and treated prior to release or discharge. The schematic presented here is a conceptual model of measures implemented to manage arisings and runoff;
  A. Arisings from the launch / reception pit, or any other significant excavation (e.g., cable joint bays), will be directed the treatment train.
  B. Arising control area i.e., a temporary bund. Gross solids will be temporarily deposited here. Water arsing with the material will be allowed to drain to sump.
  C. Sump / Pump. Sump will discharge by gravity / pumped to stilling pond.
  D. Temporary stilling pond. This can be constructed using soils for bunding in combination with an impermeable liner.
  E. The outfall from the stilling pond will be buffered (coarse aggregate) to dissipate energy and diffuse discharging water.
  F. Silt Screen. A silt screen will be in place down gradient of the Stilling Pond outfall. This is a precautionary measure to mitigate peak loads or surcharges in the system.
  G. Monitoring Location/s. Discharge quality will be monitored in real time using telemetry systems. Monitoring of discharge quality will be carried out at the outfall of the stilling pond i.e., before being actually discharged to surface vegetation or surface water (licenced).
  H. Sump / Pump. Discharge By-Pass. If water discharging from the stilling pond exceeds quality reference limits water will be diverted (pumped) from the stilling pond to the settlement / treatment tank.
  I. Stilling Pond By-Pass. Similar to Discharge By-Pass, if conditions dictate water can be diverted directly to Settlement / Treatment Tank.
  J. Settlement / Treatment Tank. A settlement tank will in line and ready to use if required i.e., water quality at stilling pond outfall fails to meet quality reference limits. The tank will be equipped with treatment systems which will be activated as the need arises, for example; very fine particles which are very slow to settle can be treated with a flocculant agent to promote settlement of particles.
  K. GAC Vessel/s. As a precautionary measure, GAC (Granulated Activated Carbon) vessel/s will be in line and ready to use if required. GAC vessels are used to filter out low concentrations of hydrocarbons. Significant hydrocarbon contamination is only envisaged under accidental circumstances. If a hydrocarbon spill does occur, normal operations will pause and the treatment train will be utilised to remediate captured contaminated runoff.
  L. GAC Vessel By-Pass. If the quality of the water is acceptable in terms of hydrocarbon contamination. As there are no GAC Vessels on site, this will not be required.
  M. Treated water will be discharge by gravity / pump to the stilling pond for additional clarification, monitoring and buffered discharge to vegetated area.
  N. Silt Bag. A silt bag can be used as alternative to stilling ponds. However, silt bags must only be used as primary method in lower risk areas i.e., outside of buffer zones, etc. Stilling ponds will be the primary method (D, N) is circumstances where risk is elevated, however a gate valve and silt bag can be included in the treatment train and used as an emergency discharge route in the event that the stilling pond needs remediation or maintenance.
- In all instances, stilling ponds (D), Silt Bags (N) and outfalls (E) will be situated outside of surface water buffer zones. At many locations, particularly at HDD locations works will be within buffer zones. In these instances, the treatment train can be positioned upgradient along the road where discharge to vegetated areas / roadside drains can be managed.

Conceptual Treatment Train Layout for HDD – Plan View



HDD – Section

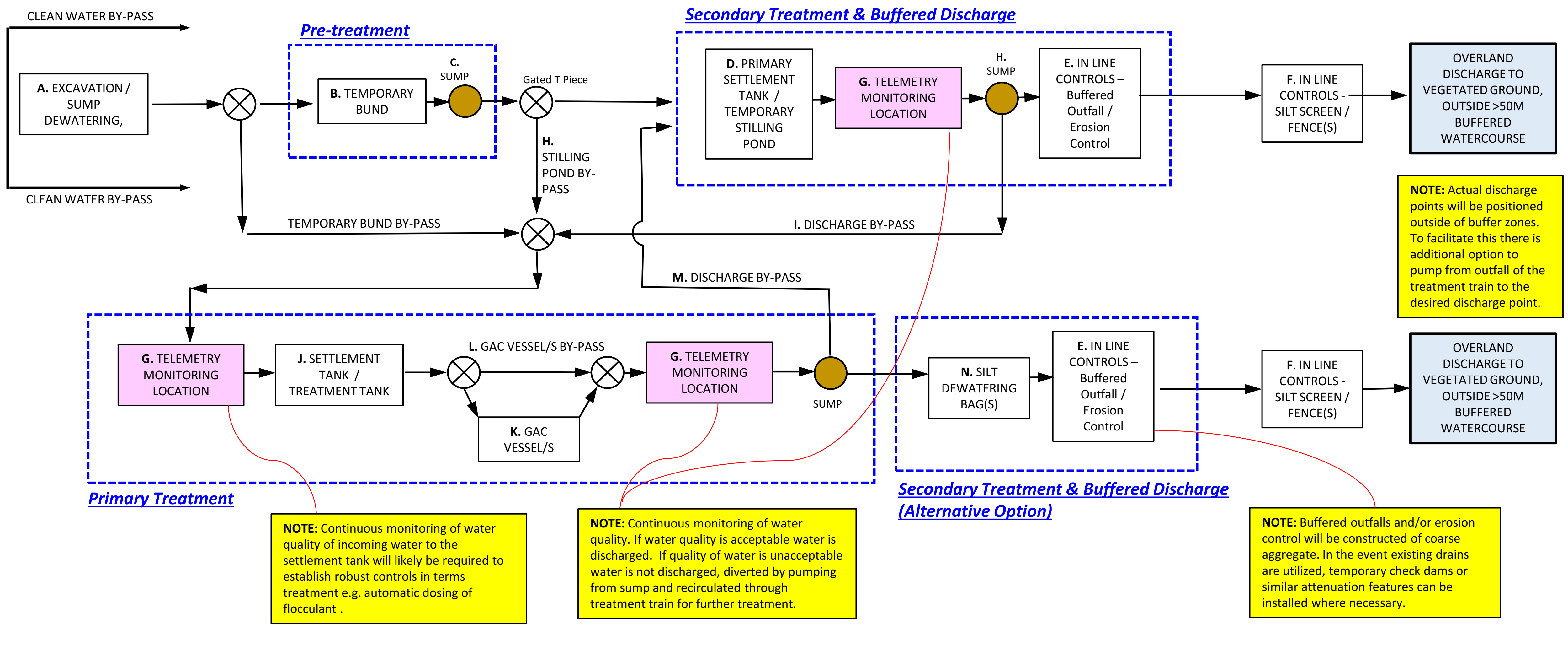


Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 9** **Treatment Train Layout for Active Runoff Management (e.g. HDD)**	**Date:**	18/11/2022	**Reviewed By:**	SK	
	Revision:	00 DRAFT			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

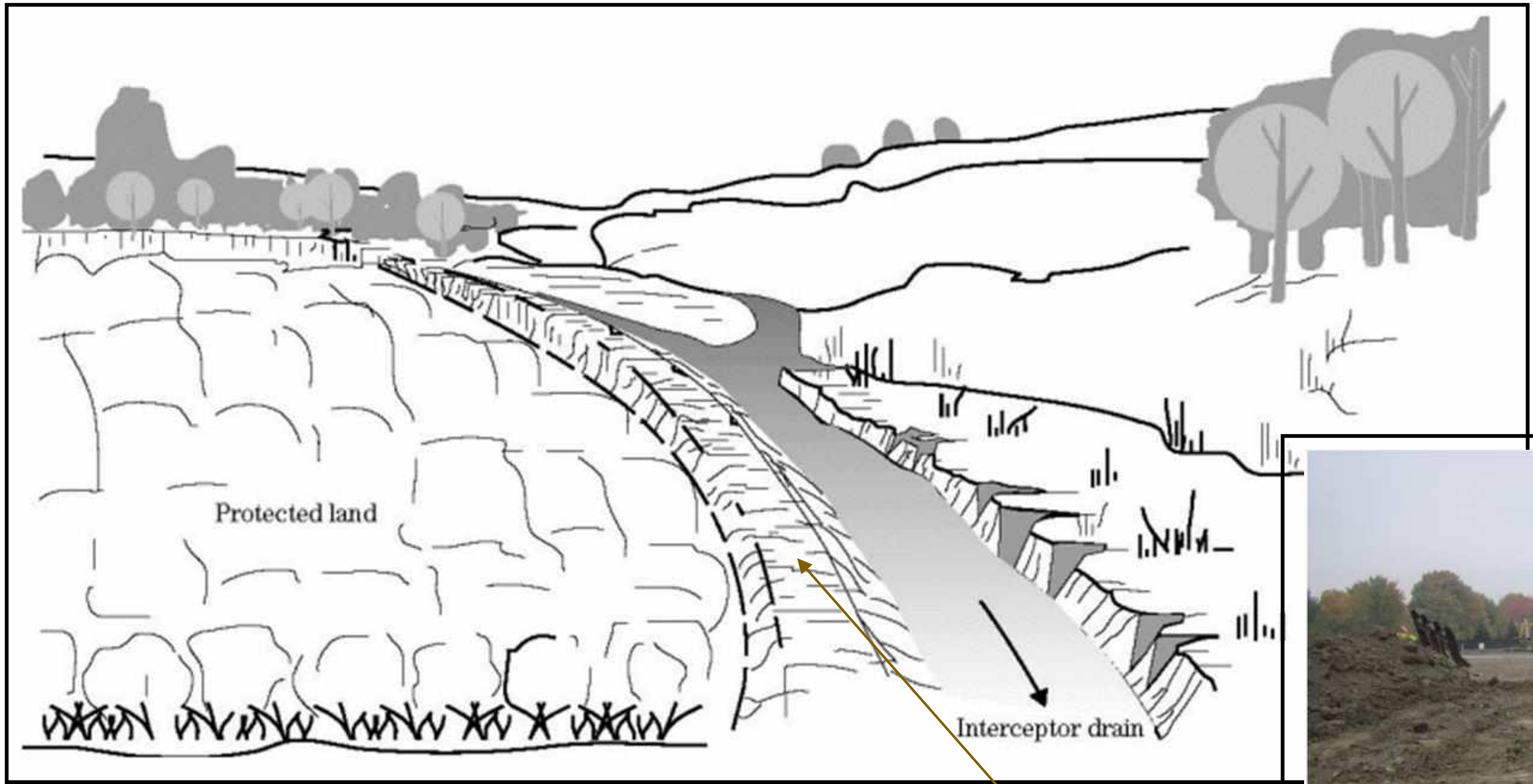
Conceptual Dewatering and Treatment Train Flow Diagram

Contaminated water arising from construction works, namely; excavations and temporary stockpiling, will be contained and treated prior to release or discharge.
The schematic presented here is a conceptual model of measures implemented to manage arisings and runoff.



Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 10 Conceptual Dewatering and Treatment Train Flow Diagram**	**Date:**	18/11/2022	**Reviewed By:**	SK	
	Revision:	00 DRAFT			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.



Conceptual graphic of an interceptor drain
(NRCS/USDA.gov, 2007) Available at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_017651.pdf

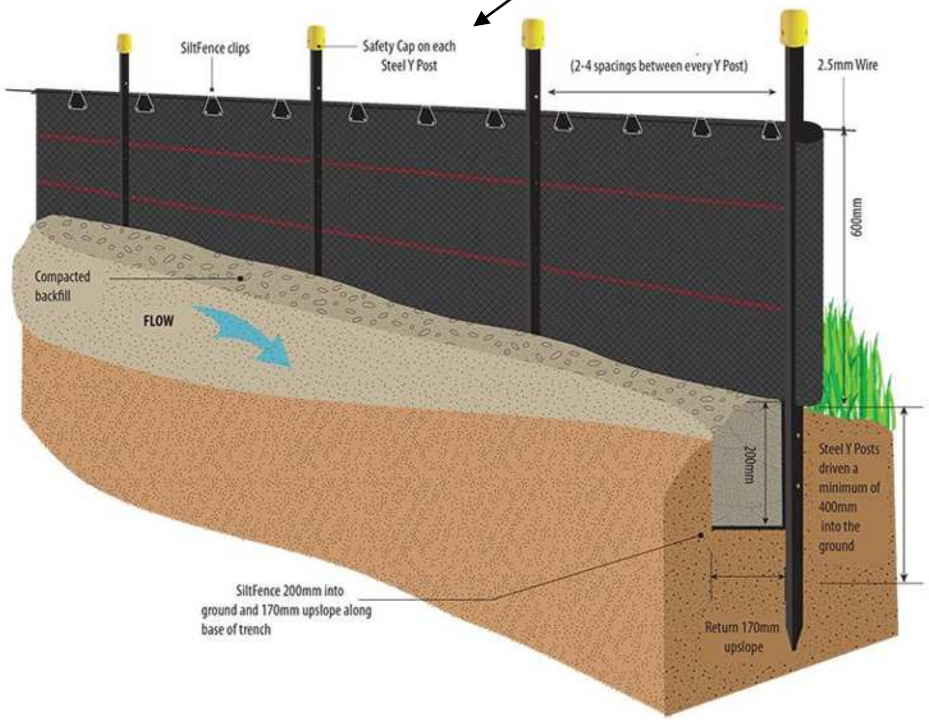
Built-up berm

Example of a temporary berm
(Green Infrastructure Ontario, 2012) Available at:
https://greeninfrastructureontario.org/infiltration-trench-swale-construction/

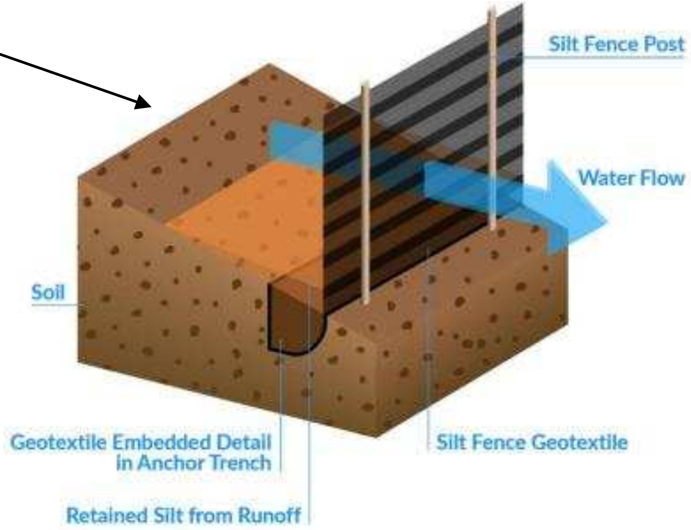
Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientists	
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4: Conceptual & Information Graphics – Tile 11 Interceptor Drain & Spoil Berms**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Temporary barrier fabric used to retain erosion of sand, silt, and clay. Geotextile silt fencing acts as a vertical, permeable, interceptor to sediment-laden waters from construction.



Conceptual graphic of a silt fence
Tech Weave (2020) Available at:<https://techweave.com/silt-fences/>



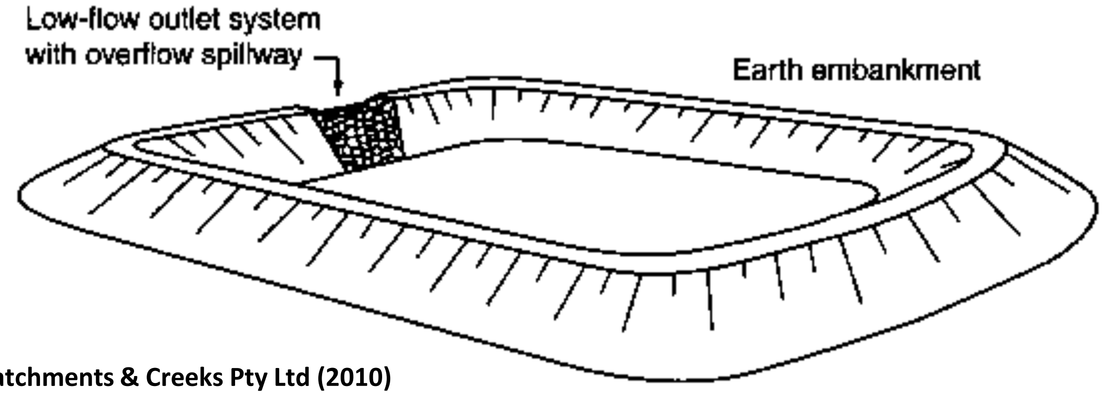
Conceptual graphic of a silt fence
Available at: https://www.pub.gov.sg/Documents/SiltFences.pdf

Example of Silt fencing in use
(EnviroPro, 2022) Available at:
<https://www.enviropro.co.uk/entry/153977/Siltbuster/Terrastop-silt-fences-for-erosion-and-runoff-control/>

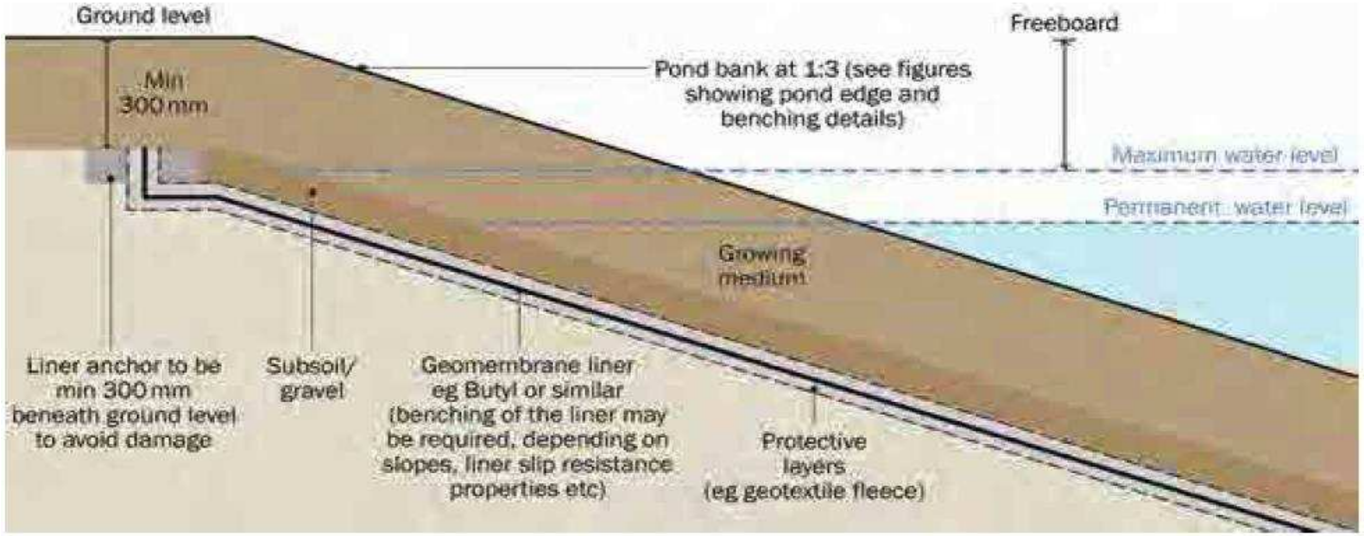
Example of Silt fencing in use
Bowman Construction Supply (2023) Available at:<https://www.bowmanconstructionsupply.com/products/silt-fence/>

Silt fences control runoff by allowing water to pass through the fabric while collecting leftover sediment.

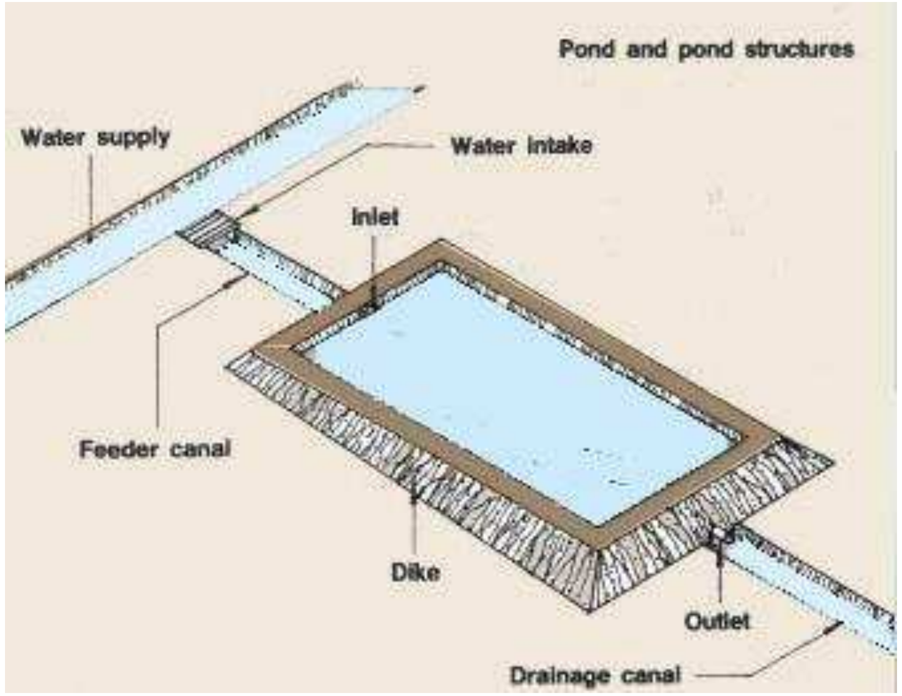
Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 12 Silt Fencing**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00		



Catchments & Creeks Pty Ltd (2010)
<https://www.catchmentsandcreeks.com.au/docs/SEP-1.pdf>



CIRIA SuDS Manual (2015)

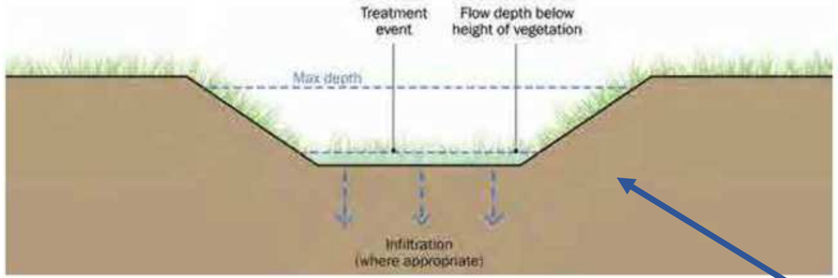


United Nations Food and Agriculture Organization
<https://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6708e/x6708e01.htm>

Ponds should be designed to mimic natural forms and have varying depths which can provide a range of different habitats.

Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 13 Settlement Ponds**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.



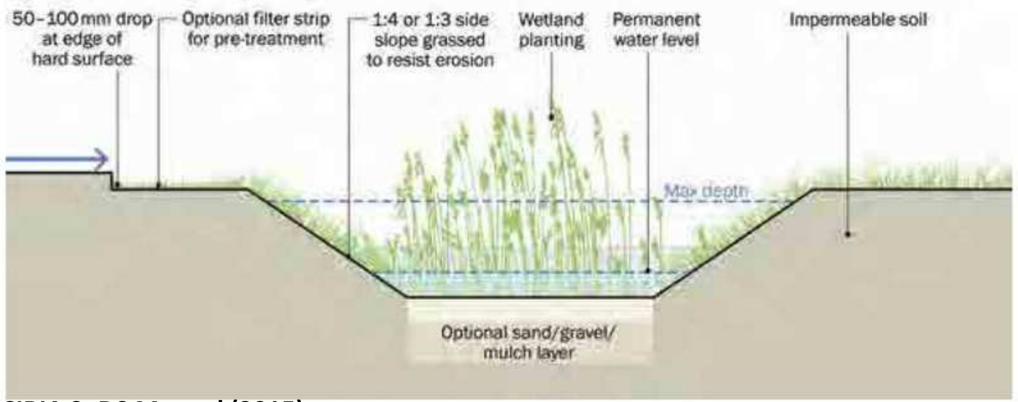
CIRIA SuDS Manual (2015)

A swale can have check dams installed at measured intervals across the flow path, that temporarily pond runoff to increase pollutant retention and infiltration and further decrease flow velocity.

Swale channels are broad and shallow and covered by vegetation, which slows the flow of water and facilitates sedimentation as well as filtration through the roots and soil matrix, evapotranspiration and infiltration into the underlying soil.

Massachusetts Department of Environmental Protection (2023)
<https://megamanual.geosyntec.com/npsmanual/checkdams.aspx>

Shallow, vegetated, open channel designed to direct, treat and attenuate surface water runoff with a potential for biodiversity benefits.

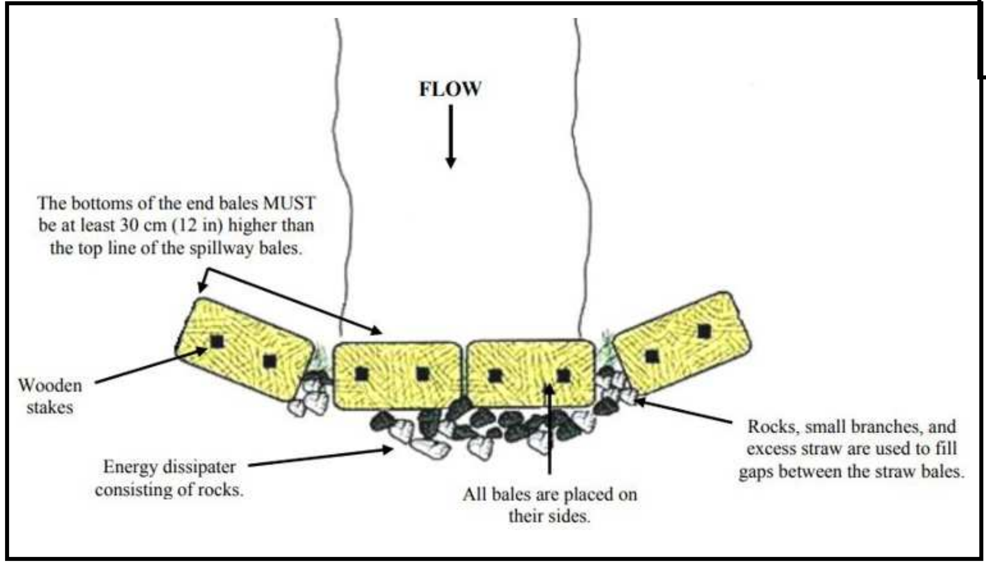


CIRIA SuDS Manual (2015)

Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 14** **Check Dams – General Considerations**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Example of a Strawbale Checked Dam
Robichaud, et al. (2019)



Conceptual graphic of a straw bale checked dam
(Storrar, 2013)

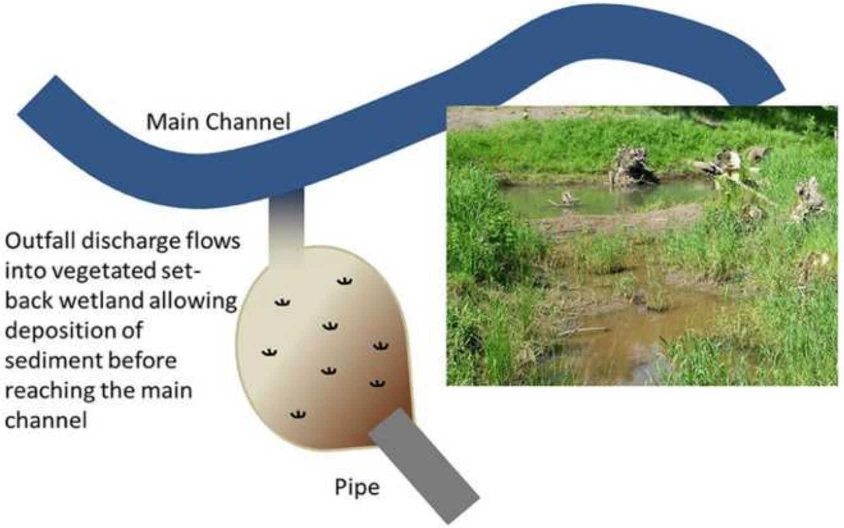
Example of a Strawbale Checked Dam
(Kawartha Conservation, 2020)

Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist	RSK
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 15** **Examples of Mitigation Measures to Reduce Sediment Transport**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Example of buffered outfall with coarse aggregate
(Catchments and Creeks Pty Ltd., 2020)

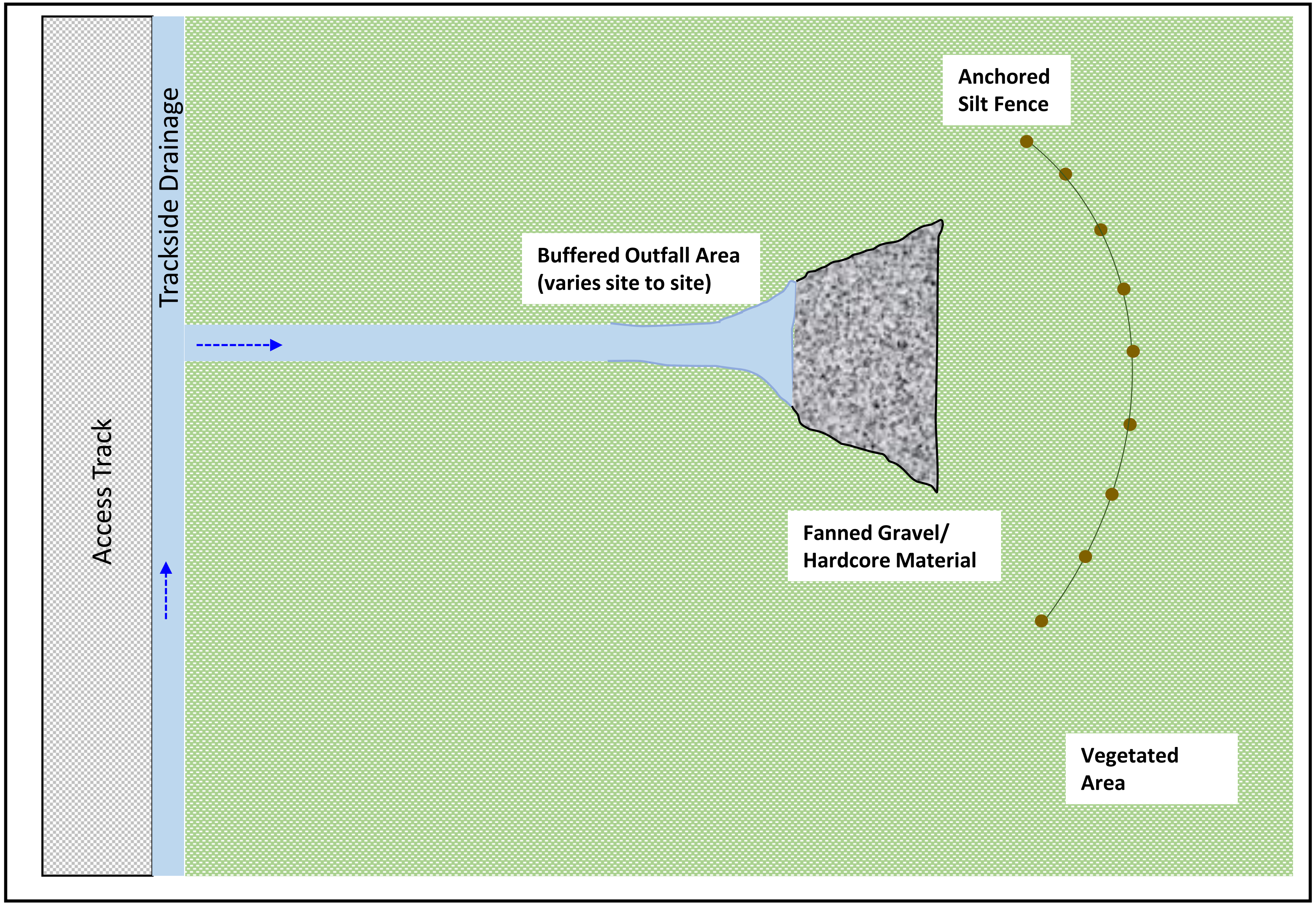
Example of a silt bag
(Cascade Geotechnical Inc., 2022)



Conceptual graphic of a discharge to vegetated outfall
(Janes-Bassett *et al.,* 2016)

Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientists	
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 16** **Examples of Mitigation Measures to Reduce Sediment Transport**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

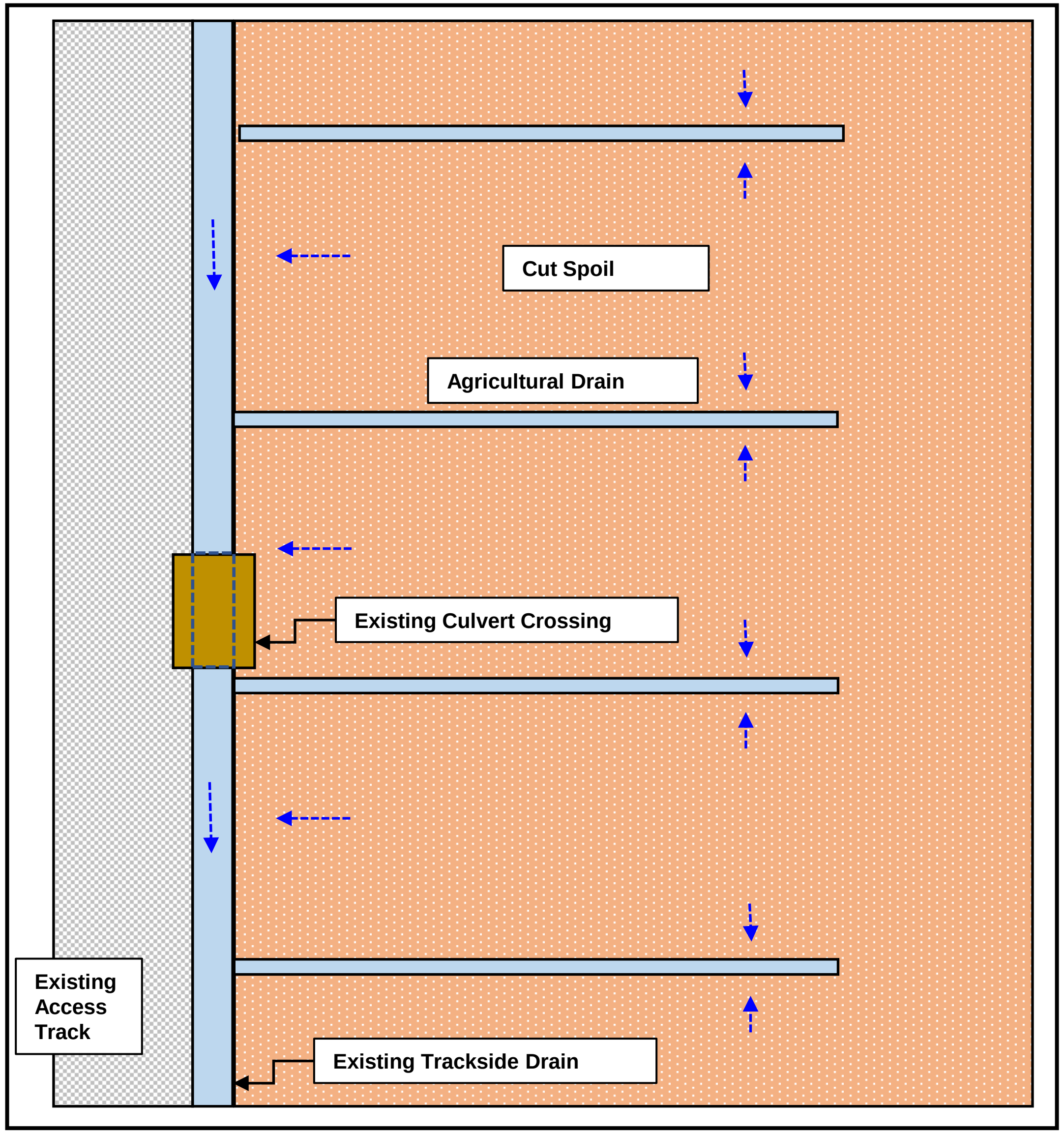
Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.



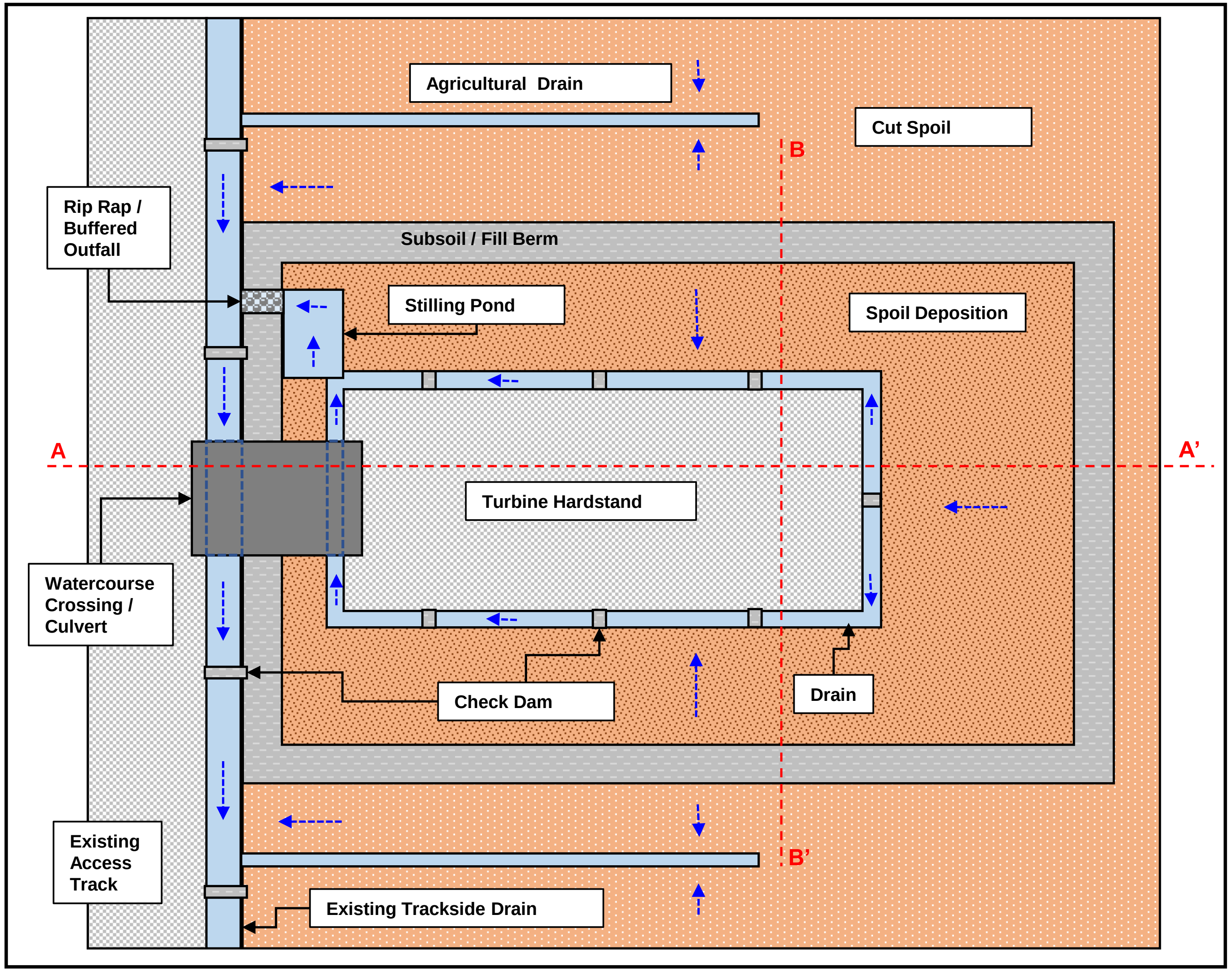
Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist	RSK
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 17** **Collector Drains and Buffered Outfalls**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Existing Drainage Scenario

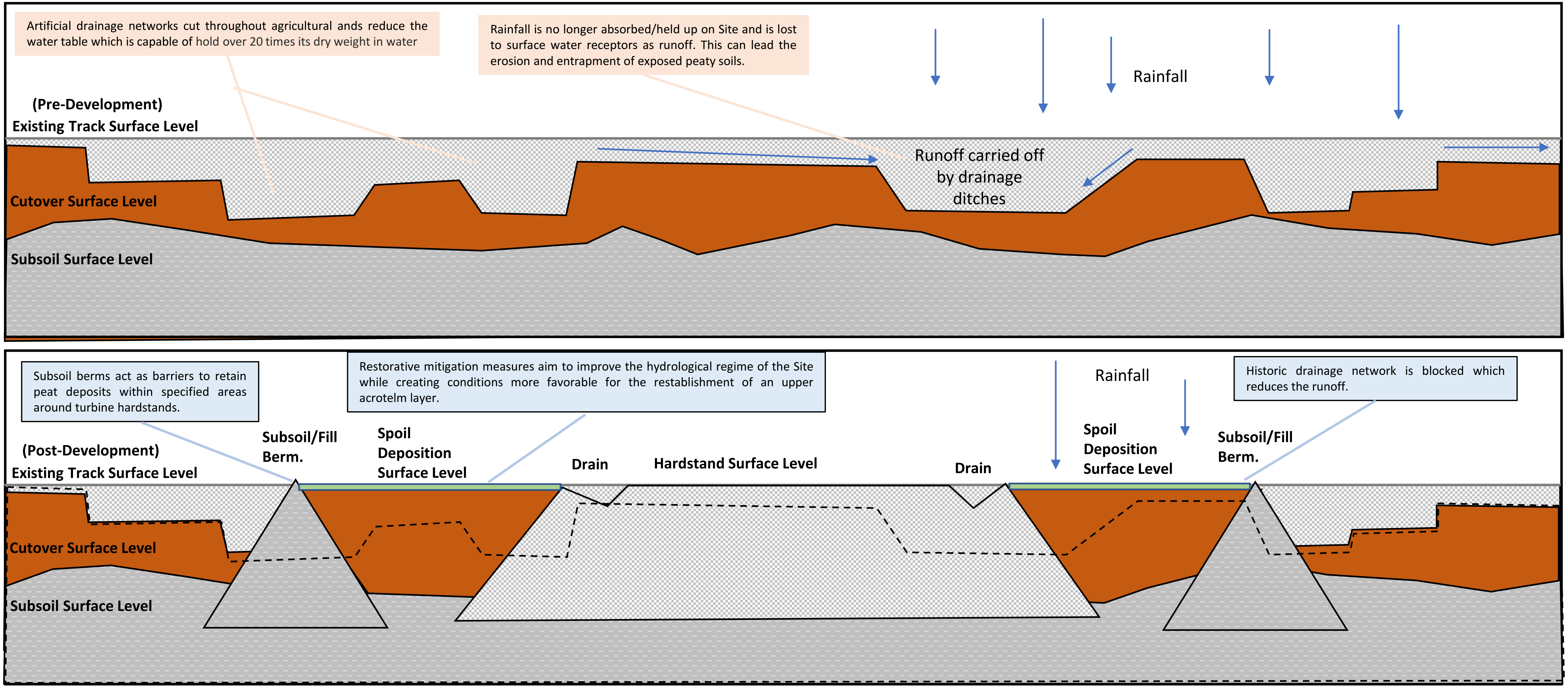


Proposed Drainage Scenario



Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 18** **Examples of Conceptual Hardstand – Plan**	**Date:**	03/05/23	**Reviewed By:**	SK
	Revision:	02		

Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.



Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 19** **Spoil Deposition Areas – Linear view**	**Date:**	03/05/23	**Reviewed By:**	SK	
	Revision:	02			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

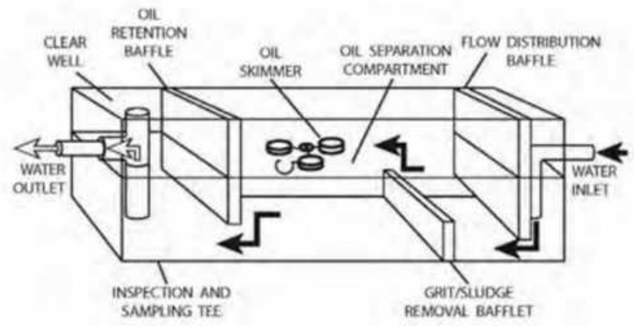
Example of a temporary spill pallet bund (Road Ware, 2023)
Available at: <https://www.roadware.co.uk/ibc-storage-tank-pallet-spill-containment-bund-stand/?sku=IBCSP&gclid=Cj0KCQiA8aOeBhCWARIsANRFrQFTsDlSEUrk4rdov4TcTBQOwNZguishep9-yj6_qx9NexUXnAv6ONkaAq8ZEALw_wcB>

Example of a temporary spill pallet bund (Road Ware, 2023)
Available at: <https://www.roadware.co.uk/gsp2ibc-galvanised-steel-double-ibc-spill-pallet-bund/?gclid=Cj0KCQiA8aOeBhCWARIsANRFrQGfh5e3lUi9TcfRiXMAcEnilLo5gFmKlb0_dHBi7MRkIwiM0cU7F2oaAkDSEALw_wcB>

Example of a temporary spill pallet bund (Road Ware, 2023)
Available at: <https://www.roadware.co.uk/bp4c-covered-4-drum-spill-pallet-bund-sump/?gclid=Cj0KCQiA8aOeBhCWARIsANRFrQFNE1gbC8i9OUP2HLpHeKcFDNjrurp_ui5Nz6rmRa1WblNXRH17di8aAn-kEALw_wcB>

Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist	RSK
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 – Conceptual & Information Graphics – Tile 20 Examples Environmental 'Good Practice' of Bunded Materials**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

Example of an oil-water separator
Minerex Environmental Limited, an RSK Group company



Siltbuster ® (2017) "Solutions for Suspended Solids Removal: Hire, Sales & Technical Support" Siltbuster Ltd. Available at: https://www.siltbuster.co.uk/wp-content/uploads/2020/10/Solutions-for-Suspended-Solids-Removal.pdf.

Cross-section of oil-water separator
Mohr, Kirby S. (2014)

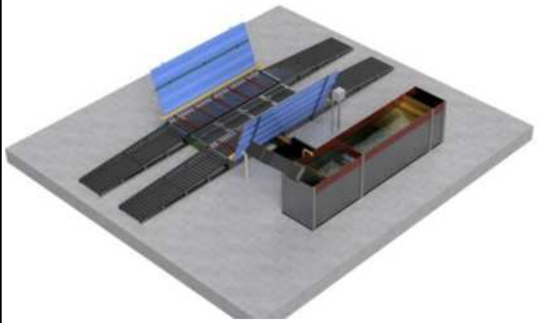
Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientists
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 – Conceptuel & Information Graphics – Tile 21 Settlement Tank**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Meeds Environmental, LLC, 2012
<http://www.meedsenvironmental.com/wheel.php>

Construction.co.uk, 2023
<https://www.construction.co.uk/c/217313/wheelwash-ltd>

Neptune Wash Solutions, 2023
<https://www.neptunewash.com/automated-wheel-wash-systems/>

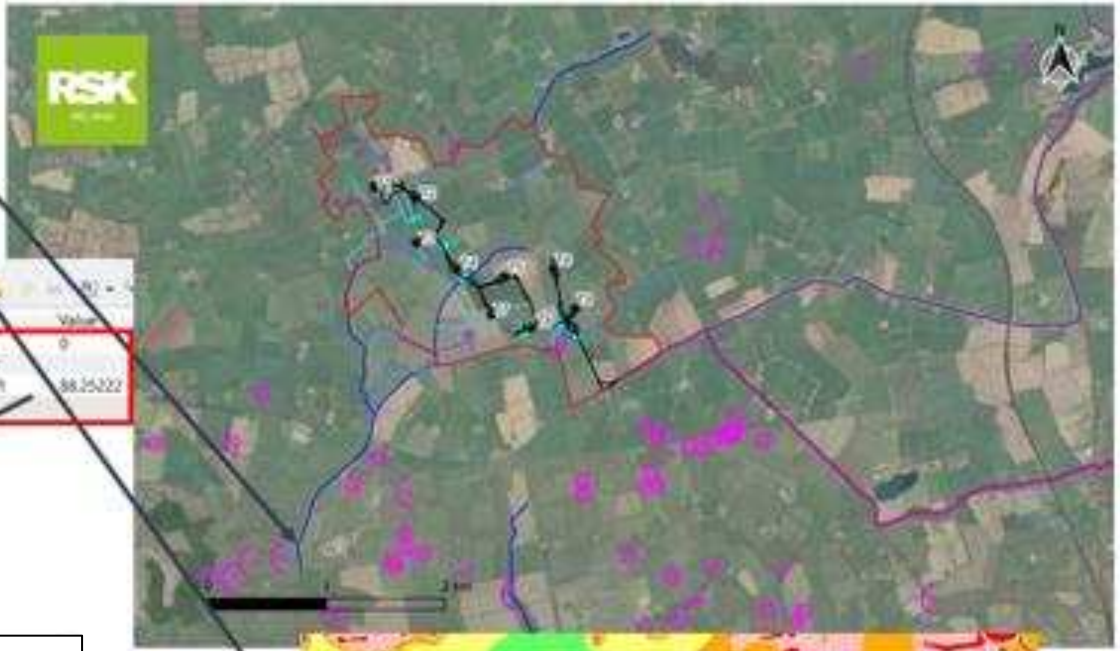


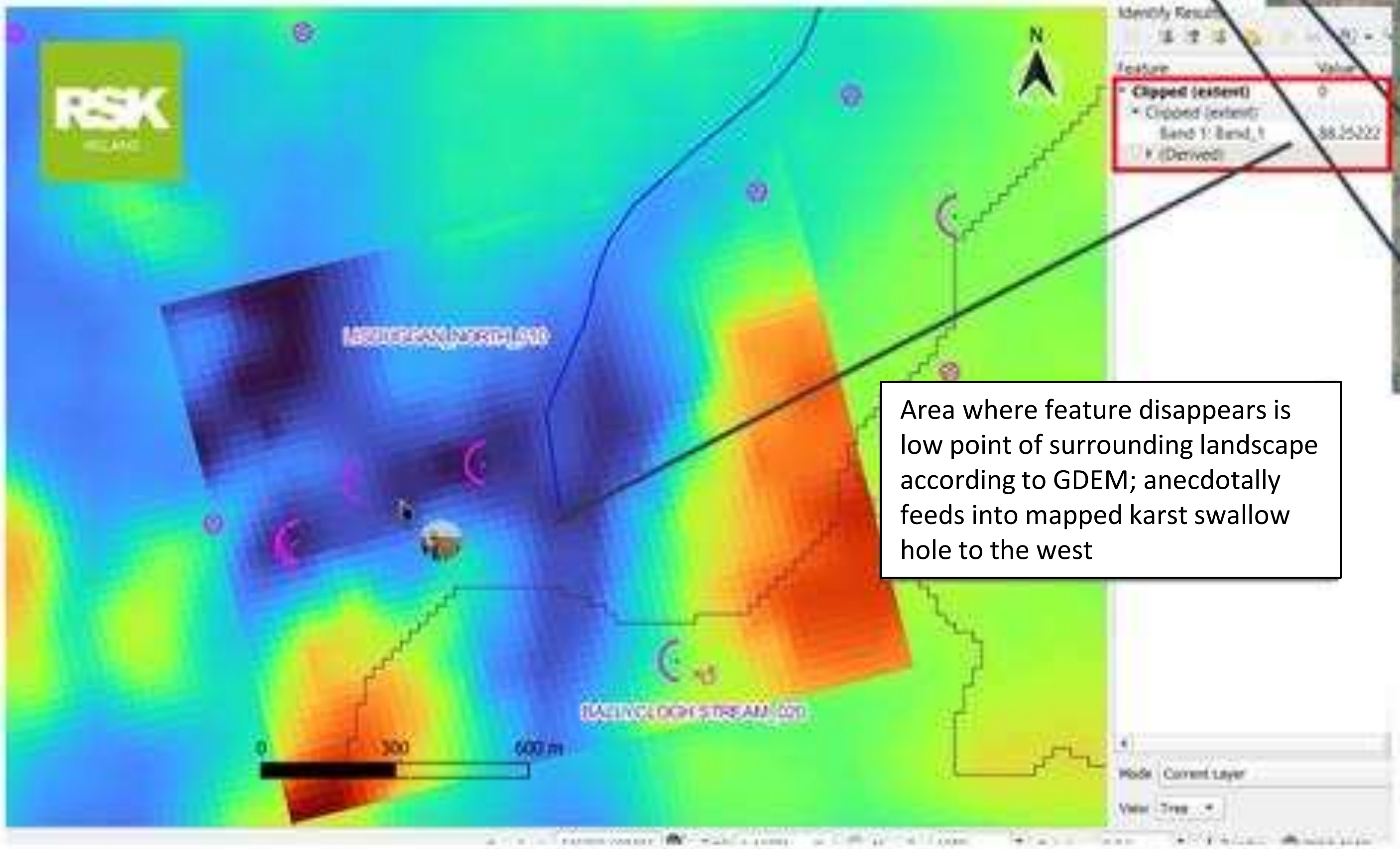
KKE Corporation, 2023
<https://kkewash.com/en-gb/8-4-agc-portable-tire-wash/>

Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 - Conceptuel & Information Graphics – Tile 22 Wheel Washout Station**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00		

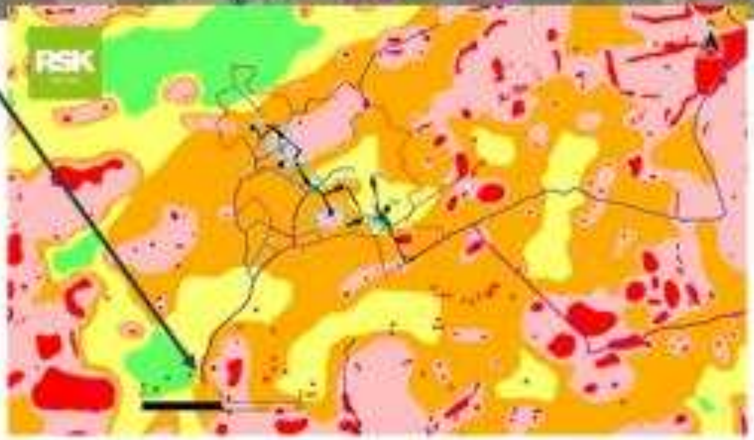
Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Surface water feature ends / disappears underground, identifying a direct connection to groundwater, that is mapped as 'high' vulnerability





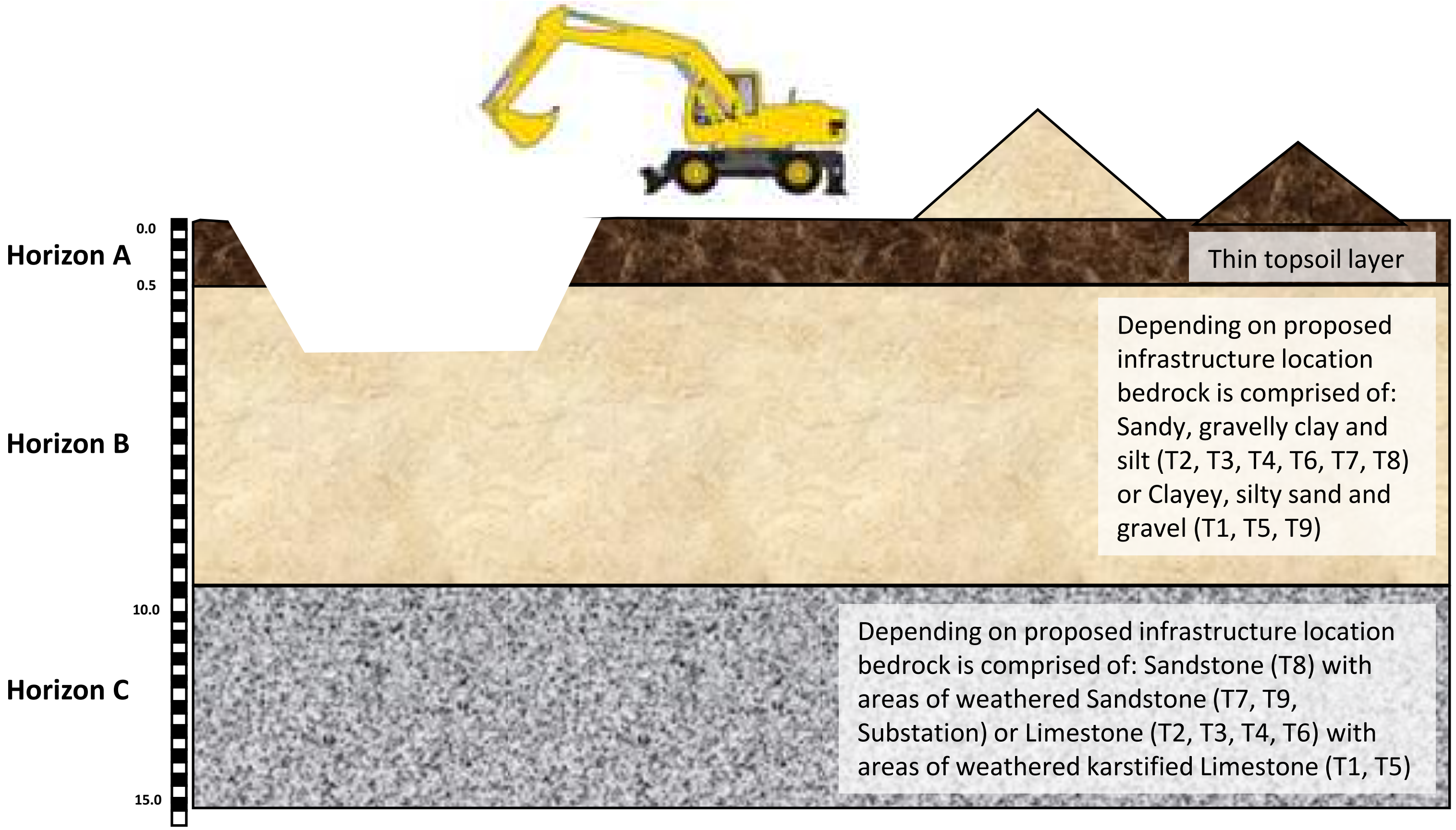
Area where feature disappears is low point of surrounding landscape according to GDEM; anecdotally feeds into mapped karst swallow hole to the west



Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist	RSK
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 - Conceptuel & Information Graphics – Tile 23 Underground Karst features**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

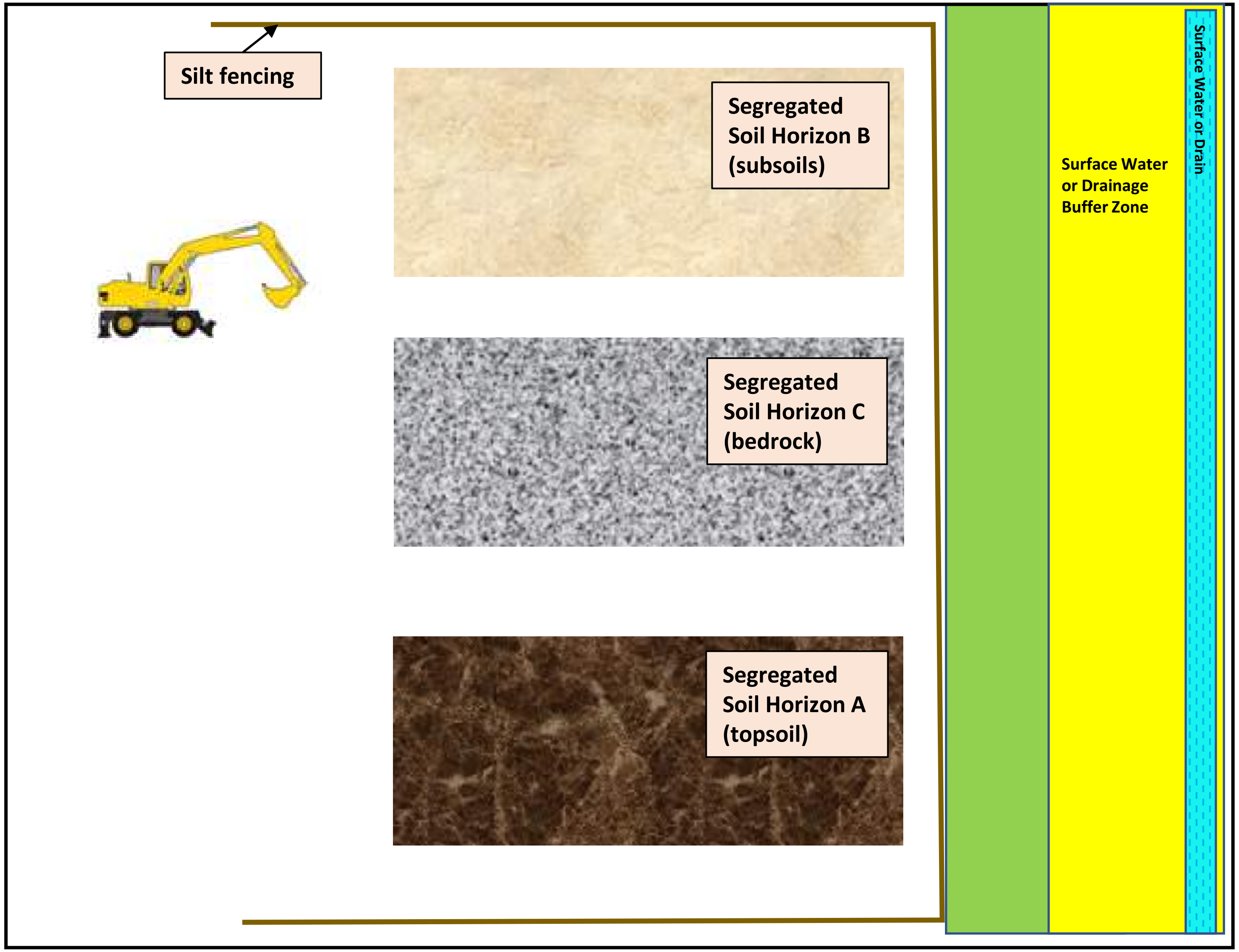
- The three principal materials excavated in order of depth will include topsoil at the surface, subsoils, and weathered and broken bedrock (Horizons A-C, respectfully).
- On receipt of consent, a geotechnical site investigation will be undertaken, including trialpitting to obtain higher resolution data on soil stratigraphy and soil types.
- A suitably qualified geotechnical / soil scientist will supervise all excavation and the principal material types (topsoil, subsoil and bedrock) will be segregated as they arise.
- Temporary storage locations and stockpiled arisings will be managed in such a way that as to not mix induvial soils types which will, in turn will facilitate reuse on Site. Some measures which will be taken include;
    - Designated areas for each type of material which will be adequately sized based on Material Balance Assessment calculations and planned storage height.
    - Incorporating the planned movement of materials for example; Topsoil will be the first material to be excavated and the last to be used in reinstatement.
    - Adequate space between stockpiles to reduce the potential of mixing when material is being deposited or removed, or if localized stability issues arise for example; stockpile collapse.
    - It is also important to mitigate against the entrainment of solids in runoff (EIAR Chapter 9 – Hydrology & hydrogeology).
- In order to reduce the amount of arisings to be managed or stored at any one time during the construction phase, a Materials Balance Assessment and Materials Management Plan will be developed with a view to identifying suitable locations for permanent reinstatement as early as possible, for example; as the construction phase progresses, opportunities to move arisings to a permanent reinstatement area in one movement will be taken as often as possible.
- Backfilling in layers will be carried out at the designated reinstatement locations, this will include; use of material as fill under infrastructure, backfill around newly installed infrastructure e.g. foundations, and potentially in improvement areas.
- Infilling with material in identified soil horizons to revert these areas to baseline levels.



Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist	
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 - Conceptuel & Information Graphics – Tile 24** **Conceptual Soil Horizon Graphic**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	RSK
	Revision:	00			

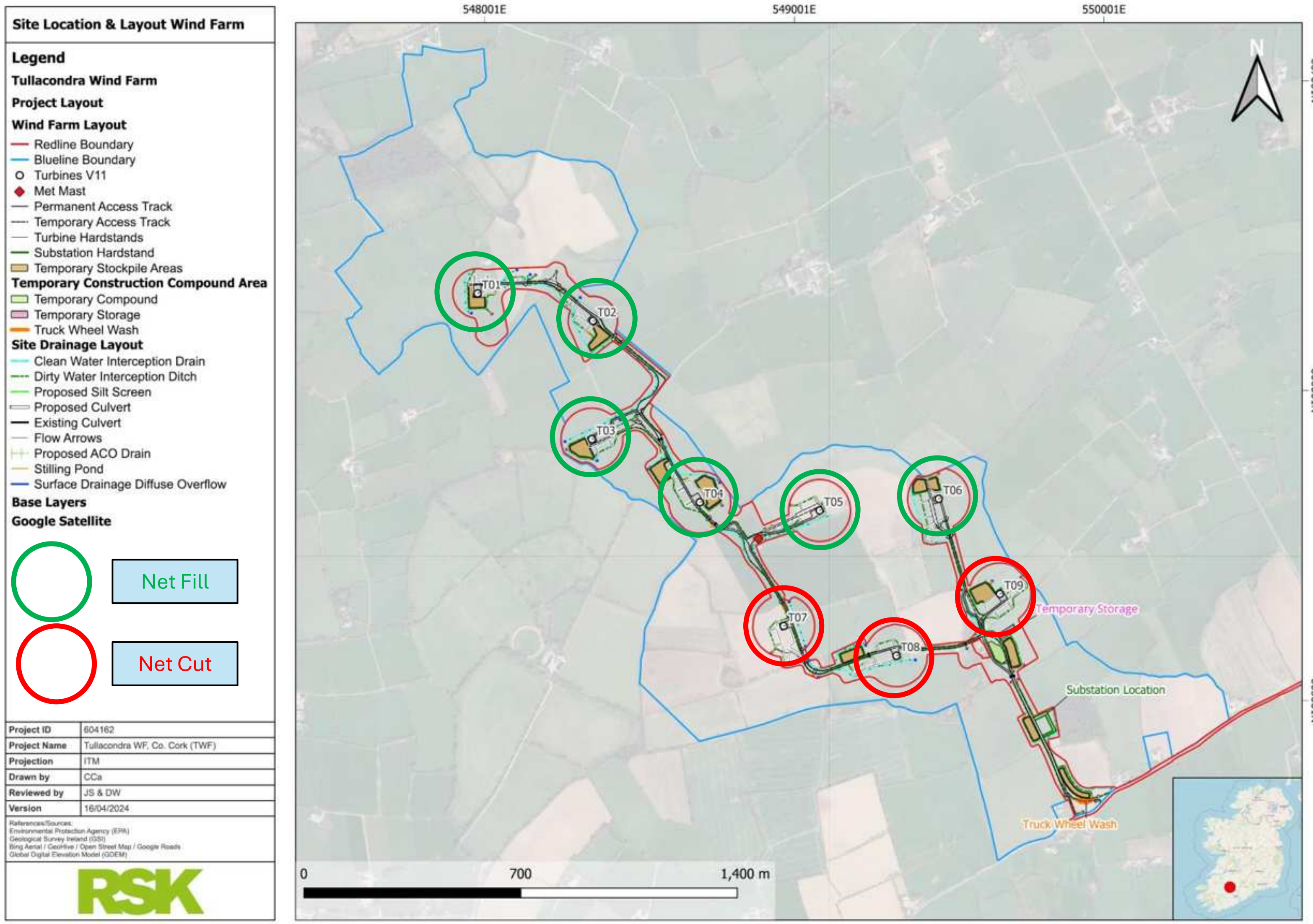
Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

- All stockpiles will be covered with high-grade polythene sheeting to prevent run-off of rainwater and leaching of potential contaminants from the stockpiled material generation and/or the generation of dust.
- Recovered material destined for reuse off site will comply with Article 27 or Article 28 of the EPA to be classified as a by-product or as end-of-life waste, or Certificate of Registration for topsoil.
- Excess soils which cannot be reused will be tested and classified as a waste and disposed of appropriately.
- Temporary stockpiles will avoid areas on Site near artificial drainage channels(outside designated surface water buffer zones and will adhere to mitigation measures outline in **EIAR Chapter 9 Hydrology and Hydrogeology,** in particular in dealing with entrainment of soils in surface water runoff.



Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist
	Client:	Tullacondra Green Energy Ltd		
Figure Name: **Appendix 9.4 - Conceptuel & Information Graphics – Tile 25 Conceptual Management of Stockpiles Graphic**	**Date:**	07/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00		

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.



Note: Data points presented are georeferenced using open source data and/or a handheld GPS. This drawing / map is considered a conceptual model with reasonable accuracy for the purposes of environmental assessment. This drawing should not be relied upon for detailed design purposes.

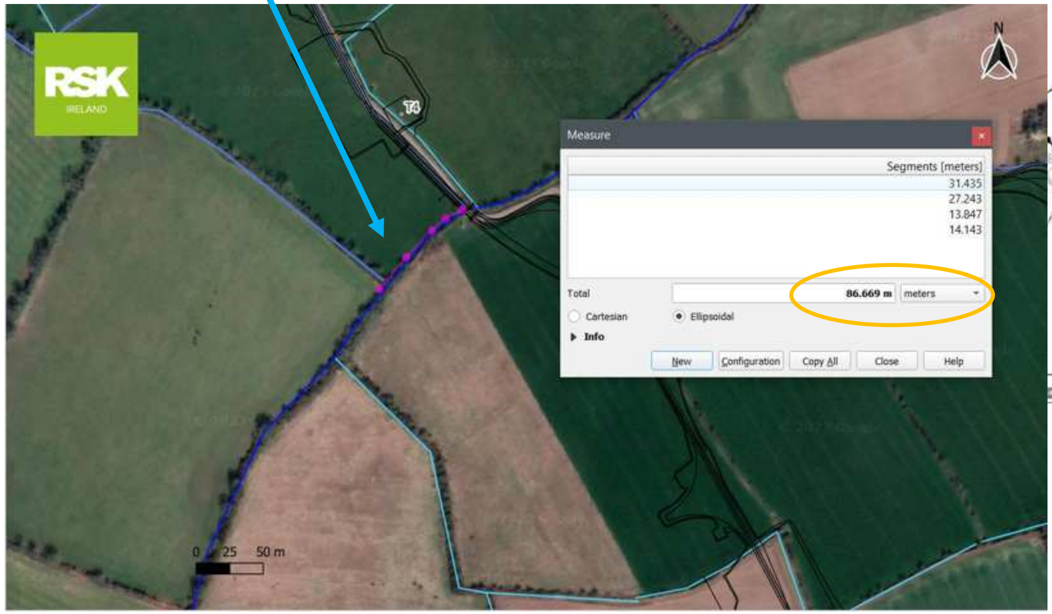
1. Topsoil will be stripped off from all locations, stored for most of construction phase, and used last in reinstatement.
2. Subsoil and some bedrock will be removed and replaced with concrete foundations i.e. net excess fill material. Subsoils can be used as engineering fill (pending detailed SI and Geotechnical testing). Subsoils also required for backfilling foundation construction areas.
3. The sequence of works will be such that excess material arising from net cut areas (T7 T8 T9) will be deposited directly in destination net fill areas (T1,2,3,4,5,6, Substation, Access Tracks, and SuDS features e.g. berms and constructed drainage) where possible.
4. To limit the storage area required further, the sequence of work can be conducted in a phased approach, for example; splitting site in two parts, focusing initially on net cut locations (T7,8,9) and exhausting reuse of arisings in proximal net fill locations, starting with Access Tracks, Substation, T5, and T6.
5. This will approximately half the total volumes to be managed generally at any time, and will further reduce storage requirements by means of efficient cut and fill movements.
6. More detailed engineering assessment including site investigation and geotechnical testing will inform a detailed materials balance assessment and materials management plan, including a detailed breakdown of the sequence of excavations, movements and deposits of soil and rock arisings.

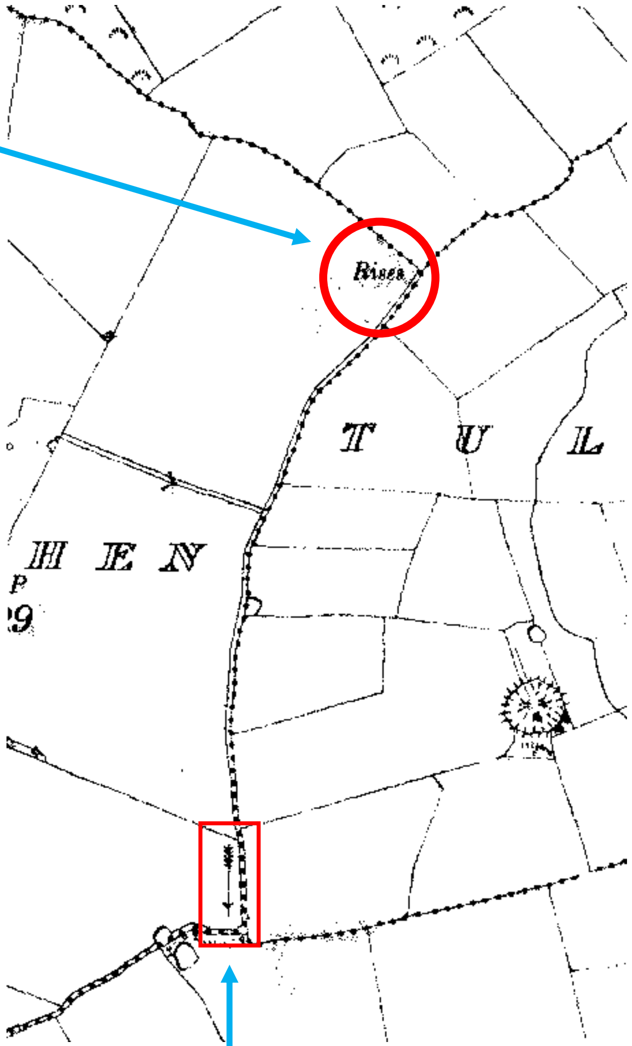
Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist	RSK
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 - Conceptuel & Information Graphics – Tile 26 Conceptual Management of Stockpiles Graphic**	**Date:**	24/03/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	01			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

The remaining portion of the feature indicated in RSK map, (north / east of "Rises"), the feature is not recorded as a surface water feature but instead mapped as a 'main artery' of the existing drainage network. Note this 'main artery' was observed to be dry during Site visits.

Portion of drain (southwest of proposed T4 location) historically recorded as a surface water drainage feature with flow. Recorded headwater / beginning of the surface water feature is denoted by "Rises", which is approx. 90m distance from the field boundary associated with T4.

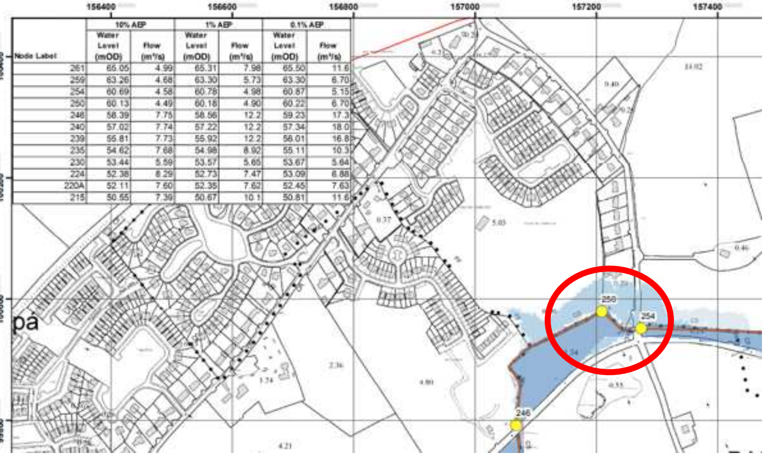




Flow of water in a southerly direction from where it rises

Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist	RSK
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 - Conceptuel & Information Graphics – Tile 27** **Historic Surface Water Feature Cassini 6-inch map**	**Date:**	27/02/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

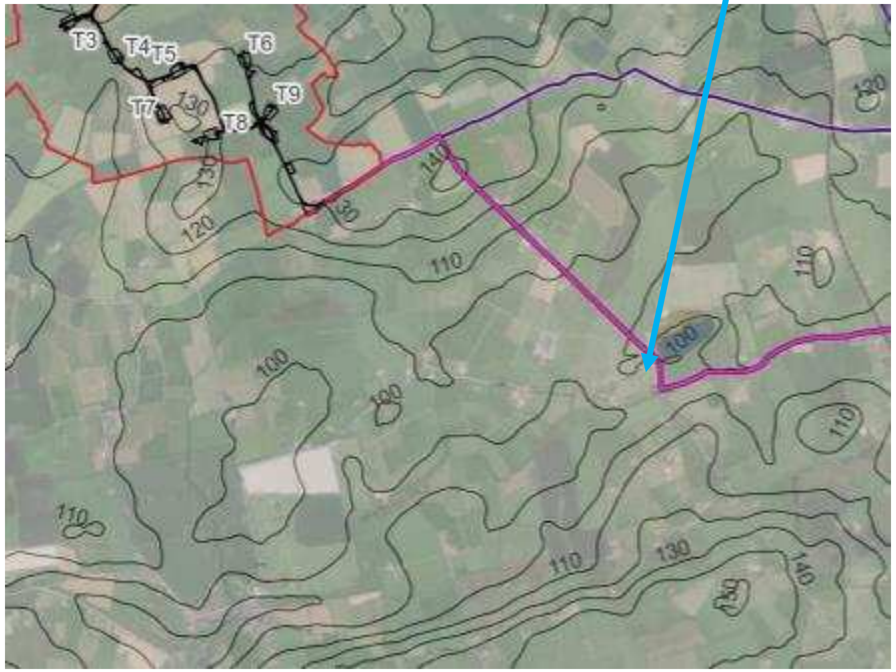
Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

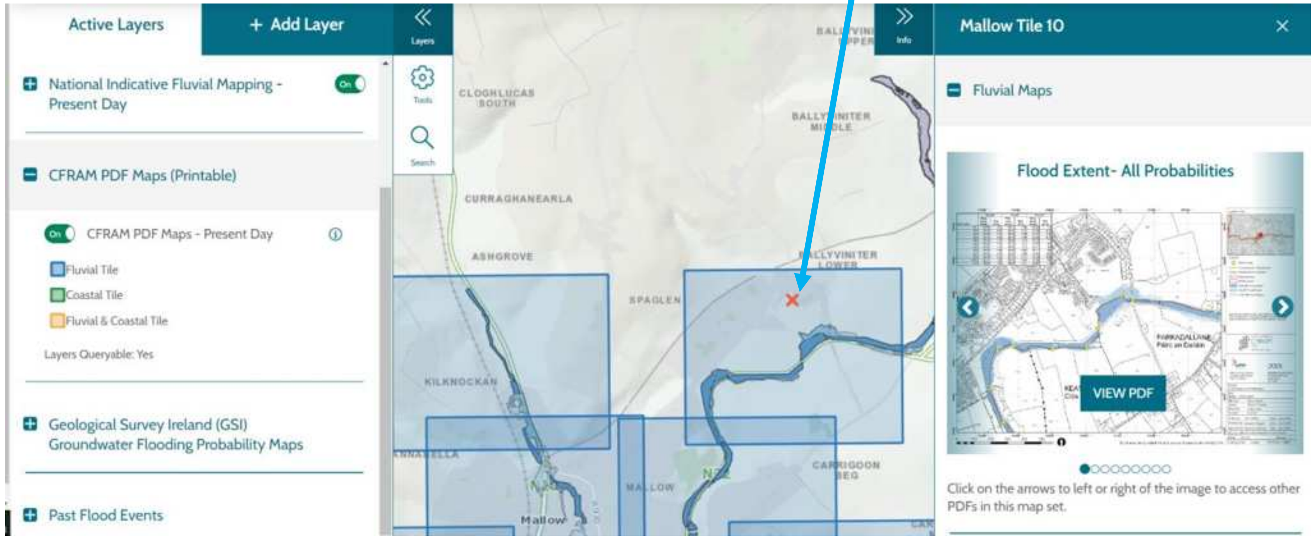


Node Label	10% AEP Water Level (mOD)	10% AEP Flow (m³/s)	1% AEP Water Level (mOD)	1% AEP Flow (m³/s)	0.1% AEP Water Level (mOD)	0.1% AEP Flow (m³/s)
261	65.05	4.99	65.31	7.98	65.50	11.6
259	63.26	4.68	63.30	5.73	63.30	6.70
254	60.69	4.58	60.78	4.98	60.87	5.15
250	60.13	4.49	60.18	4.90	60.22	6.70
246	58.39	7.75	58.56	12.2	59.23	17.3
240	57.02	7.74	57.22	12.2	57.34	18.0
239	55.81	7.73	55.92	12.2	56.01	16.8
235	54.62	7.68	54.98	8.92	55.11	10.3
230	53.44	5.59	53.57	5.65	53.67	5.64
224	52.38	8.29	52.73	7.47	53.09	6.88
220A	52.11	7.60	52.35	7.62	52.45	7.63
215	50.55	7.39	50.67	10.1	50.81	11.6

FLOOD RISK IDENTIFIED

FLOOD RISK IDENTIFIED





Site Name: **Tullacondra Green Energy Project, Co. Cork**	**Project No.**	604162	**Drawn By:**	Colleen McClung Graduate Project Scientist	
	Client:	Tullacondra Green Energy Ltd			
Figure Name: **Appendix 9.4 - Conceptuel & Information Graphics – Tile 28** **Identified Flood Risk Along Grid Connection Route**	**Date:**	27/02/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

EIAR VOLUME III
Appendices

CHAPTER 9 – HYDROLOGY AND HYDROGEOLOGY

Appendix 9.5: Flood Risk Assessment

Tullacondra Green Energy Limited

Tullacondra Green Energy Project

Appendix 9.5: Flood Risk Assessment (FRA)

604162-R04 (05)

June 2024

RSK GENERAL NOTES

Project No.: 604162-R4(05)

Title: Tullacondra Green Energy Project– Flood Risk Assessment

Client: Tullacondra Green Energy Limited

Date: 10/05/2024

Office: Dublin

Status: FINAL

Author	Jayne Stephens	**Technical reviewer**	Sven Klinkenbergh
Signature		Signature	
Date:	10/05/2024	Date:	10/05/2024

Project manager	Sven Klinkenbergh	**Quality reviewer**	Sven Klinkenbergh
Signature		Signature	
Date:	10/05/2024	Date:	10/05/2024

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*All map assessments use "site location" which incorporates 3rd party lands.

FLOOD RISK ASSESSMENT

1 Introduction

RSK Ireland was commissioned to carry out a Flood Risk Assessment by Tullacondra Green Energy Limited (the Client). This report presents the findings of the flood risk assessment of the proposed Tullacondra Green Energy Project (the Development) which comprises a nine turbine wind farm on a 58.6 hectare site located in north Cork approximately 5.2km west of the N20 between Buttevant and New Twopothouse. The proposed development includes works in and alongside public roads to install cabling to connect the wind farm to the National Grid at the Mallow 110kV substation. This Flood Risk Assessment report has been prepared to accompany a planning application for the proposed development to Cork County Council.

This flood risk assessment has been carried out in accordance with the Department of Housing and Local Government (DEHLG) and the Office of Public Works (OPW) guidelines "The Planning System and Flood Risk Management Guidelines for Planning Authorities" (November 2009). It identifies and sets out possible mitigation measures against potential risks of flooding from various sources. Sources of possible flooding include coastal, fluvial, pluvial (direct heavy rain), groundwater and human/mechanical error.

RSK (Ireland) Ltd. (RSK), part of RSK Group, is a consultancy providing environmental services in the hydrological, hydrogeological and other environmental disciplines. The company and group provide consultancy to clients in both the public and private sectors. More information can be found at www.rskgroup.com.

2 Sources of information

2.1 Desk Study

2.1.1 EPA

The Environmental Protection Agency (EPA) Maps Application was consulted to identify to local hydrology around the vicinity of the site along with specific Water Framework Directive (WFD) status and risks for the referenced waterbodies[1.]

2.1.2 Flood Maps

Flood Hazard Maps, produced by the Office of Public Works under the Southwestern Catchment Flood Risk Management Plan (CFRAM) study, were consulted to determine present-day risks to flooding in relation to the proposed development. The Office of Public Works (OPW) mapping study for Ireland is available on their website; floodinfo.ie[2].

2.1.3 Google Earth Pro

National Grid Reference and topography mapping of the study area setting was drawn from Google Earth Pro (2022) TerraMetrics; version 7.3 (beta), Tullacondra, Co. Cork, Ireland.

[1] EPA Unified GIS Application (2022)

[2] OPW Flood Maps and Catchment Flood Risk Assessment and Management (CFRAM) Programme (2022)

52°11’48.95” N 8°44’58.77” W, Eye alt 2.95km. Places layers. SIO, NOAA, US Navy, NGA, GEBCO.

2.1.4 LiDAR

LiDAR data commissioned by Greensource.

2.1.5 GSI

Geological Survey Ireland Spatial Resources from the Department of the Environment, Climate and Communications, were utilised to determine the site’s hydrogeology, site-specific aquifer and vulnerability, borehole/well information, soil and subsoils data as well as Corine 2018 land use classification[3].

2.1.6 OSI

Records from the National mapping agency of Ireland, the Ordnance Survey, were studied, on the websites interactive GeoHive Map Viewer (i.e., First Edition 6-inch map (1839-1842)) to determine the Site’s flood history[4].

3 Site Description

3.1 Location

- Site Name: Tullacondra Green Energy Project (Wind Farm and Grid Connection Route)
- Site Irish Grid Reference: 149262.8,105824.3

The Site Location is shown in **Figure 1** below.

The works for installation of the underground cabling to connect the wind farm site to the boundary of the Mallow 110kV substation via two option routes are predominantly within the public road corridor of local and regional roads, crossing the N20 national primary road and the N72 national secondary road. The works for transporting turbine components to the wind farm site are proposed via two option routes from ports at Foynes and Ringaskiddy.

The temporary accommodating works will be within and adjacent to the public road corridors of national primary and secondary roads (N69, N20, N28, N27, N8) and local roads requiring temporary removal of street furniture, cutting through roundabouts, creation of temporary surfaces in road verges, and clearance and trimming back of vegetation.

The wind farm site for the proposed Project is located along the L5302 at Croughta and consists primarily of mixed farmland habitat with hedgerows and occasional areas of scrub, ponds and lakes, and man-made drains and ditches. The area in which the turbines will be located ranges in elevation from 133m above Ordnance Datum (AOD) in the south to 120m AOD in the north. The settlement pattern within approximately 2km from the proposed turbine locations is characterised by dwellings and farm buildings located mainly along the public roads, with some older and newer dwellings located down long private lanes. In some cases, newer dwellings have been built closer to the road, whilst the older dwelling remains at the end of the private lane, and apparently have been subsumed into the farmyard, being surrounded by sheds. The

[3] Geological Survey Ireland Spatial Resources (2022)

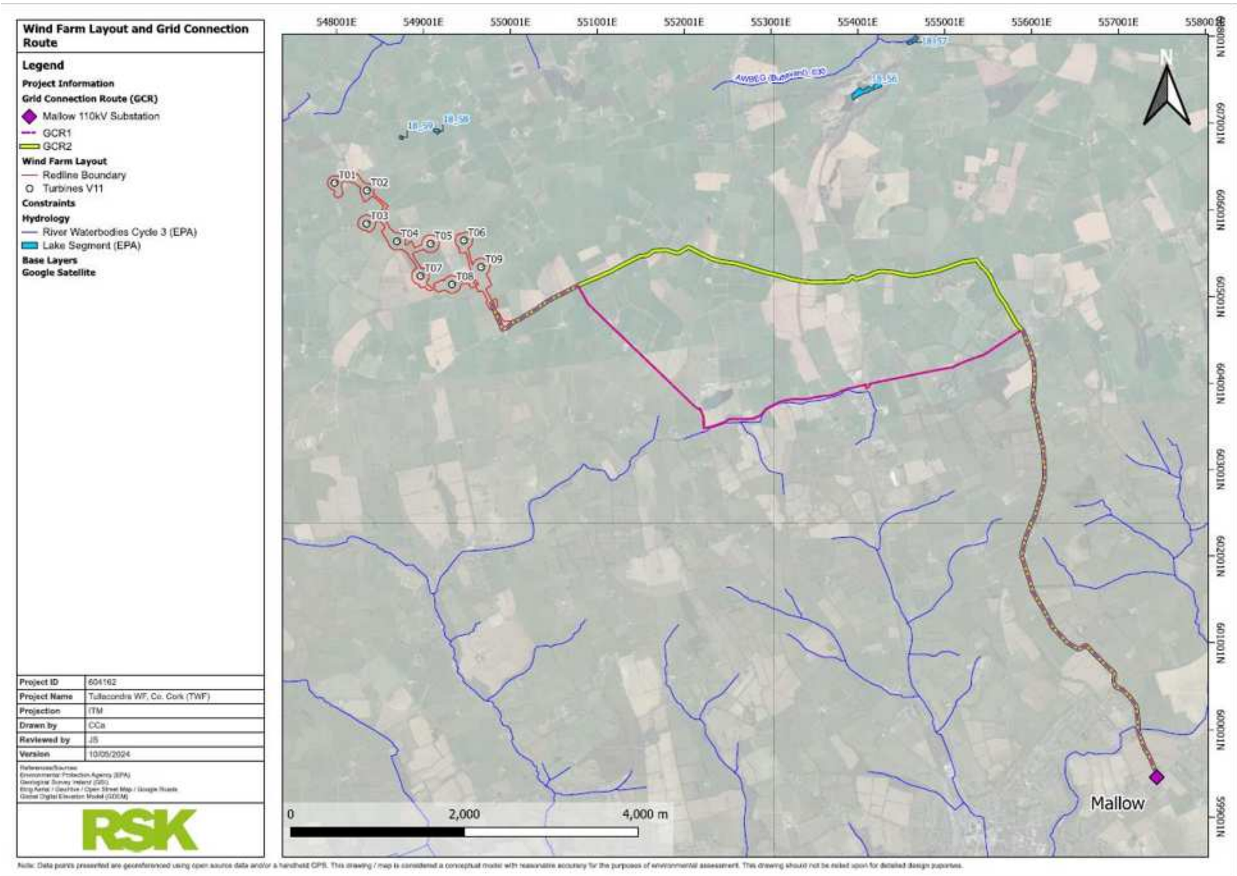
[4] Government of Ireland and Ordnance Survey Ireland (2022)

few commercial properties in the study area include on-farm enterprises which are associated with the main dwelling.

The works for installation of the underground cabling to connect the wind farm site to the boundary of the Mallow 110kV substation via two option routes are predominantly within the public road corridor of local and regional roads, crossing the N20 national primary road and the N72 national secondary road. The works for transporting turbine components to the wind farm site are proposed via two option routes from ports at Foynes and Ringaskiddy.

The temporary accommodating works will be within and adjacent to the public road corridors of national primary and secondary roads (N69, N20, N28, N27, N8) and local roads requiring temporary removal of street furniture, cutting through roundabouts, creation of temporary surfaces in road verges, and clearance and trimming back of vegetation.

Figure 1: Wind Farm Layout and Grid Connection Route



3.2 Site Hydrology

Surface water networks draining the wind farm site and Grid Connection Route (GCR) are mapped and presented in **Figure 2**. Surface water networks associated with particular turbine locations are presented in the Surface Water Flow Chart in **Figure 3**.

Figure 2: Site Hydrology Overview (EPA,2023)

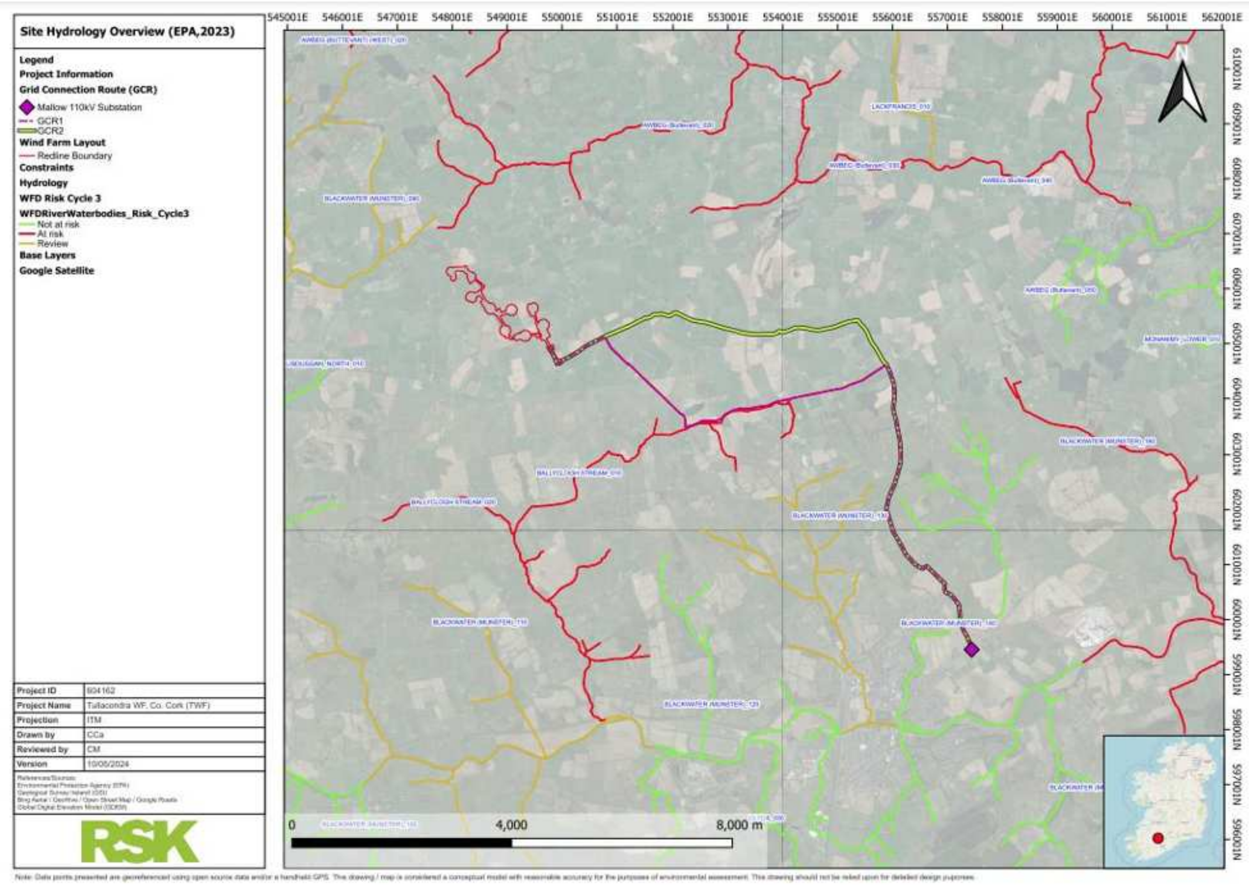
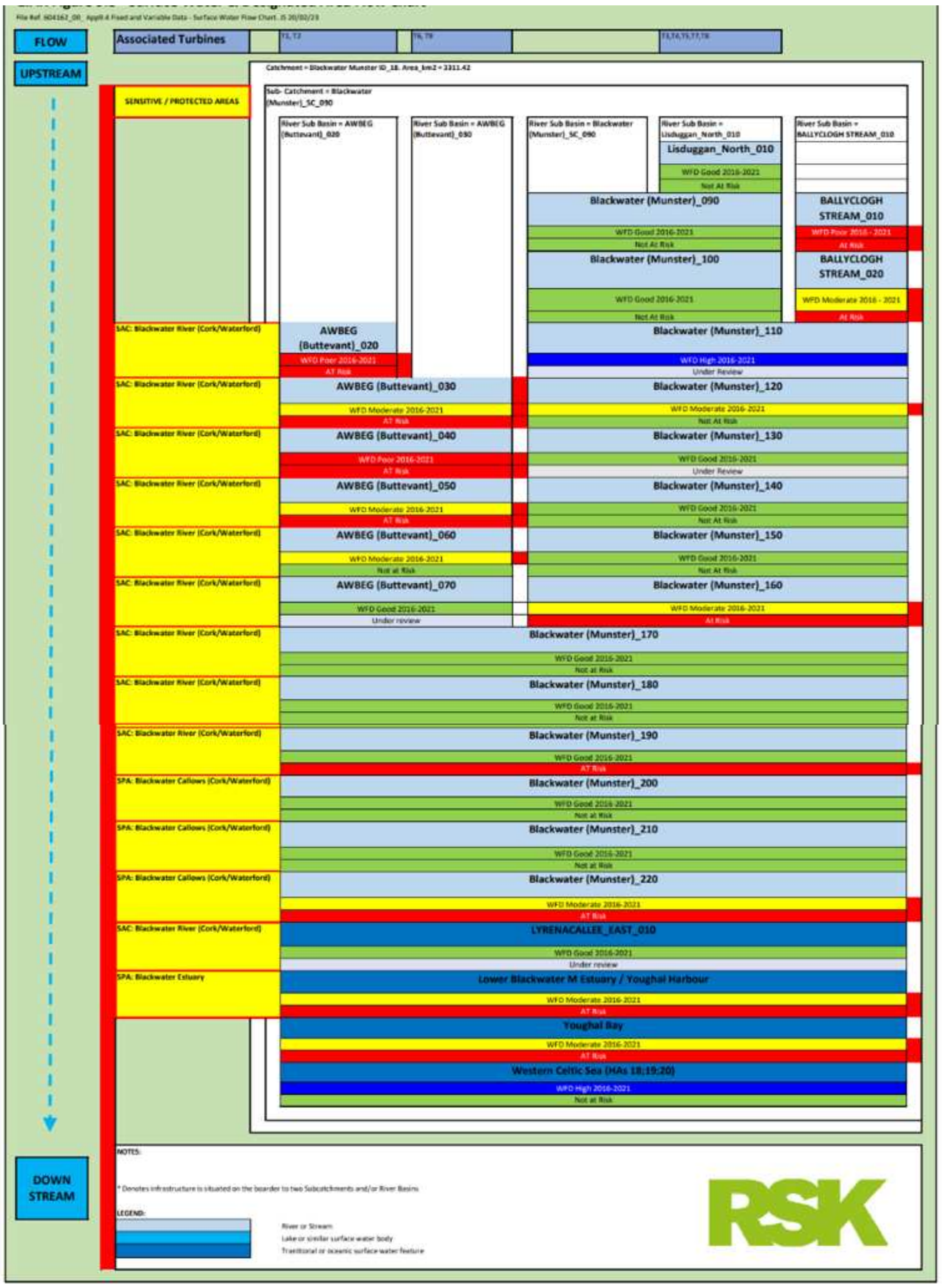


Figure 3: Surface water flow network for Turbine Locations (RSK)



The Tullacondra Green Energy Project and Grid Connection Route are situated within the Blackwater (Munster) Catchment (ID: 18; Area: 3,308km^2).

Surface water runoff associated with the wind farm site and Grid Connection Route drains into three sub catchments and/or five river sub basins, or four rivers:

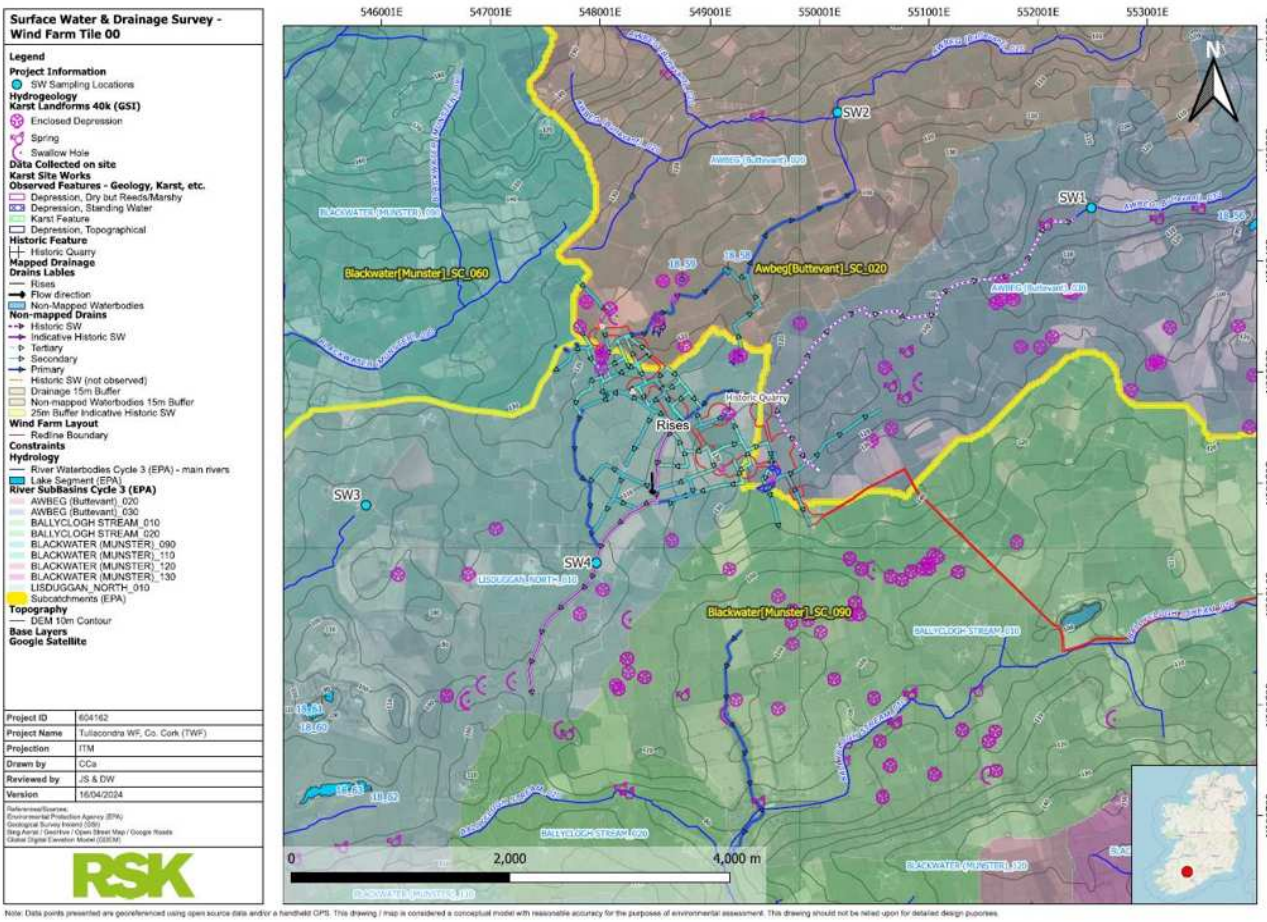
- Sub Catchment: Awbeg [Buttevant]_SC_020, River Sub Basins: Awbeg (Buttevant)_020 and Awbeg [Buttevant]_030
- Sub Catchment: Blackwater [Munster]_SC_090; River Sub Basins: Ballyclogh Stream_010 and Lisduggan_North_010

- Sub Catchment: Blackwater [Munster]_SC_060; River Sub Basin: Blackwater (Munster)_090

All surface waters draining from the site eventually combine in the River Blackwater (Munster)_170, from which waters eventually flow to the Upper and Lower Blackwater Estuary, the Youghal Estuary through to Youghal Bay and into the Celtic Sea.

In terms of local drainage and non-mapped surface water features the site characterised by extensive artificial drainage networks including in association with agricultural and land reclamation / improvement works. These drainage features flow north east, east andsouth westerly directions which follows the topography and then flow into mapped rivers to the north and east of the site. The drain to the south west ends in close proximity to karst featuresin **Figure 4** below.

Figure 4: Site Drainage - Karst features on Site.

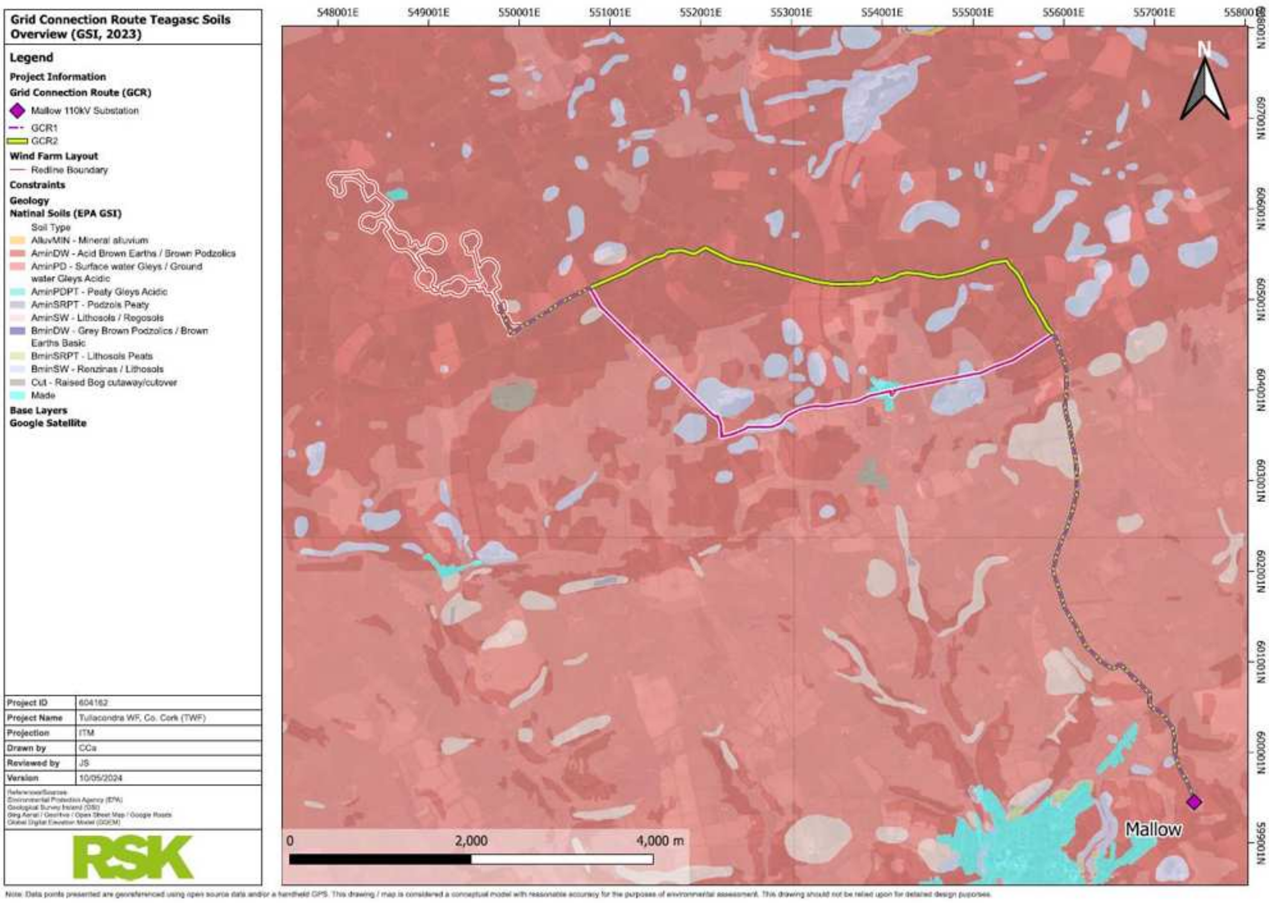


3.3 Site Soil & Subsoil Geology

Soils

The underlying soil cover, according to the National Soil database (GSI, 2022), of the site is predominately categorised as 'Acid Brown Earths, Brown Podzolics' with a description of 'Acid Deep Well Drained Mineral Drained Mineral' - Derived from mainly non-calcareous parent materials. A small pocket of 'Peaty Gleys', that is 'Acid Poorly Drained Mineral Soils with Peaty Topsoil' - Derived from mainly non-calcareous parent materials was mapped along with 'Surface water Gleys and Ground water Gleys' comprised of 'Acid Deep Poorly Drained Mineral - Derived from mainly non-calcareous parent materials' presented in **Figure 5** below.

Figure 5: Grid Connection Route Teagasc Soils Overview (GSI, 2023)



The GCR has a similar soil composition to that of the site with mainly 'Acid Brown Earths, Brown Podzolics and 'Surface water Gleys, Ground water Gleys' underlying it. There are however some smaller areas of 'Basic Shallow Well Drained Mineral - Derived from mainly calcareous parent materials' comprised of 'Shallow Brown, Earths/Grey Brown, Podzolics, Rendzinas, Lithosols, and some outcropping rock' (lavender). And 'Acid Shallow Well Drained Mineral - Derived from mainly non-calcareous parent materials' made up of 'Shallow Acid Brown, Earths/Brown Podzolics, Lithosols, Regosols, with some outcropping rock' (pink) presented in **Figure 6** below.

Figure 6: Wind Farm Teagasc Soils (GSI, 2023)

Subsoils

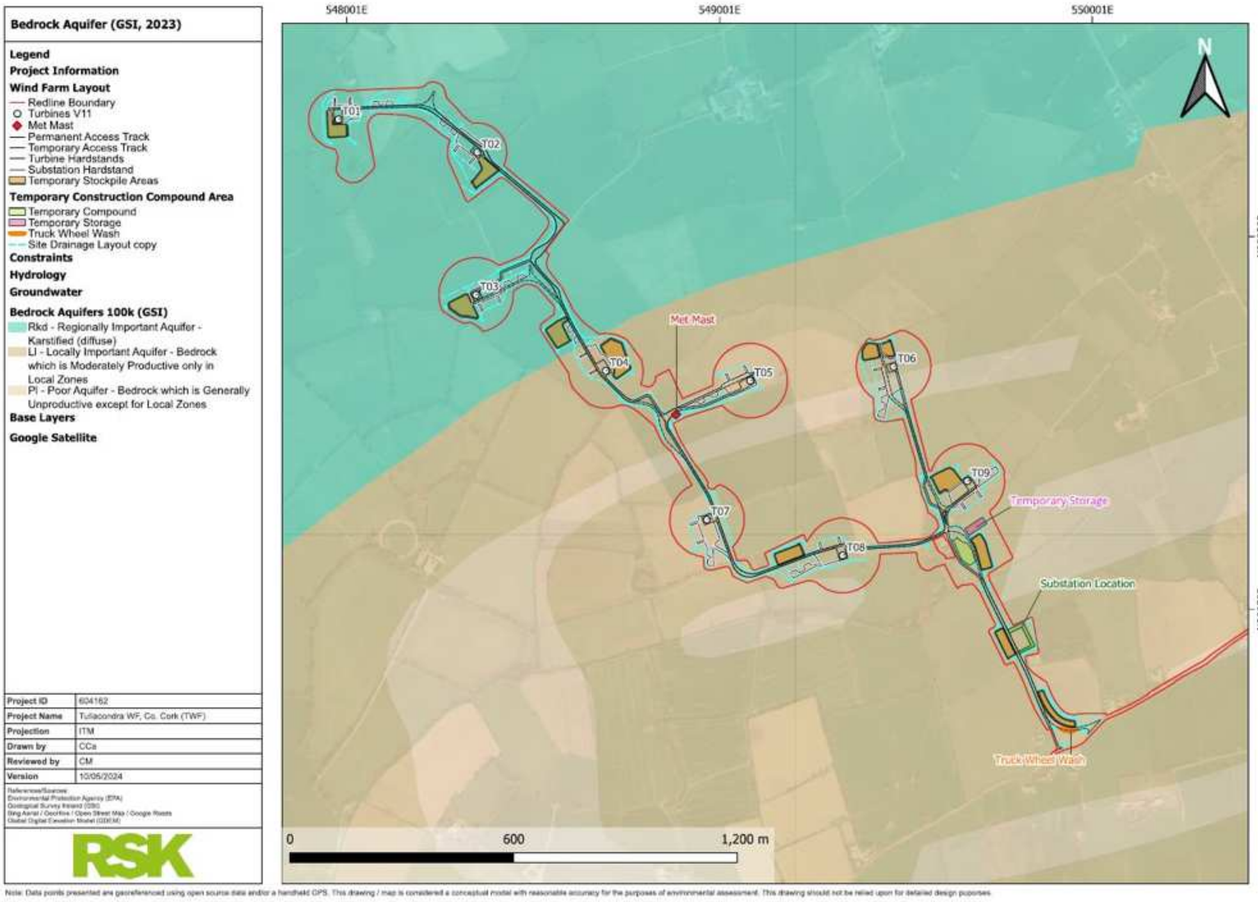
Subsoils underlying the site (GSI, 2022) are those of 'Clayey Diamicton shales and sandstones tills (Namurian)' with areas of identified bedrock at or close to surface. The majority of the GCR is underlaid by the two classes of subsoils mentioned above with an area of 'Sandy, Diamiction sandstone till (Devonian)'.

3.4 Site Hydrogeology

Consultation with GSI Groundwater maps (2023) indicate that the northern portion of the wind farm site (encompassing the location of T1, T2 and T3) is underlain by a 'Regionally Important Aquifer - Karstified (diffuse) (Rkd)'. The remaining southern portion of the development is underlain by a 'Locally Important Aquifer (Ll)' that is, bedrock which is moderately productive only in local zones and encompasses small areas of aquifers with classifications of 'Poor Aquifer (Pl)' that is, bedrock which is generally unproductive except for local zones.

The GCR is underlain by the same classification of aquifers (Rkd and LI) as the development in **Figure 7** below.

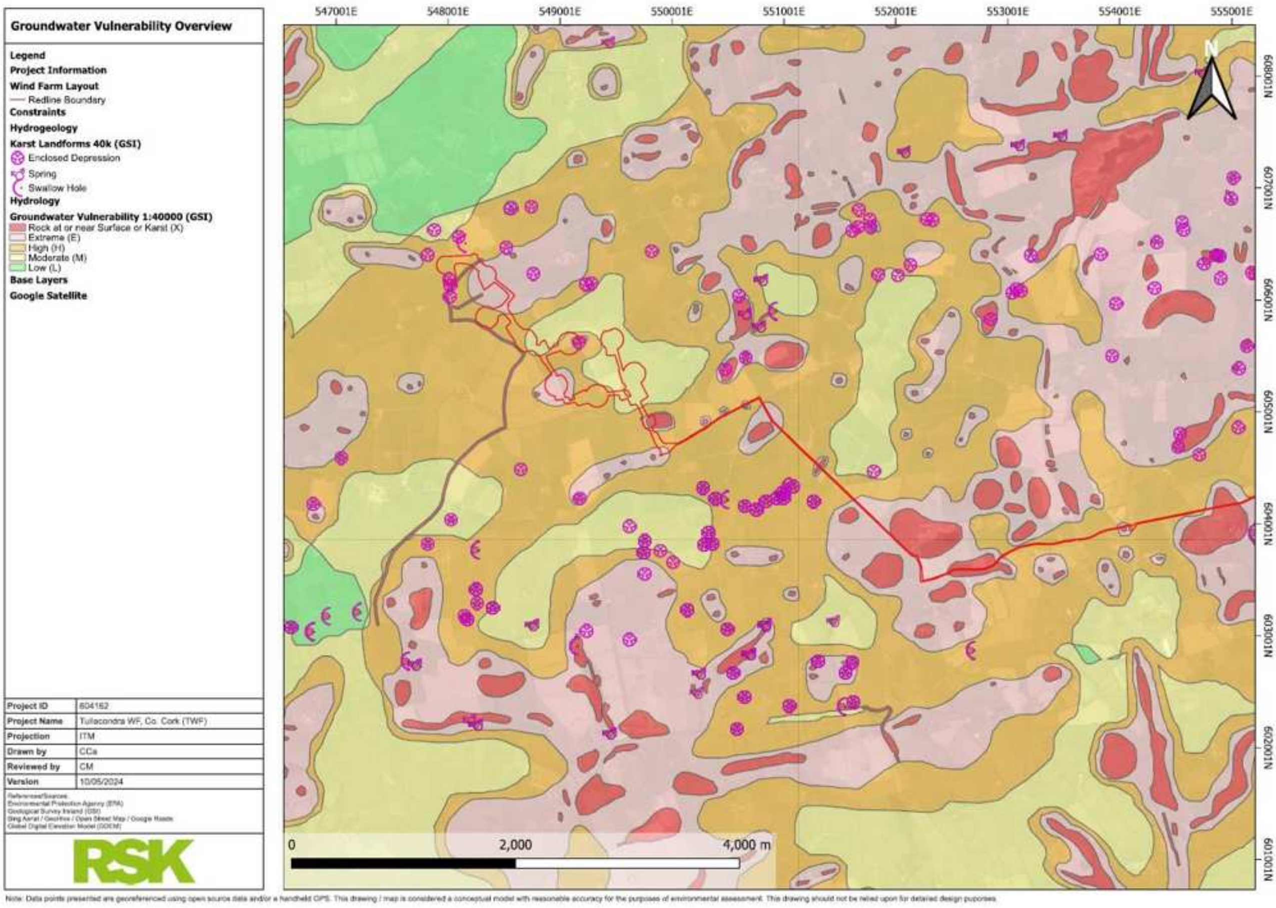
Figure 7: Bedrock Aquifer (GSI, 2023)



3.5 Groundwater Vulnerability & Recharge

The GSI Groundwater Map Viewer (2022) indicates that the wind farm site is underlain by areas classified as 'Extreme (E)'; 'High (H)'; and 'Moderate (M)' vulnerability rating (**Figure 8**). The proposed location of T1, T3, T5 and T8 have been mapped as areas with 'High (H)' vulnerability rating. The proposed locations of T2 and T7 are in areas of 'Extreme (E)' vulnerability, and the proposed location of T4, T6 and T9 are in areas of 'Moderate (M)' vulnerability. Presented in the **Figure 8** below.

Figure 8: Groundwater Vulnerability Overview



The GCR similarly traverse land with groundwater vulnerability ratings ranging from 'Moderately Vulnerable' to 'Extreme Vulnerability'.

Areas of the site underlain by Locally Important Aquifer (LI) possess a maximum annual recharge capacity of 200mm effective rain fall.

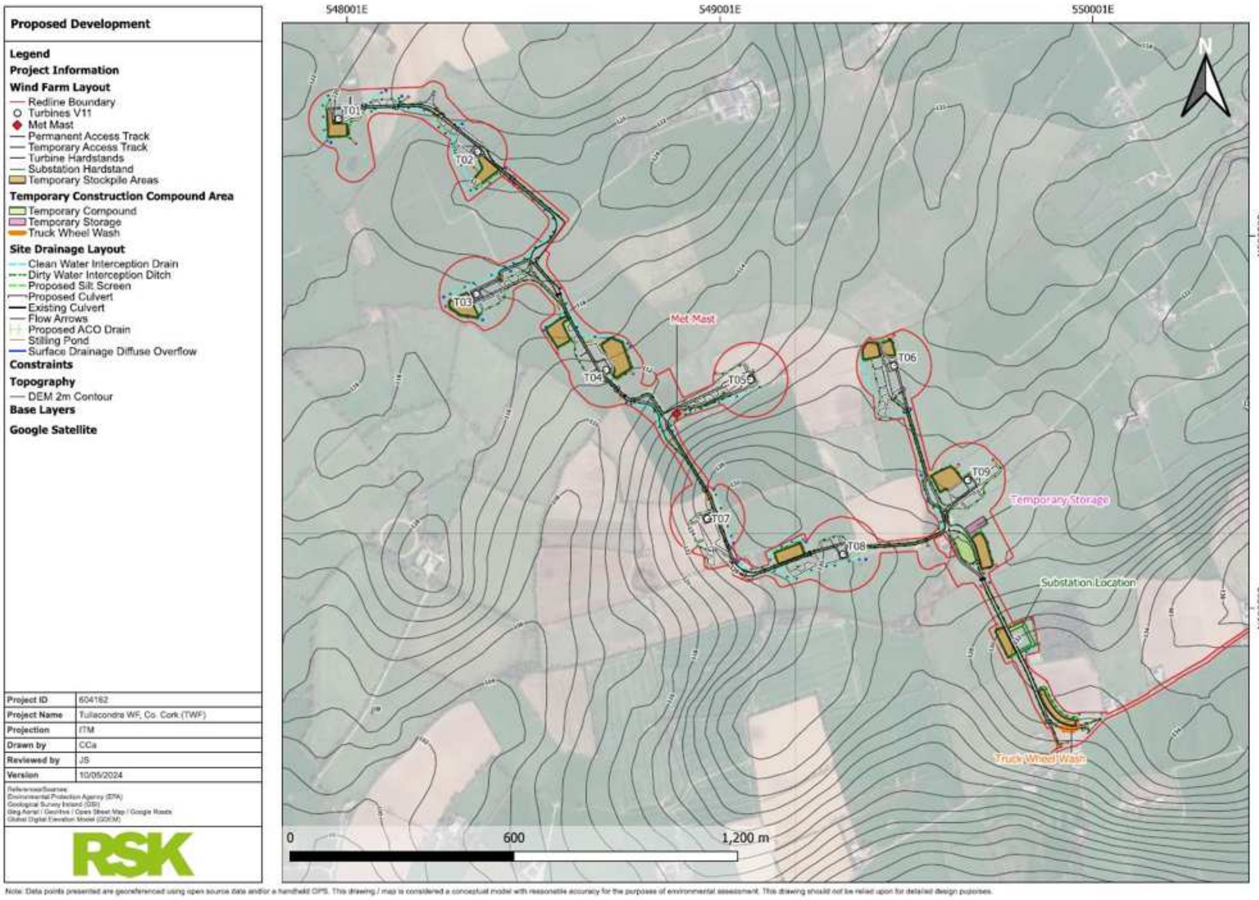
The site is characterised by low recharge rates across the site and high surface water run off rates which can surplus the recharge capacity in the underlying bedrock aquifer, this can be seen in **Figure 9** below. This implies that, particularly during seasonally wet or extreme meteorological conditions, the majority of water (rain) introduced to the site will drain off the site as surface water runoff, and the rejected recharge water volumes will likely discharge to surface waters relatively rapidly and locally. As such, the surface water network associated with the site is characterised as having a rapid hydrological response to rainfall.

Figure 9: Groundwater Recharge Overview

3.6 Proposed Development

The development is comprised of nine proposed turbines, one permanent meteorological mast, an on-site substation along with civil and electrical infrastructure and associated ancillary infrastructure (turbine foundations, turbine hardstands, site access tracks, drainage infrastructure etc.). The proposed development is situated on a 58.6 hectare site located in north Cork approximately 5.2km west of the N20 between Buttevant and New Twopothouse Village. Presented in **Figure 10** below.

Figure 10: Proposed Development



4 Flood Risk Assessment

4.1 Introduction

4.1.1 Guidelines for FRAs

The Flood Risk Assessment Report RSK Ireland will prepare follows the guidelines set out in the DEHLG/OPW Guidelines on the Planning Process and Flood Risk Management published in November 2009. This assessment will address where surface water, groundwater, tidal, fluvial and pluvial water within or around the site boundary comes from (i.e., the source), how and where it flows (i.e., the pathways) and the people and assets affected by it (i.e., the receptors). This stage aims to quantify the risk posed to the development and to the surrounding environment by this development.

In line with DEHLG Guidelines for Planning Authorities – Flood Risk Management (2009);

Flood Risk Assessment Stage 1

As per Flood Risk Management (FRM) Guidelines the purpose of Stage 1 is to identify whether there may be any flooding or surface water management issues related to either the area of regional planning guidelines, development plans and local area plans (LAP's) or a proposed development site that may warrant further investigation at the appropriate lower-level plan or planning application levels;

Flood Risk Assessment Stage 2

Stage 2 Initial flood risk assessment – to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to scope the extent of the risk of flooding which may involve preparing indicative flood zone maps. Where hydraulic models exist the potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures can be assessed. In addition, the requirements of the detailed assessment should be scoped; and

Flood Risk Assessment Stage 3

Stage 3 Detailed flood risk assessment – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development or land to be zoned, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures.

Sources of Flooding

The components to be considered in the identification and assessment of flood risk are:

- Tidal-flooding from high sea levels. Flooding occurs when sea levels along the coast or in estuaries exceed neighbouring land levels, or overcome coastal defences where these exist, or when waves overtop the coastline or coastal defences.
- Fluvial–flooding from water courses. Flooding occurs when rivers and streams break their banks and water flows out onto the adjacent low-lying areas (the natural floodplains). This can arise where the runoff from heavy rain exceeds the natural capacity of the river channel and can be exacerbated where a channel is blocked or constrained or, in estuarine areas, where high tide levels impede the flow of the river out into the sea. While there is a lot of uncertainty on the impacts of climate change on rainfall patterns, there is a clear potential that fluvial flood risk could increase into the future.
- Pluvial–flooding from rainfall / surface water. Flooding occurs when the amount of rainfall exceeds the capacity of urban storm water drainage systems or the infiltration capacity of the ground to absorb it. This excess water flows overland, ponding in natural or man-made hollows and low-lying areas or behind obstructions. This occurs as a rapid response to intense rainfall before the flood waters eventually enter a piped or natural drainage system. This type of flooding is driven in particular by short, intense rainstorms.
- Ground Water–flooding from springs / raised ground water. Flooding occurs when the level of water stored in the ground rises as a result of prolonged rainfall, to meet the ground surface and flows out over it, i.e., when the capacity of this underground reservoir is exceeded. Groundwater flooding results from the interaction of site-specific factors such as local geology, rainfall infiltration routes and tidal variations. While the water level may rise slowly, it may cause flooding for extended periods of time. Hence, such flooding may often result in significant damage to property or disruption to transport. In Ireland, groundwater flooding is most commonly related to turloughs in the karstic limestone areas prevalent in particular in the west of Ireland.

- Human/mechanical error–flooding due to human or mechanical error. Flooding can also be caused by the failure or exceedance of capacity of built or man-made infrastructure, such as bridge collapses, from blocked piped sewerage networks, or the failure or over-topping of reservoirs or other water-retaining embankments (such as raised canals).

4.1.2 Assessing Flood Risk

The two components of flood risk, as outlined in the FRM Guidelines, are the likelihood of flooding and the potential consequences arising from planned works; expressed as:

Flood Risk = Probability of flooding x Consequences of flooding

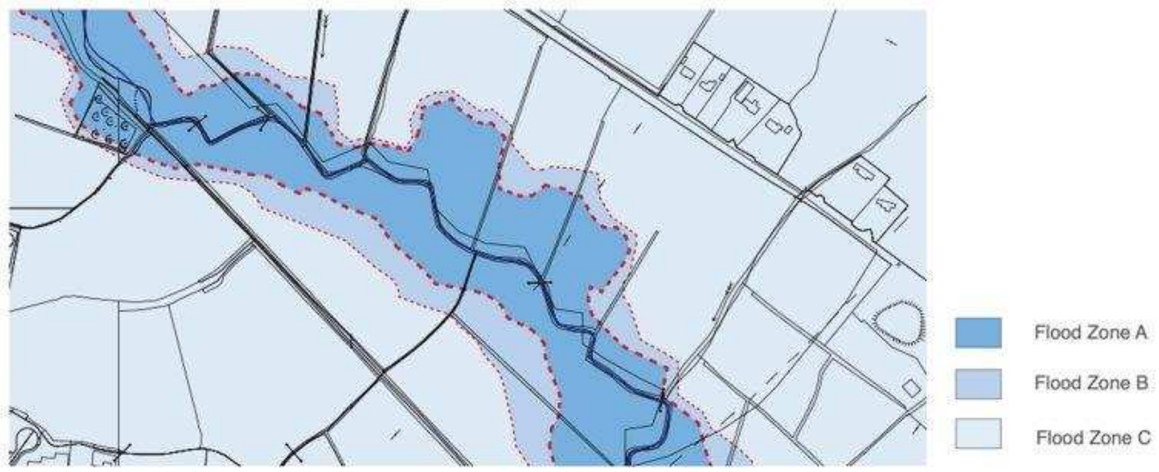
- *Likelihood of flooding is normally defined as the percentage probability of a flood of a given magnitude or severity occurring or being exceeded in any given year. For example, a 1% probability indicates the severity of a flood that is expected to be exceeded on average once in 100 years, i.e., it has a 1 in 100 (1%) chance of occurring in any one year.*
- *Consequences of flooding depend on the hazards associated with the flooding (e.g., depth of water, speed of flow, rate of onset, duration, wave- action effects, water quality), and the vulnerability of people, property and the environment potentially affected by a flood (e.g., the age profile of the population, the type of development, presence and reliability of mitigation measures etc).*

4.1.3 Assessing Likelihood of Flood Risk

In the FRM Guidelines, the likelihood of a flood occurring in an area is identified and separated into Flood Zones presented in **Figure 11** below, which indicate a high, moderate or low risk of flooding from fluvial or tidal sources, defined as follows:

- Flood Zone A - Where the probability of flooding is highest (greater than 1% Annual Exceedance Probability (AEP) or 1 in 100 for river flooding and 0.5% AEP or 1 in 200 for coastal flooding) and where a wide range of receptors would be located and therefore vulnerable.
- Flood Zone B - Where the probability of flooding is moderate (between 0.1% AEP or 1 in 1000 and 1% AEP or 1 in 100 for river flooding and between 0.1% AEP or 1 in 1000 year and 0.5% AEP or 1 in 200 for coastal flooding).
- Flood Zone C - Where the probability of flooding is low (less than 0.1% AEP or 1 in 1000 for both river and coastal flooding).

Figure 11: Indicative Flood zone map from (Dept of Housing, Local Government and Heritage, 2009)



As outlined in the FRM Guidelines, future developments must avoid where possible areas at risk of flooding, The FRM Guidelines categorises all types of development as either; 1. Highly Vulnerable, 2. Less Vulnerable and 3. Water Compatible e.g. flood infrastructure, docks, amenity open space (**Figure 12**). As the development of the Project is essential infrastructure including electricity substations, it is considered a 'Highly vulnerable development' and locating within Flood Zone C is recommended i.e. outside of Probable Flood Zones A (1 in 100) and B (1 in 1000).

Figure 12: Classification of vulnerability of different types of development (OPW, 2009)

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Mineral working and processing; and Local transport infrastructure.
Water-compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).

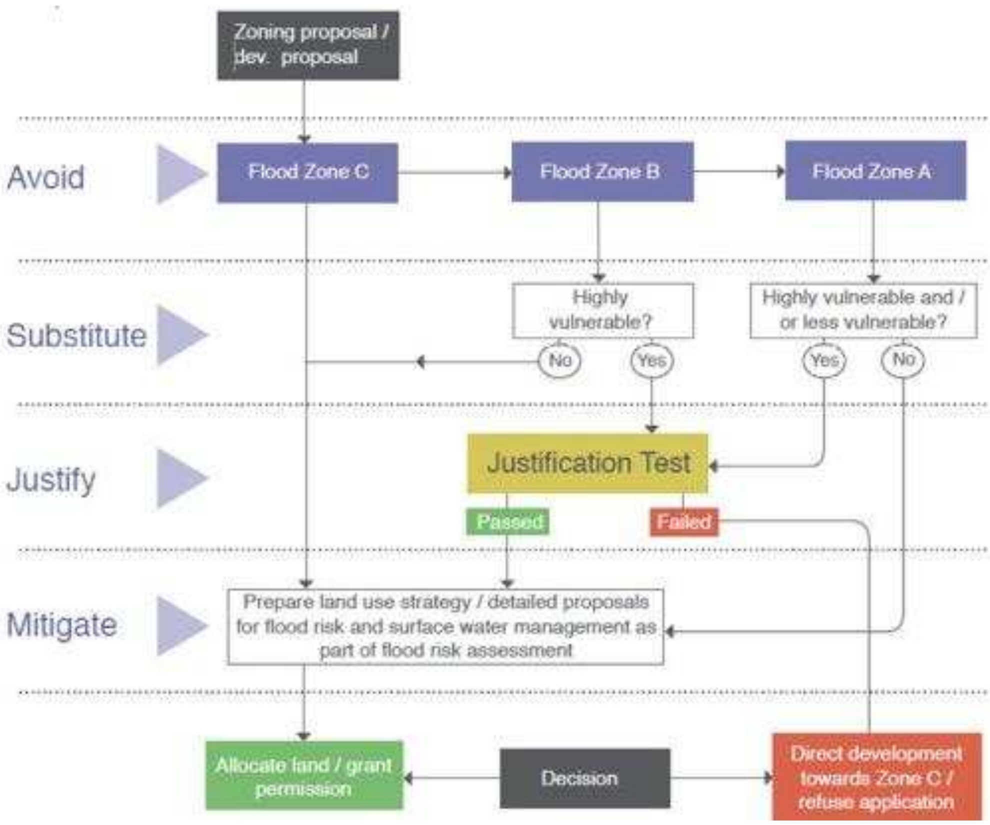
*Uses not listed here should be considered on their own merits

Presented in **Figure 13,** from the OPW (2009), a Justification Test is a guiding document that aims to determine the appropriateness of a particular development in areas that may be at risk of flooding. A Justification Test is required to assess such proposals in the light of proper planning and sustainable development objectives. As outlined in **Figure 14,** there is a sequential approach to mechanism in planning process (OPW, 2022), depending on the Flood Zone and the Justification Test.

Figure 13: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification test (OPW, 2009)

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Figure 14: Sequential approach to mechanism in planning process (OPW, 2022)



4.2 Stage 1 – Flood Risk Identification

The flood risk identification stage was carried out in order to establish whether a flood risk exists within the boundaries of the proposed development or the surrounding vicinity.

4.2.1 Existing Flood Records

Inspection of Base Maps from Ordinance Survey of Ireland records, i.e. First Edition 6-inch map (1839-1842) indicate that neither the site itself, nor the surrounding area are susceptible to flooding. The National Indicative Fluvial Mapping database (Present Day) operated by the OPW has identified all surface waterbodies draining the Site: Awbeg(Buttevant)_020, Awbeg(Buttevant)_030, Ballyclough Steam_020 and Lisduggan_North_010 as being both low (0.1% AEP) and medium probability (1% AEP) risk to flood (**Figure 15a & 15b**).

Figure 15a: National Indicative Fluvial Maps, Present day, low probability, not considering Climate Change (OPW,2023)

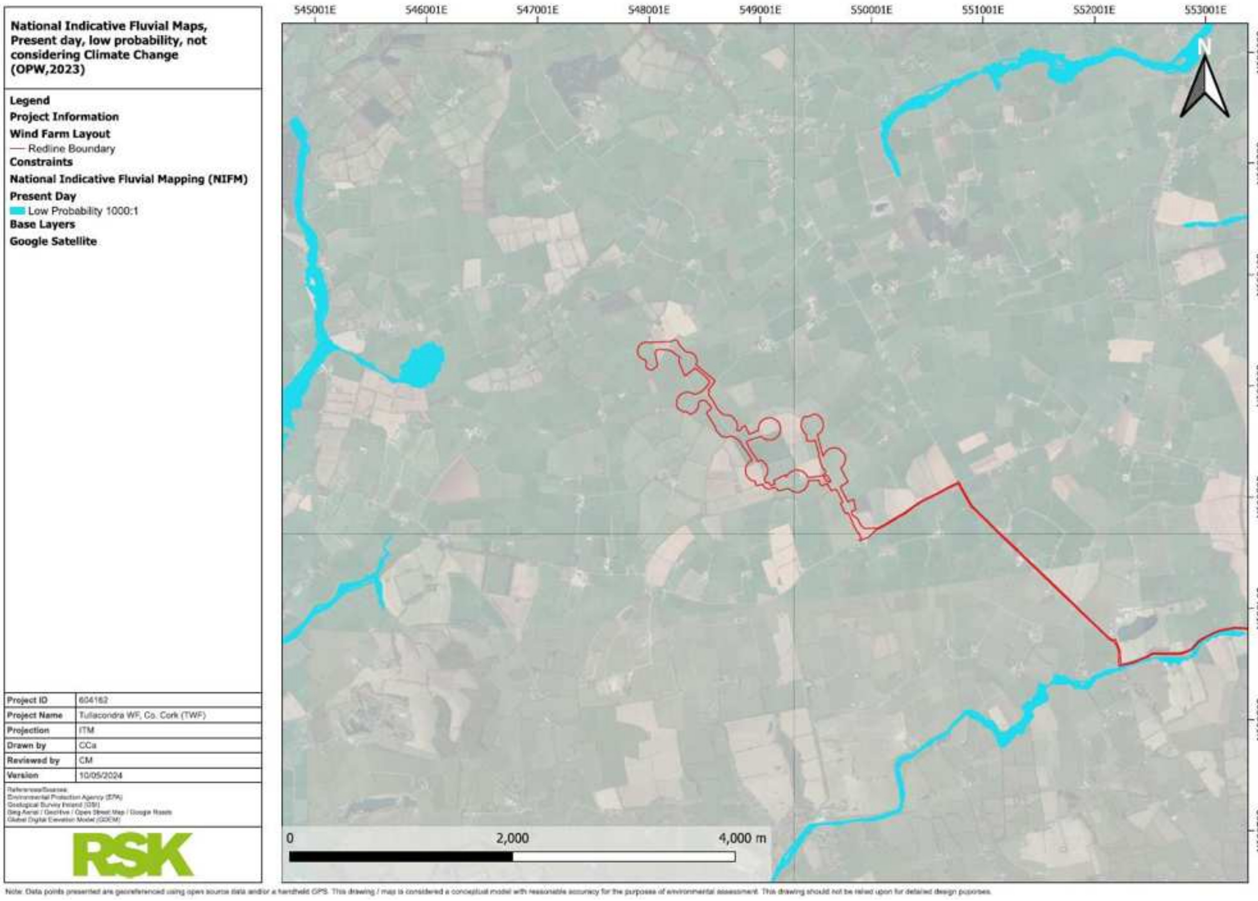
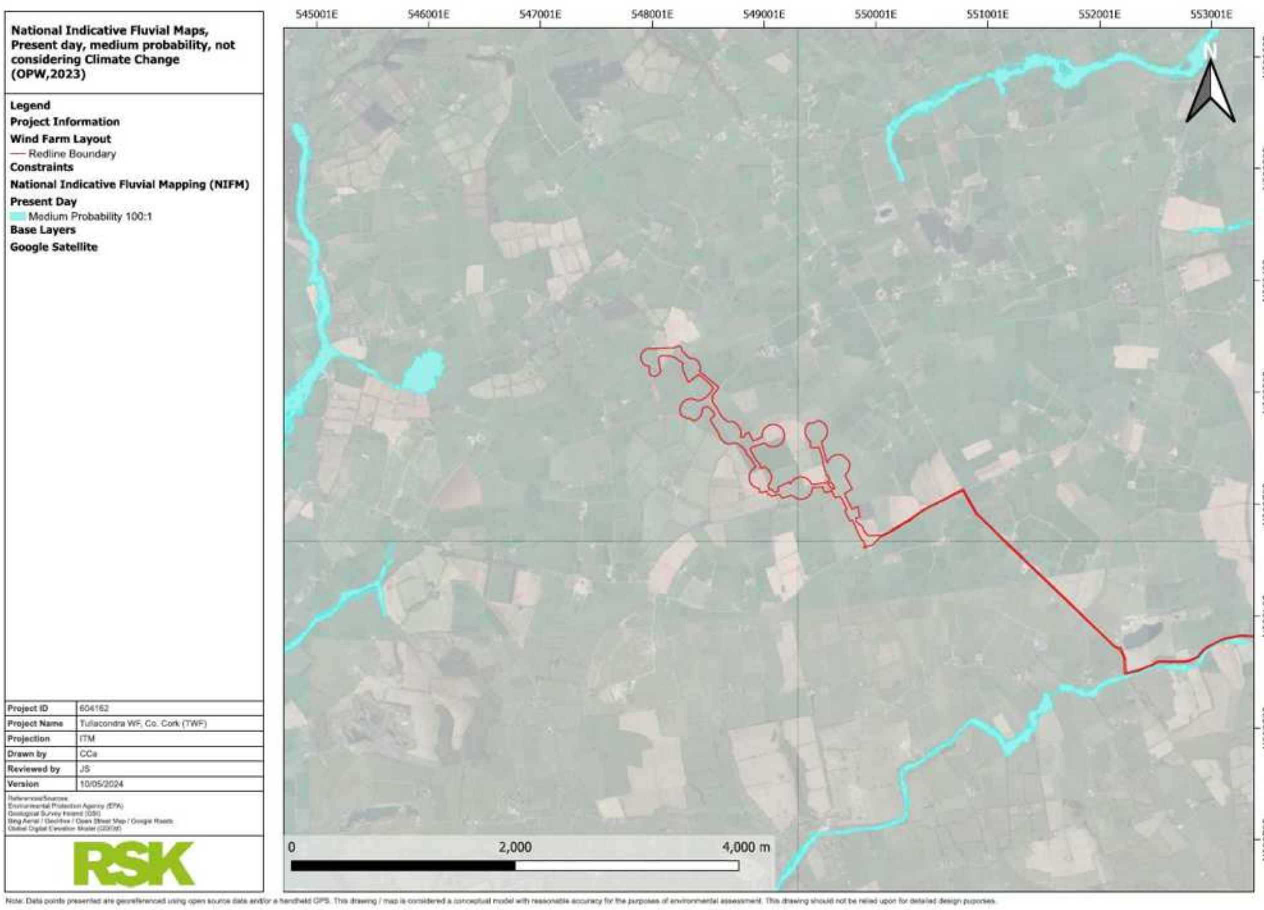
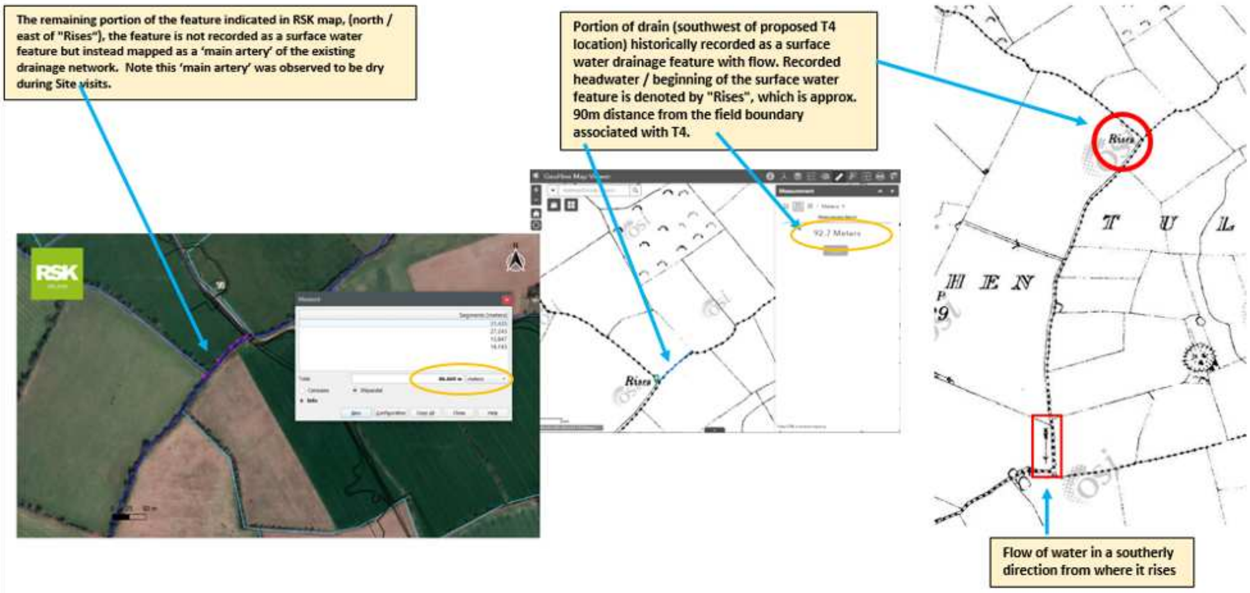


Figure 15b: National Indicative Fluvial Maps, Present day, medium probability, not considering Climate Change (OPW,2023)



There have been a number of reoccurring pluvial, and fluvial floods in the vicinity of the proposed development site due to low lying land and fluvial river. There is one historic flood event on the OPW Database due to karst features and karst aquifers present (**Figure 16** and **Figure 4)**. There has been Fluvial Flood risks identified on the Grid Connection Route, which falls within Flood Zone, A, B and C (**Figure 17**).

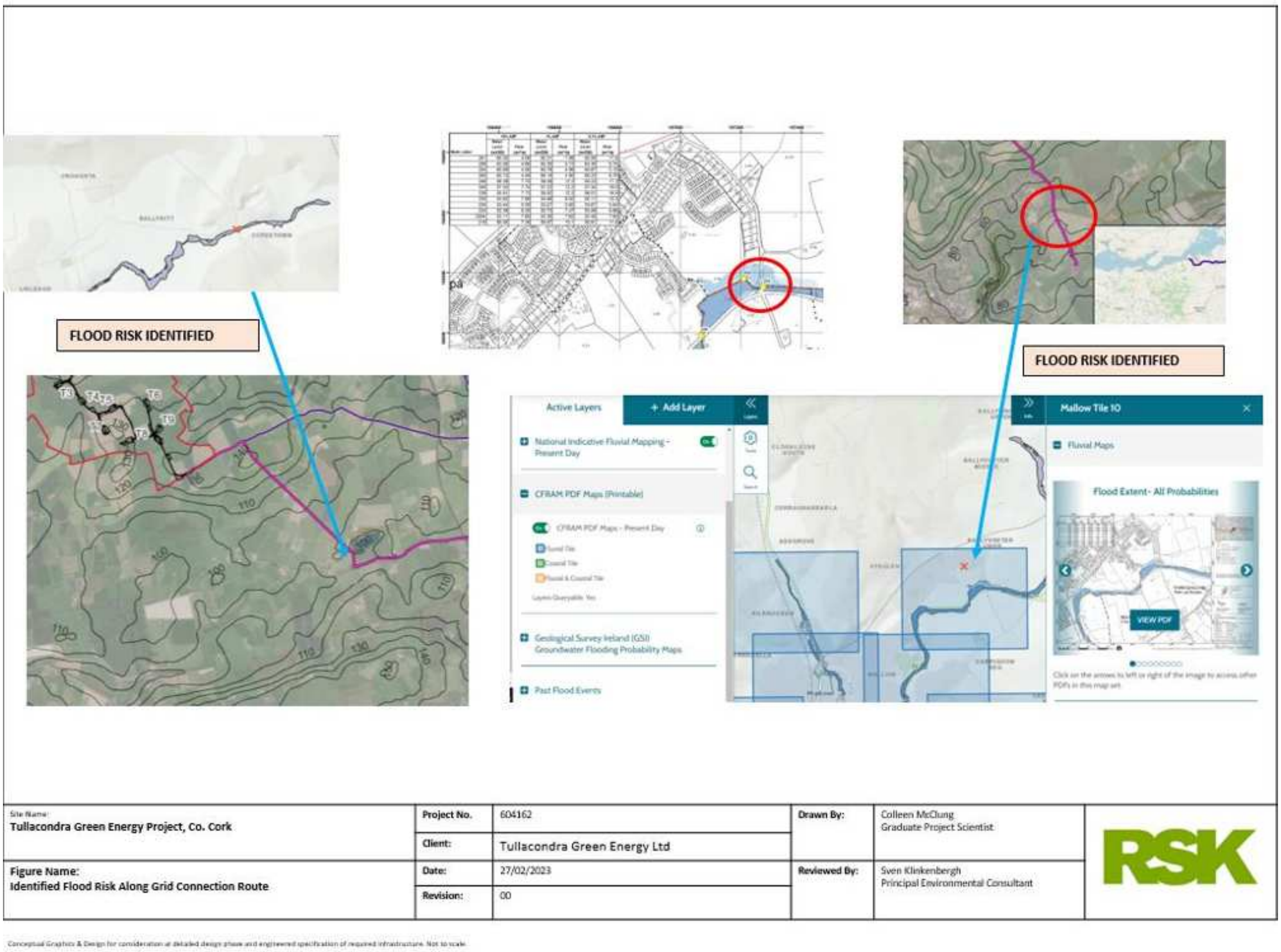
Figure 16: Historic Surface Water Feature Cassini 6-inch map



Site Name: Tullacondra Green Energy Project, Co. Cork	Project No.	604162	Drawn By:	Colleen McClung Graduate Project Scientist	RSK
	Client:	Tullacondra Green Energy Ltd			
Figure Name: Historic Surface Water Feature Cassini 6-inch map	Date:	27/02/2023	Reviewed By:	Sven Klinkenbergh Principal Environmental Consultant	
	Revision:	00			

Conceptual Graphics & Design for consideration at detailed design phase and engineered specification of required infrastructure. Not to scale.

Figure 17: Identified Flood Risk Along Grid Connection Route



4.2.2 Tidal Flooding

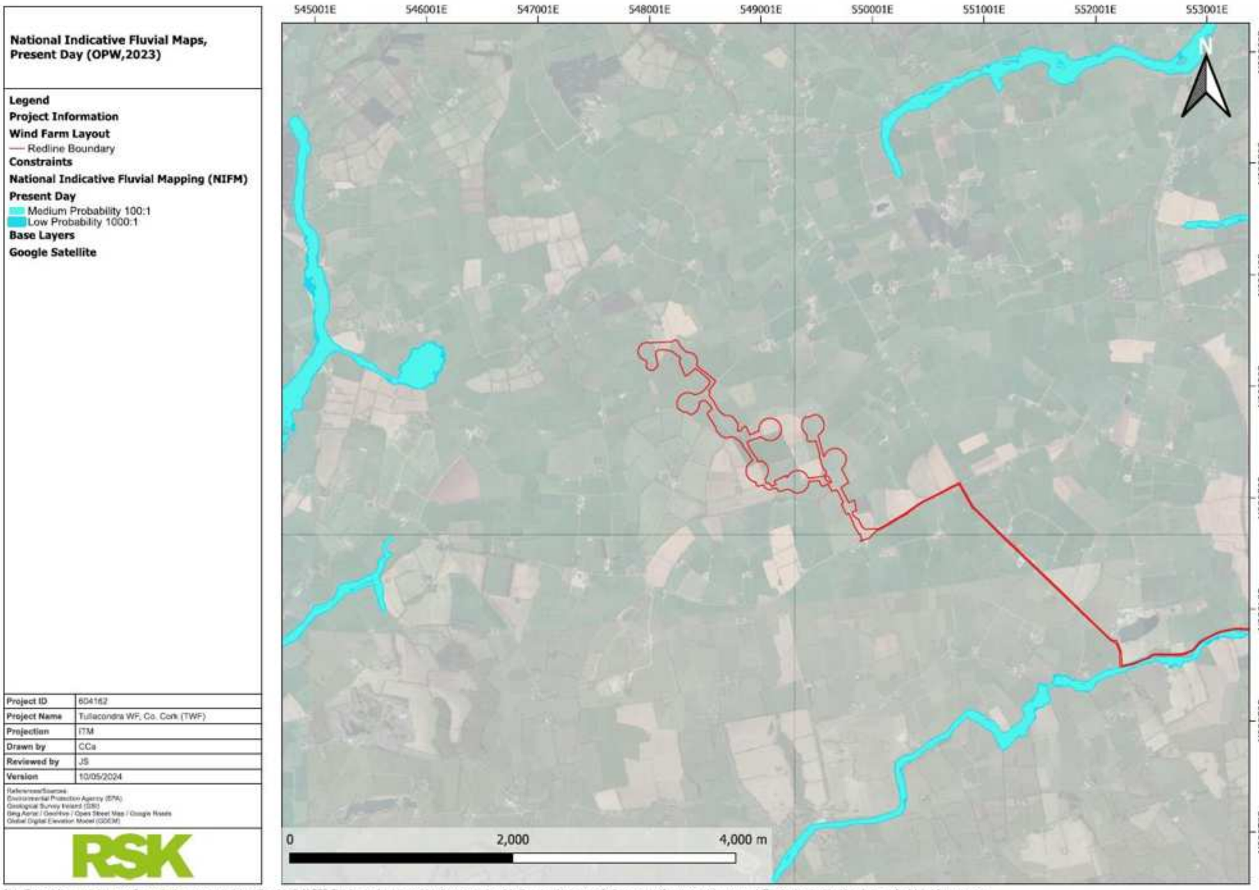
Tidal flooding is caused by elevated sea levels or overtopping by wave action. No coastal flood zones are identified at the site or surrounding area. The Celtic Sea is located 80km east of the site. Due to both the inland nature and elevation of the proposed development site, the residual risk from tidal flooding is considered nil.

4.2.3 Fluvial Flooding

Fluvial flooding is caused by rivers, watercourses or ditches overflowing. Historic flood maps dating (1839-1842), were reviewed for the proposed development area and did not indicate a history of flooding at the site from small streams or tributaries found within or near site boundaries.

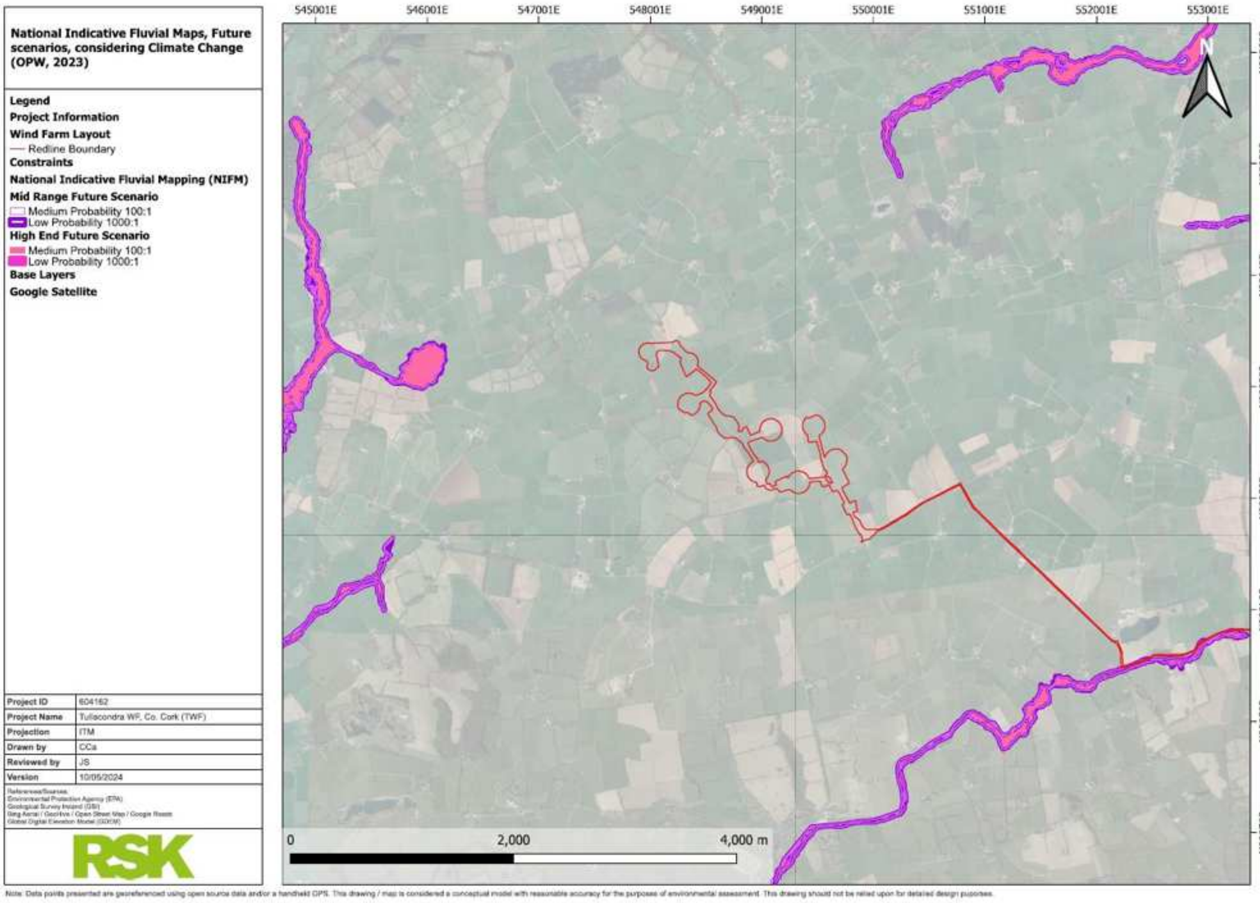
The most recent, comprehensive flood-maps, produced by the OPW (2016) under the South Western Catchment Flood Risk Assessment and Management (CFRAM) programme do not indicate any flood extents within the proposed site boundaries, therefore all areas outside the 0.1% AEP flood extent (the proposed development), are classified as Flood Zone C. CFRAM flood-maps confirm that the proposed development site is in Flood Zone C and is a suitable development for this area (**Figures 18a & 18b)**.

Figure 18a: National Indicative Fluvial Maps, Present Day (OPW,2023)



Note: Data points presented are georeferenced using open source data and/or a handheld GPS. This drawing / map is considered a conceptual model with reasonable accuracy for the purposes of environmental assessment. This drawing should not be relied upon for detailed design purposes.

Figure 18b: National Indicative Fluvial Maps, Future scenarios, considering Climate Change (OPW, 2023)



Information gathered in the National Fluvial Indicative Maps of the present day identified fluvial flood risks on the Grid Connection Route. Different sections of the Grid Connection Route falls into Flood Zone A, B and C (**Figure 17)**.

There is no identified fluvial flood risk within or around the wind farm site boundary.

4.2.4 Pluvial Flooding

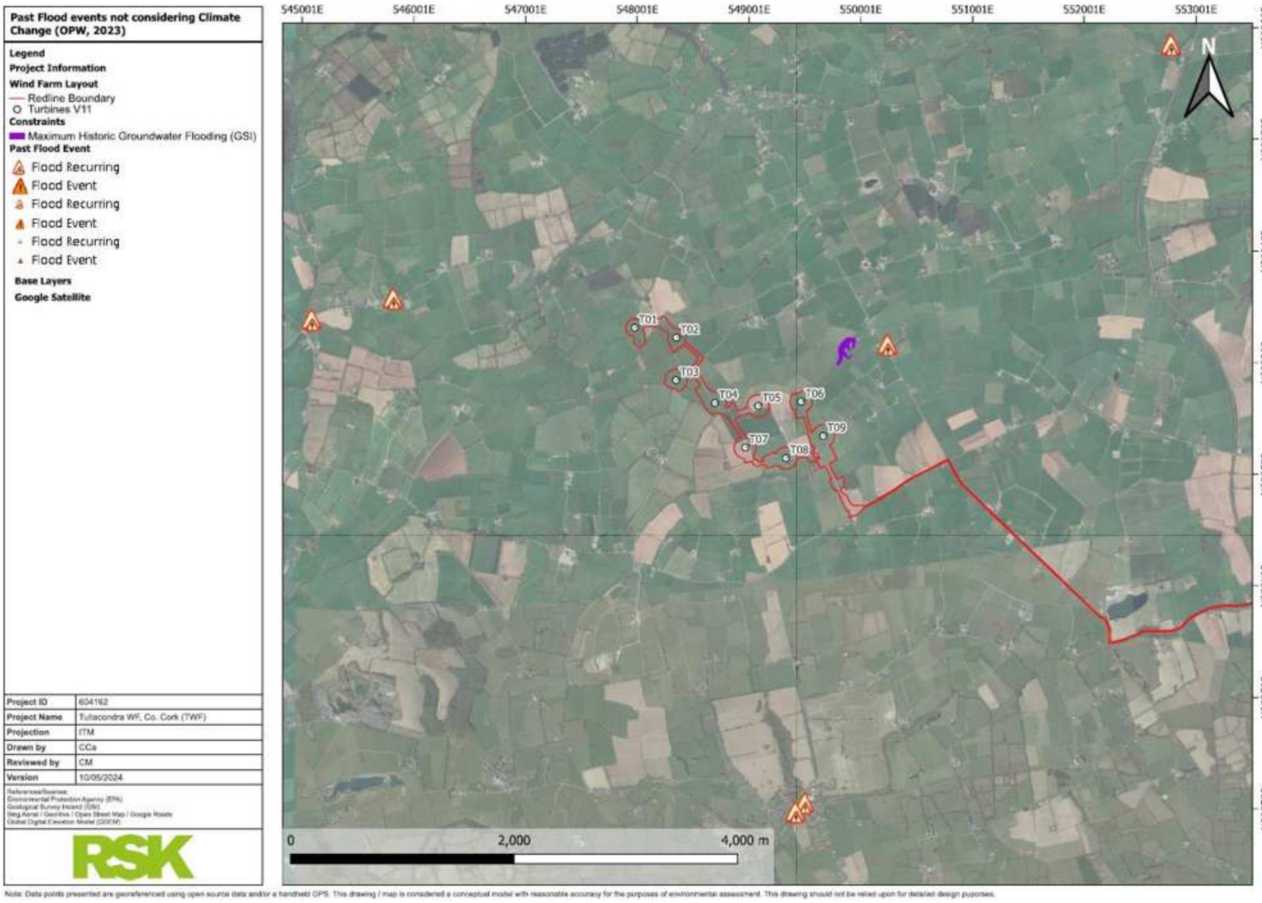
Pluvial flooding is usually caused by intense rainfall that may only last a few hours, often referred to as flooding from surface water. Surface water flooding can also occur as a result of overland flow or ponding during periods of extreme prolonged rainfall. During pluvial flooding events, water follows natural valley lines, creating flow paths along roads, through and around developments and ponding in low spots, which often coincide with fluvial floodplains in low lying areas. It is generally noted, areas at risk from fluvial flooding will almost certainly be at risk from pluvial flooding. Pluvial flood maps produced as part of the OPW's CFRAM do not indicate pluvial flood zones at the development site, or surrounding area. Therefore, the residual risk from pluvial flooding is considered nil.

4.2.5 Groundwater Flooding

Groundwater flooding can occur on some sites in connection with high water tables and increased recharge following long periods of wet weather. Groundwater flooding typically occurs in areas underlain by limestone and where underlying geology is highly permeable with high capacity to receive and store rainfall. There has been previously documented groundwater flooding approximately 500m to the northeast of the site boundary (**Figure 19**). According to the Geological Survey Ireland (GSI), Groundwater Flooding Probability Maps (2016-2019), there is no evidence of a Low, Medium or High Probability groundwater flooding event within the site or near its vicinity. Therefore, the residual risk from groundwater flooding is considered low.

There are no direct connections to groundwater associated with works on site, despite a swallow hole identified, this is located upslope of works. This is not significant in terms of flood risk. Hydrological response at the site will be lowered with use of SuDS. Neutral to beneficial effect to flood risk as a function of the Development.

Figure 19: Past Flood events not considering Climate Change (OPW, 2023)



It should be noted that there is ‘Kilmaclenine’ groundwater monitoring station (ID: GWIE_SW_G_04405000003), situated c. 400m from the southwest of the site presented in (**Figure 20**).

Figure 20: Hydrometric stations for River Discharge Rates (EPA, 2023)

Site Name: Tullacondra Green Energy Project, Co. Cork	**Project No.**	604162	**Drawn By:**	Jayne Stephens Environmental Consultant
	Client:	Tullacondra Green Energy Ltd		
Figure Name: Hydrometric stations used for River discharge rates (Q values) (EPA, 2023)	**Date:**	24/02/2023	**Reviewed By:**	Sven Klinkenbergh Principal Environmental Consultant
	Revision:	00 DRAFT		

4.2.6 Human and/or Mechanical Error

A Surface Water Management Plan (SWMP) EIAR **Volume III, Appendix 5.1 Appendix A** has been developed as part of the scheme design and there will not be an increase in run-off from the site as a result of the scheme.

There is currently no mapped drainage on the OPW Drainage maps, that reside within the boundaries of the Development.

4.2.7 Summary of Stage 1 Flood Risk Assessment

This Stage 1 Flood Risk Assessment was compiled and based on data presented in public records, in accordance with the guidelines set out in the DEHLG/OPW Guidelines on the Planning Process and Flood Risk Management published in November 2009. From reviewing the available records there is evidence of historic flooding in the areas surrounding the site (**Figure 11**), there is also one historic groundwater flooding event that occurred to the northeast of the site as shown in **Figure 19**. Subsequent analysis GSI maps indicate karst springs c. 800m southeast of this historic flood event. Comprehensive flood-maps, produced by the OPW (2016) under the South-western Catchment Flood Risk Assessment and Management (CFRAM) programme confirm that the proposed development resides in a Flood Zone C. The review of National indicative Fluvial maps identified flood risks on the Grid Connection Route, which falls within Flood Zones A, B and C (**Figure 17**).

4.2.8 Stage 1 Conclusion

In keeping with the Stage 1 Flood Risk Assessment, the review of available information has **identified no flood hazards for the Development**. The nature of the Development is industrial as opposed to residential or leisure, and as such, this type of development is categorized as a '**Less Vulnerable Development**', according to FRM Guidelines. Therefore, the Development is considered an '**appropriate**' development for Flood Zone C.

4.3 Stage 2 – Initial Flood Risk Assessment

4.3.1 Assessing Potential Impacts of Development

As stated in the concluding remarks of Stage 1; the Development is considered an 'appropriate' development for Flood Zone C.

While the South Western Catchment Flood Risk Assessment and Management (CFRAM) programme did not indicate any flood extents within the proposed site boundaries, there are probable flood areas downstream of the Development. The closest mapped probable flood areas are associated with the River Blackwater [Munster] at;

- Firville West approximately 13.47 kilometres south of the wind farm site near Mallow town.

Successive portions of the River Blackwater, flowing east have been mapped with flood extents, they are:, Mallow, Fermoy, Ballyduff and Youghal.

The number of recorded and reoccurring flood events in the vicinity of the site have the potential to be further adversely impacted should recommended mitigation measures (Section 4.3.3) not be put in place.

4.3.2 Assessing Potential Effects of Development – Increased Hydraulic Loading

Rainfall and Evapotranspiration

Rainfall data for the region associated with the Development site has been assessed in terms of the following parameters;

Historical average and max monthly rainfall and effective rainfall. Effective rainfall is calculated as being rainfall minus evapotranspiration equals effective rainfall, or the amount of rainfall which will contribute to surface water runoff discharge volumes and/or groundwater recharge.

Potential significant storm events including events with a 1 in 100 year return period over 1 hour duration, 25 day duration.

The above storm events plus allowance (+20%) accounting for climate change.

Data from the meteorological stations listed in **Table 1** are used in this assessment[5]. Using data presented in **Table 3** (Irish Grid; 148991, 106182), storm event of 25 days duration with a 1 in 100 year return period is inferred to be 286.5mm. For the purpose of this assessment, predicted extreme or worst-case values are used, as presented in **Table 2.**

Table 1: Meteorological Stations (Met Eireann, 2022)

Category	Meteorological Station/s & Data Set	Approx. Distance from the Site (km)
Rainfall (Historical Monthly)	Cork Airport	54
Rainfall (2021/22 Monthly/Daily)	Cork Airport	54

[5] Met Eireann, Historical Data, Available at; www.met.ie, Accessed; October 2022

Table 2: EIA Specific Assessment Data (Met Eireann, 2022)

Category	Value (mm Rain)
Average Annual Effective Rainfall (Long term) (mm/year)	1,227.9
Max monthly effective rainfall (mm/month)	1,473.48
1 in 100 Year Rainfall Event (25 day duration) (mm/month)	286.5
1 in 100 Year Rainfall Event (25 day duration) (mm/month) +20% Accounting for Climate Change	343.8
1 in 100 Year Rainfall Event (1 hour duration) (mm/hour)	36.3
1 in 100 Year Rainfall Event (1 hour duration) (mm/hour) +20% Accounting for Climate Change	43.56

Table 3: Met Eireann Return Period Rainfall Depths (Irish Grid; 148991, 106182)[6]

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 148991, Northing: 106182,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	
5 mins	2.8,	3.9,	4.5,	5.3,	5.9,	6.4,	7.8,	9.5,	10.6,	12.1,	13.4,	14.5,	16.1,	17.3,	1
10 mins	3.9,	5.4,	6.2,	7.4,	8.2,	8.9,	10.9,	13.2,	14.7,	16.8,	18.7,	20.2,	22.4,	24.1,	2
15 mins	4.6,	6.3,	7.3,	8.7,	9.7,	10.4,	12.8,	15.5,	17.3,	19.8,	22.0,	23.7,	26.4,	28.4,	3
30 mins	6.0,	8.3,	9.5,	11.2,	12.4,	13.3,	16.3,	19.5,	21.7,	24.7,	27.3,	29.4,	32.5,	34.9,	3
1 hours	8.0,	10.8,	12.3,	14.5,	15.9,	17.0,	20.6,	24.6,	27.2,	30.7,	33.9,	36.3,	40.0,	42.8,	4
2 hours	10.5,	14.1,	15.9,	18.6,	20.4,	21.8,	26.1,	30.9,	34.0,	38.3,	42.0,	44.9,	49.2,	52.5,	5
3 hours	12.4,	16.4,	18.5,	21.6,	23.6,	25.1,	30.0,	35.4,	38.8,	43.5,	47.6,	50.8,	55.6,	59.2,	6
4 hours	13.9,	18.4,	20.6,	24.0,	26.1,	27.8,	33.1,	38.9,	42.6,	47.7,	52.1,	55.5,	60.6,	64.5,	6
6 hours	16.4,	21.4,	24.0,	27.8,	30.2,	32.1,	38.0,	44.5,	48.6,	54.2,	59.1,	62.8,	68.4,	72.7,	7
9 hours	19.3,	25.0,	28.0,	32.2,	35.0,	37.1,	43.7,	50.9,	55.4,	61.6,	67.0,	71.1,	77.2,	81.9,	8
12 hours	21.6,	28.0,	31.2,	35.8,	38.8,	41.0,	48.2,	55.9,	60.8,	67.5,	73.3,	77.6,	84.2,	89.2,	9
18 hours	25.5,	32.7,	36.3,	41.5,	44.8,	47.4,	55.4,	64.0,	69.4,	76.8,	83.1,	87.9,	95.1,	100.5,	10
24 hours	28.6,	36.5,	40.4,	46.0,	49.7,	52.5,	61.1,	70.3,	76.2,	84.1,	90.9,	96.0,	103.7,	109.5,	11
2 days	36.2,	45.1,	49.5,	55.7,	59.6,	62.6,	71.9,	81.7,	87.8,	96.0,	102.9,	108.2,	116.0,	121.8,	12
3 days	42.8,	52.6,	57.4,	64.1,	68.4,	71.6,	81.5,	91.8,	98.2,	106.8,	114.1,	119.5,	127.6,	133.6,	13
4 days	48.8,	59.4,	64.6,	71.7,	76.3,	79.7,	90.2,	101.1,	107.8,	116.7,	124.3,	129.9,	138.3,	144.5,	14
6 days	59.9,	71.9,	77.7,	85.7,	90.8,	94.5,	106.1,	117.9,	125.2,	134.8,	142.9,	149.0,	157.8,	164.4,	16
8 days	70.2,	83.4,	89.8,	98.5,	104.0,	108.1,	120.5,	133.3,	141.0,	151.3,	159.9,	166.3,	175.7,	182.6,	18
10 days	80.0,	94.3,	101.2,	110.6,	116.5,	120.9,	134.1,	147.7,	155.9,	166.8,	175.8,	182.5,	192.3,	199.6,	20
12 days	89.4,	104.8,	112.1,	122.1,	128.4,	133.1,	147.1,	161.4,	170.0,	181.4,	190.9,	197.9,	208.1,	215.7,	22
16 days	107.5,	124.9,	133.0,	144.2,	151.1,	156.3,	171.7,	187.3,	196.7,	209.0,	219.3,	226.8,	237.9,	246.0,	25
20 days	125.0,	144.1,	153.0,	165.2,	172.8,	178.3,	195.0,	211.8,	221.9,	235.1,	246.1,	254.1,	265.8,	274.5,	28
25 days	146.3,	167.4,	177.2,	190.5,	198.8,	204.9,	223.0,	241.1,	252.0,	266.2,	277.9,	286.5,	299.0,	308.2,	31

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

[6] Met Eireann, Rainfall Return Periods, Available at; https://www.met.ie/climate/services/rainfall-return-periods , Accessed; October 2022

Preliminary Water Balance Assessment

For the purposes of assessing changes in runoff at the site as a function of the Development, the following data compiled from GIS mapping software is considered **(FRA Section 3 – Site Description)**;

- Turbine foundation and hardstands = c. 44,550m^2
- New access track / turning points / lay-by = c. 35,070m^2
- Substation / other Hardstand = c. 2,475m^2 x 1
- 1 in 100 year rainfall event = c. 36.3mm of rainfall in 1 hour.
- Recharge capacity = 60% of Effective Rainfall (Note: This is considered a conservative value i.e. higher potential recharge coefficient in the range associated with the site. In areas of peat the recharge will be considerably less, and considering the capped recharge of the underlying bedrock aquifer the rate of recharge will likely be considerably less across the site, particularly during wet / winter months associated with elevated flood risk generally).
- There is limited river discharge rate (Q) including discharge percentile data available for surface water features associated with the site. However, consultation of the EPA Hydronet map viewer indicates that the estimated River Discharge (Q) at:
    - AWBEG (Buttevant)(Main channel) Hydrometric station (ID:18_1078) situated c. 6.2 kilometres downstream of the site on the River AWBEG (Buttevant) has been observed to reach up to c. 0.406m^3/second (December).
    - Blackwater Hydrometric station (ID:18_528) situated c. 3.5 kilometres from site, has been observed to reach c. 0.437m^3/second (December).
    - Lisduggan North Hydrometric station (ID:18_696) situated c. 5 kilometres from the site has been observed to reach up to c. 0.442m^3/second (January).

This assessment is considered a simple preliminary water balance assessment for the purposes of qualifying and adding context to potential impacts of the development in terms of hydrological response to rainfall and flooding. It considers and uses site specific data as well as associated downstream attribute data. (Note: This is not considered advanced modelling for flood risk assessment (FRA Stage 3)).

Table 4 summarises a preliminary water balance analysis and potential net increase in runoff for the Development during a 1 in 100 year storm event.

Table 5 summarises a preliminary water balance analysis and potential net increase in runoff for the Development during a 1 in 100 year storm event relative to baseline conditions.

Table 4: Micro-catchment Areas and Baseline Runoff Volumes (1 in 100 Year Storm)

Net Increase in Runoff as a function of the Development per Micro-catchment Areas and Baseline Runoff Volumes (1 in 100 Year Hour Storm Event)															
					Greenfield Scenario					Developed Scenario					
Micro Catchment	**Category**	**Unit**	**Approximate Area (m2)**	**1 in 100 Year Rainfall Event (m/hour Rain)**	**Capped Recharge Capacity. Percentage of Effective Rainfall** (Conservative Value for Water Balanace Calc's)	**Rejected Recharge / Runoff (m/hour Rain)**	**Runoff Discharge Rate (m3/hour)**	**Net Increase Runoff Discharge Rate (m3/sec)**	**Runoff Discharge Rate (m3/sec)**	**Recharge Capacity. Percentage of Effective Rainfall** (Hardstand Areas assumed impermeable)	**Rejected Recharge / Runoff (m/hour Rain)**	**Runoff Discharge Rate (m3/hour)**	**Net Increase Runoff Discharge Rate (m3/sec)**	**Runoff Discharge Rate (m3/sec)**	**Net Increase (m3/sec)**
SW1	Turbines Hardstand	No.	-		20.00%	0	-	-		0.00%	0	-	-		
SW1	New Access Track	m	-		20.00%	0	-	-		0.00%	0	-	-		
SW1	**Subtotal**								-					-	**-**
SW2	Turbines Hardstand	No.	9900	0.0363	20.00%	0.02904	287.50	0.08		0.00%	0.0363	359.37	0.10		
SW2	New Access Track	m	7,014.00	0.0363	20.00%	0.02904	203.69	0.06		0.00%	0.0363	254.61	0.07		
SW2	**Subtotal**								0.14					0.17	**0.034**
SW3	Turbines Hardstand	No.	14,850.00	0.0363	20.00%	0.02904	431.24	0.12		0.00%	0.0363	539.06	0.15		
SW3	Compound	No.	2,150.00	0.0363	20.00%	0.02904	62.44	0.02		0.00%	0.0363	78.05	0.02		
SW3	Substation Hardstand	No.	2,475.00	0.0363	20.00%	0.02904	71.87	0.02		0.00%	0.0363	89.84	0.02		
SW3	New Access Track	m	8,767.50	0.0363	20.00%	0.02904	254.61	0.07		0.00%	0.0363	318.26	0.09		
SW3	**Subtotal**								0.23					0.28	**0.057**
SW4	Turbines Hardstand	No.	-	0.0363	20.00%	0.02904	-	-		0.00%	0.0363	-	-		
SW4	New Access Track	m	1,753.50	0.0363	20.00%	0.02904	50.92	0.01		0.00%	0.0363	63.65	0.02		
SW4	**Subtotal**								0.01					0.02	**0.004**
SW5	Turbines Hardstand	No.	19800	0.0363	20.00%	0.02904	574.99	0.16		0.00%	0.0363	718.74	0.20		
SW5	Met Mast		64												
SW5	New Access Track	m	17,353.00	0.0363	20.00%	0.02904	503.93	0.14		0.00%	0.0363	629.91	0.17		
SW5	**Subtotal**								0.30					0.37	**0.075**
											Total	**3051.4869**	**0.85**	**0.85**	**0.170**

Table 5: Net Increase in Runoff as a function of the Development per Micro-catchment Areas and Baseline Runoff Volumes

Proposed Dvelopment Baseline Run off Volumes (1 in 100 Year Hour Storm Event)												
Proposed Development			Approximate Area (m2)	1 in 100 Year Rainfall Event (m/hour Rain)	Capped Recharge Capacity. Percentage of Effective Rainfall (Conservative Value for Water Balanace Calc's)	Rejected Recharge / Runoff (m/hour Rain)	Runoff Discharge Rate (m3/hour)	Runoff Discharge Rate (m3/sec)	Net Increase (m3/sec)	Net Increase as percentage against baseline micro catchment runoff (%)	Indicative High Water Discharge (Q) Rate <15km downstream. (m3/sec)	
SW1			-	0.0363	20.00%	0.02904	-	-	-	-	20.00	0.00%
SW2			16,914.00	0.0363	20.00%	0.02904	491.18	0.14	0.034	25.00%	20.00	0.17%
SW3			28,242.50	0.0363	20.00%	0.02904	820.16	0.23	0.057	25.00%	20.00	0.28%
SW4			1,753.50	0.0363	20.00%	0.02904	50.92	0.01	0.004	0.00%	20.00	0.02%
SW5			37,217.00	0.0363	20.00%	0.02904	1,080.78	0.30	0.075	24.96%	20.00	0.37%
						Total	**2,443.05**	**0.68**	**0.166**	24.46%	**20.000**	0.83%

Water balance calculations allow for the addition of area for hardstand infrastructure required (land take) during the construction and operational phases of the Development. This equates to approximately 154,200m^2. A 1 in 100 year storm event scenario results in a net increase of surface water runoff associated with the Development, calculated to be c. 0.509m^3/second, or 0.83% relative to the site area (red line boundary). This net increase relative to the scale of the site or the scale of the associated catchment is considered an slight effect, no imperceptible or negligible impact of the Development. With suitable mitigation measures, the pressure to the surface water bodies and sites downgradient can be reduced to a neutral impact.

4.3.3 Mitigation Measures Associated with the Development

Flood Relief Schemes, outlined by the OPW, were in place for Fermoy in 2011 & 2015 and Mallow in 2010 & 2013 but have since been completed. There is currently a Flood Risk Management Scheme, outlined by the OPW, in place for the River basin Blackwater(Munster) which is downstream of the site (OPW, 2018).

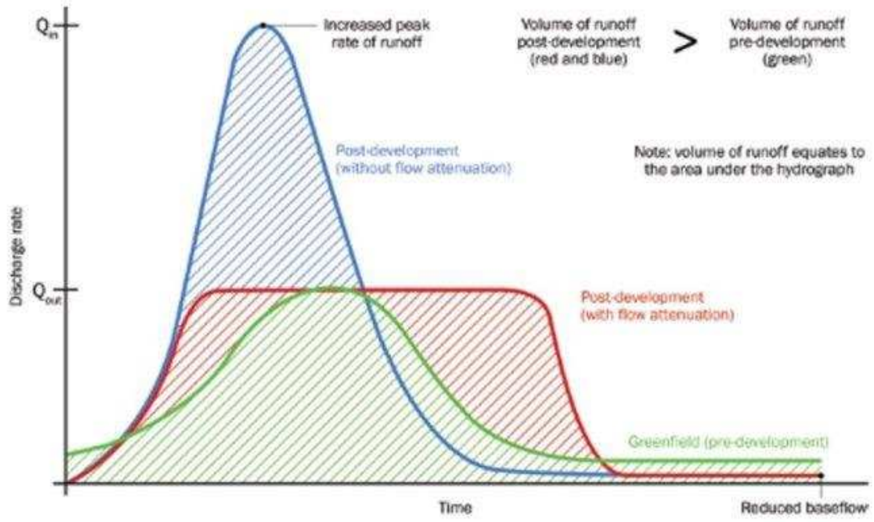
These include Measures Applicable in All Areas, which are detailed as:

Sustainable Urban Drainage Systems (SUDS). Objective: Planning authorities will seek to reduce the extent of hard surfacing and paving and require the use of sustainable drainage techniques to reduce the potential impact of development on flood risk downstream. A Hydrograph is presented in **Figure 21**, if SUDS measures are not in place following an increase in sealed land, rainfall and surface waters would peak following the blue peak. In development where SUDS measures are implemented the rainfall and surface water levels will follow the red line as water is retained and released and a slower discharge rate.

The Grid Connection Route trench is temporary, and the existing road surface will be reinstated once the grid cable is installed. No increase in hardstanding is proposed. As such the road surface will not be permanently altered. The installation of the Grid Connection Route will not alter the prevailing or baseline hydrology at the existing Mallow Substation and will have neither a positive or negative impact on this existing issue.

Land Use Management and Natural Flood Risk Management. Objective: during the project-level assessments of physical works and more broadly at a catchment-level to identify any measures, such as natural water retention measures (such as restoration of A wetlands and woodlands), that can have benefits for Water Framework Directive, flood risk management and biodiversity objectives.

Figure 21: Example of a hydrograph (CIRCA, 2015)



Future Flood Relief Schemes include Kanturk

'Fluvial Flood Defences on the Dalua and Allow rivers comprising of walls and embankments along with storm water pump stations.'

Under the 2019-2020 Work Programme of the Common Implementation Strategy (CIS) for the Water Framework Directive (WFD) (European Union, 2018), the Working Group Programme of Measures has built on the previously developed guidance for supporting the implementation of Natural Water Retention Measures (NWRM) in Europe (European Commission, 2015).

The OPW and EPA Catchments Unit in conjunction with Local Authorities are actively adopting and promoting NWRM as part of a broader suite of mitigation measures that could contribute to the achievement of environmental objectives (WFD) set out in the second River Basin Management Plan (RBMP) (EPA Catchment Unit, 2020).

In the 2019-2020 work programme of CIS for the WFD (European Union, 2018), it was identified that River Basin Management and flood Risk Management are key to achieving the goals set out in the Sustainable Development Goals (SDG6).

Flood Relief Scheme and flood risk management Objectives such as Land Use Management and Natural Flood Risk Management are relevant to the proposed development, whereby; the assessment and design of Development will qualify and mitigate any potential adverse impact in terms of hydrological response to rainfall and flood risk within or downstream of the Development. The objective of mitigation in this respect will be to achieve, at a minimum, a neutral impact, and to identify and promote beneficial impacts (net decrease in hydrological response to rainfall) at the site, particularly in terms of Natural Water Retention Measures (NWRM) as part of baseline conditions, namely; restoration of peatlands, wetlands and woodlands.

To mitigate any net change in hydraulic loading to surface waters during the construction and operational phase of the Development, the following examples can be utilised where appropriate;

- Check dams, dams, other flow restricting infrastructure

- Collector drains
- Permanent stilling ponds
- Attenuation lagoons
- Buffered outfalls to vegetated areas
- Controlling dewatering flow/pump rates
- Restricting pumped water discharge directly to drainage or surface water networks.
- Offline storage ponds, overland sediment traps,
- Floodplain and riparian woodland
- Riverbank restoration
- River morphology and floodplain restoration – removal of embankments, re-meandered river reach
- In stream structure – large woody debris
- Catchment woodlands
- Land and soil management practices – cover crops, cross contour hedgerows.

To mitigate for the increase in hardstanding on the wind farm site the actions below will be implemented.

An Environmental Manager / Ecological Clerk of Works (ECoW) with appropriate experience will be appointed for the duration of the construction phase to oversee the implementation of the CEMP.

Construction of the hardstanding areas for the turbines and the met mast will require the laying of geotextile material on the foundation surface, and placement of engineered stone and a top dressing, following excavation of soil, subsoil and rock as required, this will avoid any excess run off from the excavated area.

Earthworks will be limited to meteorologically dry periods and will not occur during sustained or intense rainfall events to avoid suspended soils entering the surface water networks.

All drainage- related mitigation measures will form part of a robust Sustainable Drainage System (SuDS) on the site.

Drainage facilities will be provided to manage runoff from tracks, hardstanding areas, turbine bases, and spoil storage areas such as

- Silt Screens
- Interceptor Drains
- include the existing drainage network in designing and specify the treatment train and attenuation features, including improving, modifying, and constructing attenuation features in drainage channels.

Sustainable Drainage System (SuDS) on the Site.

- Collector drains and/or soil berms (See EIAR **Chapter 9 Hydrology and Hydrogeology Section 9.6.3**)
- Buffered redistribution of clean runoff downgradient of the development footprint by means of culverts and buffered outfalls to vegetated areas.
- Attenuation features such as check dams, stilling ponds

Following construction, the hardstands and crane pads will be grassed over, and the upgraded and new internal site tracks will be utilised to access farmlands.

The Development has the potential to result in increased volumes of runoff during the operational phases of the Development relative to baseline conditions. However, with the appropriate environmental engineering controls and mitigation measures, previously outlined, these potential impacts will be reduced.

The combined attenuation capacity of the proposed drainage infrastructure will be designed to attenuate net increase in water runoff as calculated in **Table 4** & **Table 5**, including during extreme storm events relative to greenfield or baseline runoff rates. These mitigation measures required during the construction and operational phases will buffer the discharge rate and reduce the hydrological response to rainfall at the site, maintain (or improve) the hydrological regime at the site, in turn reducing loading on the receiving surface water drainage network. This will mitigate against the potential for rapid runoff and rapid hydrological responses to rainfall, lessening the likelihood to flooding of the drainage network or downstream of the Development.

Mitigation measures will be considered and designed in line with engineering and construction best practices and methodologies, including the following guidance documents (non-exhaustive);

- Scottish Environment Protection Agency (SEPA) (2009) Flood Risk Management (Scotland) Act 2009 – Surface Water management Planning Guidance
- UK Department for the Environment, Food, and Rural Affairs (DEFRA) (2010) Surface Water Management Plan Technical Guidance
- Scottish Environment Protection Agency (SEPA) (2015) Natural Flood Management Handbook
- CIRIA (2006) Control of Water Pollution from Linear Construction Projects – Technical Guidance
- CIRIA (2015) The SuDS Manual (C753)

The following observations and recommendations are made with a view to ensuring mitigation measures are designed and deployed effectively;

The magnitude of potential net increase in runoff as a function for the development at the site is considered an **adverse effect but not significant**, (flood risk areas downstream of the site and associated with a much larger catchment compared to the site boundary). In terms of detailed engineered design of the Development and with a view to applying mitigation measures adequately, it is recommended that drainage, attenuation and associated infrastructure is designed and specified by a competent water infrastructure engineer, which might include modelling of runoff in site drainage, to ensure that all aspects are sufficiently specified. Drainage modelling, including assessment of inundation rates, lag times and discharge rates, will be particularly useful in sensitive karst areas, or where particularly sensitive environmental attributes exist downstream, for example; ecological attributes where surface water runoff and surface water quality are linked.

Detailed design and specification of drainage, attenuation and associated infrastructure will be included in a detailed Surface Water Management Plan (SWMP) prior to the commencement of the construction phase which will include detailed development drainage layout and details regarding construction, maintenance, monitoring and emergency response. It is recommended that this is done in conjunction with relevant stakeholders including relevant authorities and other stakeholders such as landholders etc. in line with River Basin Management practices i.e. engagement at local level.

4.3.4 FRA Stage 2 – Conclusions

A 1 in 100 year storm event scenario results in a net increase of surface water runoff associated with the Development, calculated to be c. 0.170m^3/second, or 0.83% relative to the site area (red line boundary). This net increase relative to the scale of the site or the scale of the associated catchment is considered an adverse but **not significant** effect of the development.

The Development will use the latest best practice guidance to ensure that flood risk within or downstream of the site is not increased as a function of the development, i.e., a neutral impact at a minimum. As a result of the mitigation measures outlined being followed there will be no impacts on hydrology offsite.

Considering the Development does not acutely or significantly impact on a probable flood risk area, FRA Stage 3 including advanced flood modelling is not required. However, it is recommended to include drainage modelling during the detailed design phase of the Development.

A detailed Surface Water Management Plan (SWMP) will be prepared prior to the construction phase commencing, with a view to ensuring that the surface water runoff at the site is managed effectively and does not exacerbate flood risk to the surrounding areas downstream. It is recommended that this is done in consultation with relevant stakeholders.

As the associated drainage - some of which is permeant for the lifetime of the Development, will be attenuated for greenfield run-off, the Development will not increase the risk of flooding elsewhere in the catchment. Based on this information, the proposed Development complies with the appropriate policy guidelines for the area and is at **no risk of flooding**.

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EIAR VOLUME III
Appendices

CHAPTER 9 – HYDROLOGY AND HYDROGEOLOGY

Appendix 9.6: Surface Water Hydrochemistry Database

EIAR Appendix 9.6 - Baseline Surface Water Hydro-Chemistry Database

RSK File Ref. 604162-R3-App9.3-(02)-Surface water Hydrochemistry Database

Sample Details	**Sampling Event** (Date Sampled)		**LIMITS re EIA (Ref. NRA)** Indicative Limits Re.: Bathing, Drinking Surface Water reg's.				
Sample ID	**ALL**			**SW1**	**SW2**	**SW3**	**SW4**
Site	**ALL**			**A1 Tullacondra**	**A1 Tullacondra**	**A1 Tullacondra**	**A1 Tullacondra**
Project COC Reference - SW R1	**07/09/2022**	Wet / High Flow		22-36008-COC1	22-36008-COC1	22-36008-COC1	22-36008-COC1
Project COC Reference - SW R2	**11/10/2021**	Dry / Low Flow		N/A	22-39600_COC2	22-39600_COC2	22-39600_COC2
Sample Type	**ALL**	Medum		Surface Water	Surface Water	Surface Water	Surface Water
Grid Reference for Sampling Location	**ALL**	ITM		E152528.696946, N107425.912257	E150205.963418, N108288.796382	E145897.409303, N104748.532240	E148007.371916, N104288.441565
Field Data - Discharge							
Surface Water Feature	**ALL**	Type		Stream/River	Stream/River	Stream/River	Stream/River
Description of sample location	**ALL**	Type		Road bridge	Alongside feature	Alongside feature	Road bridge
Width of Water Body	**ALL**	m		5.0	2.0	1.5	1
Depth (d)	**ALL**	m		<0.5	<0.5	<0.5	<0.3
Total Rain 3 Days Prior (Table 9.11)	**07/09/2022**	mm/72hours		53.8			
Total Rain 3 Days Prior (Table 9.11)	**11/10/2022**	mm/72hours		9.9			
Estimated Discharge Rate (Q)	**07/09/2022**	l/sec		0	0 to 0.5	1.0 to 1.5	0
Estimated Discharge Rate (Q)	**11/10/2022**	l/sec		N/A	1 to 0.5	1.0 to 1.5	0
Laboratory Data - Hydrochemistry							
Alkalinity, Bicarbonate as CaCO3	**07/09/2022**	mg/l		85	75	75	140
Alkalinity, Bicarbonate as CaCO3	**11/10/2022**	mg/l		n/a	99	350	110
Alkalinity, Total as CaCO3	**07/09/2022**	mg/l		86	75	75	140
Alkalinity, Total as CaCO3	**11/10/2022**	mg/l		N/A	100	350	110
Ammoniacal Nitrogen as N (low level)	**07/09/2022**	mg/l	0.02	0.1	0.066	0.07	0.058
Ammoniacal Nitrogen as N (low level)	**11/10/2022**	mg/l	0.02	N/A	0.067	<0.050	0.12
Conductivity @ 20 deg.C	**07/09/2022**	mS/cm	2.5	0.29	0.31	0.5	0.29
Conductivity @ 20 deg.C	**11/10/2022**	mS/cm	2.5	N/A	0.25	0.56	0.34
Nitrate as NO3	**07/09/2022**	mg/l		1.4	6.4	14	1.9
Nitrate as NO3	**11/10/2022**	mg/l		N/A	6.4	18	7.2
Nitrite as NO2	**07/09/2022**	mg/l	0.05	0.1	0.47	0.028	0.39
Nitrite as NO2	**11/10/2022**	mg/l	0.05	N/A	0.04	<0.020	<0.021
pH	**07/09/2022**	pH Units	>6 & <9	7.9	7.8	7.8	8
pH	**11/10/2022**	pH Units	>6 & <9	N/A	8.1	8	8.1
Phosphate (Ortho as P)	**07/09/2022**	mg/l		0.27	0.19	0.077	0.78
Phosphate (Ortho as P)	**11/10/2022**	mg/l		N/A	0.24	0.076	0.18
Phosphorus (tot.unfilt)	**07/09/2022**	µg/l		0.088	78	25	26
Phosphorus (tot.unfilt)	**11/10/2022**	µg/l		N/A	190	25	59
Suspended solids, Total	**07/09/2022**	mg/l	25	6	6	<5.0	300
Suspended solids, Total	**11/10/2022**	mg/l	25	N/A	15	6	<5.0
Colour	**07/09/2022**	Hazen Unit		69	85	180	170
Colour	**11/10/2022**	mg/l Pt/Co		N/A	<1.0	<1.0	<1.0
Turbidity	**07/09/2022**	ntu		2.5	1.2	<1.1	35
Turbidity	**11/10/2022**	ntu		N/A	<1.0	<1.0	<1.0

Note/s:

N/A = Not Applicable or Not Analysed. N/R = Not Recorded.

EIAR VOLUME III
Appendices

CHAPTER 9 – HYDROLOGY AND HYDROGEOLOGY

Appendix 9.7: Surface Water Sampling Laboratory Certificates

UKAS TESTING 2183

Final Report

Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

Report No.:	22-36008-1		
Initial Date of Issue:	11-Oct-2022		
Client	RSK Ireland		
Client Address:	Unit B, Bluebell Business Centre Old Nass Road Dublin 12 IRELAND		
Contact(s):	Colleen McClung Mairead Duffy Sven Klinkenbergh Vincent Twomey		
Project	Baseline SW Sampling (Round 1) 604162 - Tullacondra Co. Cork		
Quotation No.:	Q22-28778	**Date Received:**	21-Sep-2022
Order No.:	P2022384	**Date Instructed:**	21-Sep-2022
No. of Samples:	4		
Turnaround (Wkdays):	5	**Results Due:**	27-Sep-2022
Date Approved:	29-Sep-2022		

Approved By:

Details: Stuart Henderson, Technical Manager

Results - Water

Project: Baseline SW Sampling (Round 1) 604162 - Tullacondra Co. Cork

Client: RSK Ireland				**Chemtest Job No.:**	22-36008	22-36008	22-36008	22-36008
Quotation No.: Q22-28778				**Chemtest Sample ID.:**	1509915	1509916	1509917	1509918
Order No.: P2022384				Client Sample Ref.:	Grab Sample	Grab Sample	Grab Sample	Grab Sample
				Client Sample ID.:	SW1	SW2	SW3A	SW 4
				Sample Location:	Tributary of the Awbeg River	Tributary of the Awbeg River	River Blackwater	Blackwater Tributary
				Sample Type:	WATER	WATER	WATER	WATER
				Date Sampled:	07-Sep-2022	07-Sep-2022	07-Sep-2022	07-Sep-2022
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
pH	U	1010		N/A	7.9	7.8	7.8	8.0
Electrical Conductivity	U	1020	µS/cm	1.0	290	310	550	290
Fats, Oils & Grease	N	1025	mg/l	10	< 10	< 10	< 10	< 10
Suspended Solids At 105C	U	1030	mg/l	5.0	6.0	6.0	< 5.0	300
Colour	N	1050	Hazen unit	1.0	69	85	180	170
Turbidity	N	1060	NTU	1.0	2.5	1.2	< 1.0	35
Alkalinity (Total)	U	1220	mg/l	10	86	75	290	140
Alkalinity (Bicarbonate)	U	1220	mg CaCO3/l	10	85	75	290	140
Ammoniacal Nitrogen	U	1220	mg/l	0.050	0.10	0.066	0.070	0.058
Nitrite as NO2	U	1220	mg/l	0.020	0.10	0.47	0.028	0.39
Nitrate as NO3	U	1220	mg/l	0.50	1.4	6.4	14	1.9
Orthophosphate as PO4	U	1220	mg/l	0.050	0.27	0.24	0.077	0.78
Phosphorus (Dissolved)	U	1220	mg/l	0.020	0.088	0.078	0.025	0.26
Total Hardness as CaCO3	U	1270	mg/l	15	94	110	340	150
Copper (Dissolved)	U	1455	µg/l	0.50	2.1	5.3	< 0.50	3.5
Zinc (Dissolved)	U	1455	mg/l	0.002	0.004	0.006	0.005	0.003
Copper (Total)	N	1455	µg/l	0.50	3.6	7.0	1.7	5.0
Zinc (Total)	N	1455	µg/l	2.5	3.9	5.7	4.7	3.4
Dissolved Organic Carbon	U	1610	mg/l	2.0	25	32	69	38
Total Organic Carbon	U	1610	mg/l	2.0	22	36	65	38
Total TPH >C6-C40	U	1670	µg/l	10	< 10	< 10	< 10	< 10
Total Kjeldahl Nitrogen	N	1340	mg/l	1.0	2.2	2.1	5.2	< 1.0

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1025	Fats, Oils and Greases	Fats, Oils and Greases	Solvent extraction / Gravimetry
1030	Total Suspended Solids	Total suspended solids	Filtration of a mixed sample through a standard glass fibre filter and determination of the mass of residue retained dried at 105°C.
1050	Colour	Colour	Spetctrophotometry
1060	Turbidity	Turbidity	Spetctrophotometry
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1270	Total Hardness of Waters	Total hardness	Calculation applied to calcium and magnesium results, expressed as mg l-1 CaCO3 equivalent.
1340	Total Nitrogen in Waters	Total Nitrogen and organic Nitrogen	Persulphate digestion followed by colorimetry.
1455	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1670	Total Petroleum Hydrocarbons (TPH) in Waters by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO	Pentane extraction / GC FID detection

Report Information

Key	
U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

eurofins
Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	22-39600-1		
Initial Date of Issue:	07-Nov-2022		
Client	RSK Ireland		
Client Address:	Unit B, Bluebell Business Centre Old Nass Road Dublin 12 IRELAND		
Contact(s):	Sven Klinkenbergh Colleen McClung Mairead Duffy Vincent Twomey		
Project	Baseline SW Sampling (Round 2) 604162 - Tullacondra Co. Cork		
Quotation No.:	Q22-28778	**Date Received:**	17-Oct-2022
Order No.:	P2022415	**Date Instructed:**	17-Oct-2022
No. of Samples:	3		
Turnaround (Wkdays):	5	**Results Due:**	21-Oct-2022
Date Approved:	07-Nov-2022		

Approved By:

Details: Alison Drinkwater, Specalist Chemist

Results - Water

Project: Baseline SW Sampling (Round 2) 604162 - Tullacondra Co. Cork

Client: RSK Ireland				**Chemtest Job No.:**	22-39600	22-39600	22-39600
Quotation No.: Q22-28778				**Chemtest Sample ID.:**	1526262	1526263	1526264
Order No.: P2022415				Client Sample Ref.:	Grab Sample	Grab Sample	Grab Sample
				Client Sample ID.:	SW2	SW3A	SW 4
				Sample Location:	Tributary of the Awbeg River	River Blackwater	Blackwater Triburary
				Sample Type:	WATER	WATER	WATER
				Date Sampled:	11-Oct-2022	11-Oct-2022	11-Oct-2022
Determinand	**Accred.**	**SOP**	**Units**	**LOD**			
pH	U	1010		N/A	8.1	8.0	8.1
Electrical Conductivity	U	1020	µS/cm	1.0	250	560	340
Fats, Oils & Grease	N	1025	mg/l	10	< 10	< 10	< 10
Suspended Solids At 105C	U	1030	mg/l	5.0	15	6.0	< 5.0
Colour	N	1050	Hazen unit	1.0	< 1.0	< 1.0	< 1.0
Turbidity	N	1060	NTU	1.0	< 1.0	< 1.0	< 1.0
Alkalinity (Total)	U	1220	mg/l	10	100	350	110
Alkalinity (Bicarbonate)	U	1220	mg CaCO3/l	10	99	350	110
Ammoniacal Nitrogen	U	1220	mg/l	0.050	0.067	< 0.050	0.12
Nitrite as NO2	U	1220	mg/l	0.020	0.040	< 0.020	< 0.020
Nitrate as NO3	U	1220	mg/l	0.50	6.4	18	7.2
Orthophosphate as PO4	U	1220	mg/l	0.050	0.19	0.076	0.18
Phosphorus (Dissolved)	U	1220	mg/l	0.020	0.062	0.025	0.059
Total Hardness as CaCO3	U	1270	mg/l	15	110	320	140
Copper (Dissolved)	U	1455	µg/l	0.50	2.6	< 0.50	4.2
Zinc (Dissolved)	U	1455	mg/l	0.002	0.005	0.007	0.008
Copper (Total)	N	1455	µg/l	0.50	5.0	2.7	7.6
Zinc (Total)	N	1455	µg/l	2.5	6.0	7.8	5.3
Dissolved Organic Carbon	U	1610	mg/l	2.0	12	< 2.0	13
Total Organic Carbon	U	1610	mg/l	2.0	12	< 2.0	13
Total TPH >C6-C40	U	1670	µg/l	10	< 10	< 10	< 10
Total Kjeldahl Nitrogen	N	1340	mg/l	1.0	3.2	5.9	1.8

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
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1340	Total Nitrogen in Waters	Total Nitrogen and organic Nitrogen	Persulphate digestion followed by colorimetry.
1455	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1670	Total Petroleum Hydrocarbons (TPH) in Waters by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO	Pentane extraction / GC FID detection

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T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
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Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied

B - Sample age exceeds stability time (sampling to extraction)

C - Sample not received in appropriate containers

D - Broken Container

E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com

EIAR VOLUME III
Appendices

CHAPTER 9 – HYDROLOGY AND HYDROGEOLOGY

Appendix 9.8: Karst Features – Grid Connection Route

ID (GSI Karst Database 2023)	Description	X (ITM)	Y (ITM)	Clostest distance to GCR 1 (m)	Clostest distance to GCR 2 (m)
IE_GSI_Karst_40K_2968	Enclosed Depression	551269	604200	260	1048
IE_GSI_Karst_40K_9805	Enclosed Depression	551269	604200	260	1048
IE_GSI_Karst_40K_7139	Swallow Hole	555193	603924	286	828
IE_GSI_Karst_40K_5773	Swallow Hole	555193	603924	286	828
IE_GSI_Karst_40K_9804	Enclosed Depression	551081	604337	293	844
IE_GSI_Karst_40K_6950	Enclosed Depression	551081	604337	293	844
IE_GSI_Karst_40K_17070	Enclosed Depression	551807	604470	307	1035
IE_GSI_Karst_40K_9802	Swallow Hole	551023	604338	332	817
IE_GSI_Karst_40K_7878	Swallow Hole	551023	604338	332	817
IE_GSI_Karst_40K_16552	Enclosed Depression	550480	605379	357	357
IE_GSI_Karst_40K_16551	Enclosed Depression	550659	605488	377	376
IE_GSI_Karst_40K_2251	Enclosed Depression	550993	604281	393	853
IE_GSI_Karst_40K_9803	Enclosed Depression	550993	604281	393	853
IE_GSI_Karst_40K_16307	Enclosed Depression	555426	604806	407	288
IE_GSI_Karst_40K_7884	Enclosed Depression	551002	604232	422	901
IE_GSI_Karst_40K_8041	Enclosed Depression	551002	604232	422	901
IE_GSI_Karst_40K_7969	Enclosed Depression	550279	604321	451	451
IE_GSI_Karst_40K_11465	Enclosed Depression	550279	604321	451	451
IE_GSI_Karst_40K_11711	Enclosed Depression	550941	604231	466	875
IE_GSI_Karst_40K_7812	Enclosed Depression	550941	604231	466	875
IE_GSI_Karst_40K_16063	Enclosed Depression	555379	604849	470	300
IE_GSI_Karst_40K_16060	Enclosed Depression	554712	604617	490	634
IE_GSI_Karst_40K_6403	Swallow Hole	556339	604883	516	516
IE_GSI_Karst_40K_7954	Swallow Hole	556339	604883	516	516
IE_GSI_Karst_40K_2380	Enclosed Depression	550839	604204	556	847
IE_GSI_Karst_40K_7811	Enclosed Depression	550839	604204	556	847

IE_GSI_Karst_40K_5867	Enclosed Depression	550388	604226	588	588
IE_GSI_Karst_40K_7968	Enclosed Depression	550388	604226	588	588
IE_GSI_Karst_40K_16059	Enclosed Depression	554525	604689	598	566
IE_GSI_Karst_40K_8220	Enclosed Depression	556180	605160	609	539
IE_GSI_Karst_40K_16062	Enclosed Depression	555064	604865	632	459
IE_GSI_Karst_40K_7967	Swallow Hole	550468	604219	636	636
IE_GSI_Karst_40K_2594	Swallow Hole	550468	604219	636	636
IE_GSI_Karst_40K_6955	Spring	550778	605769	638	586
IE_GSI_Karst_40K_8466	Spring	550778	605769	638	586
IE_GSI_Karst_40K_8219	Enclosed Depression	556218	605201	663	592
IE_GSI_Karst_40K_7810	Enclosed Depression	550758	604128	666	862
IE_GSI_Karst_40K_3068	Enclosed Depression	550758	604128	666	862
IE_GSI_Karst_40K_16156	Enclosed Depression	549624	603981	708	708
IE_GSI_Karst_40K_2403	Swallow Hole	552666	602871	713	2404
IE_GSI_Karst_40K_8458	Swallow Hole	552666	602871	713	2404
IE_GSI_Karst_40K_16061	Enclosed Depression	554542	604810	713	443
IE_GSI_Karst_40K_12189	Enclosed Depression	550653	604159	717	783
IE_GSI_Karst_40K_7809	Enclosed Depression	550653	604159	717	783
IE_GSI_Karst_40K_8221	Enclosed Depression	555775	605357	745	279
IE_GSI_Karst_40K_8467	Spring	550652	605877	757	735
IE_GSI_Karst_40K_3342	Spring	550652	605877	757	735
IE_GSI_Karst_40K_8223	Enclosed Depression	555368	605213	779	141
IE_GSI_Karst_40K_3207	Swallow Hole	550900	605902	780	656
IE_GSI_Karst_40K_8465	Swallow Hole	550900	605902	780	656
IE_GSI_Karst_40K_7575	Enclosed Depression	555216	605123	788	267
IE_GSI_Karst_40K_3206	Enclosed Depression	549758	603850	793	793
IE_GSI_Karst_40K_7528	Enclosed Depression	549758	603850	793	793
IE_GSI_Karst_40K_7806	Enclosed Depression	550329	603921	809	809
IE_GSI_Karst_40K_8170	Enclosed Depression	550329	603921	809	809

IE_GSI_Karst_40K_8222	Enclosed Depression	555766	605438	826	313
IE_GSI_Karst_40K_16155	Enclosed Depression	549176	604228	839	839
IE_GSI_Karst_40K_5865	Spring	551440	603130	864	2070
IE_GSI_Karst_40K_16157	Enclosed Depression	549897	603763	865	865
IE_GSI_Karst_40K_7807	Enclosed Depression	550287	603816	888	888
IE_GSI_Karst_40K_6832	Enclosed Depression	550287	603816	888	888
IE_GSI_Karst_40K_7587	Enclosed Depression	549747	603744	899	899
IE_GSI_Karst_40K_7529	Enclosed Depression	549747	603744	899	899
IE_GSI_Karst_40K_9359	Swallow Hole	558287	599812	901	901
IE_GSI_Karst_40K_6883	Swallow Hole	558287	599812	901	901
IE_GSI_Karst_40K_7808	Enclosed Depression	550367	603822	916	916
IE_GSI_Karst_40K_8164	Enclosed Depression	550367	603822	916	916
IE_GSI_Karst_40K_16610	Enclosed Depression	550601	606036	922	902
IE_GSI_Karst_40K_16482	Enclosed Depression	549172	605619	934	934
IE_GSI_Karst_40K_2379	Swallow Hole	556859	604752	946	946
IE_GSI_Karst_40K_9357	Swallow Hole	556859	604752	946	946
IE_GSI_Karst_40K_2972	Enclosed Depression	551612	602762	949	2473
IE_GSI_Karst_40K_7138	Enclosed Depression	551612	602762	949	2473
IE_GSI_Karst_40K_16158	Enclosed Depression	550012	603659	974	974
IE_GSI_Karst_40K_16584	Enclosed Depression	555813	605622	1003	463
IE_GSI_Karst_40K_4117	Spring	550796	606184	1053	953
IE_GSI_Karst_40K_7171	Spring	550796	606184	1053	953
IE_GSI_Karst_40K_7137	Enclosed Depression	551550	602670	1058	2520
IE_GSI_Karst_40K_2369	Enclosed Depression	551550	602670	1058	2520
IE_GSI_Karst_40K_16159	Enclosed Depression	549756	603551	1088	1088
IE_GSI_Karst_40K_16585	Enclosed Depression	555066	605393	1096	38
IE_GSI_Karst_40K_9358	Swallow Hole	556959	604952	1109	1109
IE_GSI_Karst_40K_4114	Swallow Hole	556959	604952	1109	1109
IE_GSI_Karst_40K_16583	Enclosed Depression	555458	605666	1131	252

IE_GSI_Karst_40K_7134	Enclosed Depression	551307	602772	1164	2305
IE_GSI_Karst_40K_8225	Enclosed Depression	551307	602772	1164	2305
IE_GSI_Karst_40K_16095	Enclosed Depression	548653	604487	1217	1217
IE_GSI_Karst_40K_16582	Enclosed Depression	555142	605588	1218	196
IE_GSI_Karst_40K_4190	Enclosed Depression	551620	602406	1237	2784
IE_GSI_Karst_40K_7136	Enclosed Depression	551620	602406	1237	2784
IE_GSI_Karst_40K_7135	Swallow Hole	551520	602367	1322	2759
IE_GSI_Karst_40K_8224	Swallow Hole	551520	602367	1322	2759
IE_GSI_Karst_40K_17158	Enclosed Depression	556696	605681	1329	1249
IE_GSI_Karst_40K_16484	Enclosed Depression	549282	606149	1330	1330
IE_GSI_Karst_40K_16550	Enclosed Depression	549235	606139	1339	1339
IE_GSI_Karst_40K_3291	Spring	550831	603105	1353	1766
IE_GSI_Karst_40K_8457	Spring	550827	603090	1367	1777
IE_GSI_Karst_40K_6962	Spring	550827	603090	1367	1777
IE_GSI_Karst_40K_7955	Swallow Hole	557042	605400	1387	1387
IE_GSI_Karst_40K_2295	Swallow Hole	557042	605400	1387	1387
IE_GSI_Karst_40K_7960	Enclosed Depression	555976	606013	1393	839
IE_GSI_Karst_40K_8163	Enclosed Depression	555976	606013	1393	839
IE_GSI_Karst_40K_16112	Enclosed Depression	556713	605749	1394	1292
IE_GSI_Karst_40K_8452	Spring	556285	598646	1412	1412
IE_GSI_Karst_40K_8237	Spring	556285	598646	1412	1412
IE_GSI_Karst_40K_9806	Enclosed Depression	550137	603230	1415	1415
IE_GSI_Karst_40K_7176	Enclosed Depression	550137	603230	1415	1415
IE_GSI_Karst_40K_16058	Enclosed Depression	553933	605501	1511	267
IE_GSI_Karst_40K_16483	Enclosed Depression	549823	606438	1517	1517
IE_GSI_Karst_40K_16649	Enclosed Depression	551844	606225	1525	686
IE_GSI_Karst_40K_2438	Enclosed Depression	551054	602372	1616	2520
IE_GSI_Karst_40K_7133	Enclosed Depression	551054	602372	1616	2520
IE_GSI_Karst_40K_2281	Enclosed Depression	550498	603061	1616	1670

IE_GSI_Karst_40K_8456	Enclosed Depression	550498	603061	1616	1670
IE_GSI_Karst_40K_6407	Spring	550691	602841	1641	1943
IE_GSI_Karst_40K_8455	Spring	550691	602841	1641	1943
IE_GSI_Karst_40K_16650	Enclosed Depression	552020	606221	1650	650
IE_GSI_Karst_40K_105	Spring	550681	602836	1652	1945
IE_GSI_Karst_40K_16485	Enclosed Depression	548765	606236	1669	1669
IE_GSI_Karst_40K_16160	Enclosed Depression	549624	602966	1686	1686
IE_GSI_Karst_40K_16113	Enclosed Depression	556938	605955	1693	1586
IE_GSI_Karst_40K_16547	Enclosed Depression	551616	606620	1708	1089
IE_GSI_Karst_40K_16161	Enclosed Depression	549237	603045	1721	1721
IE_GSI_Karst_40K_16546	Enclosed Depression	551667	606652	1760	1116
IE_GSI_Karst_40K_17272	Enclosed Depression	555184	606244	1771	836
IE_GSI_Karst_40K_16651	Enclosed Depression	552132	606312	1795	745
IE_GSI_Karst_40K_15892	Enclosed Depression	557145	605909	1795	1751
IE_GSI_Karst_40K_16545	Enclosed Depression	551777	606650	1816	1109
IE_GSI_Karst_40K_8533	Enclosed Depression	550552	602671	1860	2058
IE_GSI_Karst_40K_2158	Enclosed Depression	550552	602671	1860	2058
IE_GSI_Karst_40K_16586	Enclosed Depression	554905	606199	1861	851
IE_GSI_Karst_40K_16903	Enclosed Depression	551767	606719	1870	1178
IE_GSI_Karst_40K_7956	Spring	556756	606283	1871	1610
IE_GSI_Karst_40K_2260	Spring	556756	606283	1871	1610
IE_GSI_Karst_40K_15899	Enclosed Depression	555944	606498	1876	1212
IE_GSI_Karst_40K_8460	Swallow Hole	548243	603769	1878	1878
IE_GSI_Karst_40K_6952	Swallow Hole	548243	603769	1878	1878
IE_GSI_Karst_40K_15893	Enclosed Depression	557286	605883	1879	1858
IE_GSI_Karst_40K_5803	Swallow Hole	549128	602912	1887	1887
IE_GSI_Karst_40K_8451	Swallow Hole	549128	602912	1887	1887
IE_GSI_Karst_40K_5806	Enclosed Depression	550647	602452	1887	2295
IE_GSI_Karst_40K_8534	Enclosed Depression	550647	602452	1887	2295

IE_GSI_Karst_40K_15898	Enclosed Depression	556364	606454	1891	1426
IE_GSI_Karst_40K_16548	Enclosed Depression	551670	606808	1898	1271
IE_GSI_Karst_40K_3747	Enclosed Depression	559089	600626	1915	1915
IE_GSI_Karst_40K_12316	Enclosed Depression	559089	600626	1915	1915
IE_GSI_Karst_40K_8464	Spring	548750	603097	1922	1922
IE_GSI_Karst_40K_2256	Spring	548750	603097	1922	1922
IE_GSI_Karst_40K_16055	Enclosed Depression	553973	605968	1961	722
IE_GSI_Karst_40K_9448	Enclosed Depression	548028	604038	1965	1965
IE_GSI_Karst_40K_15897	Enclosed Depression	557368	605957	1989	1966
IE_GSI_Karst_40K_5718	Spring	550242	602662	1993	1993
IE_GSI_Karst_40K_8454	Spring	550242	602662	1993	1993
IE_GSI_Karst_40K_16856	Enclosed Depression	548522	606468	2002	2002
IE_GSI_Karst_40K_16652	Enclosed Depression	552849	605832	2011	498
IE_GSI_Karst_40K_17269	Enclosed Depression	554312	606109	2032	816
IE_GSI_Karst_40K_7958	Enclosed Depression	554897	606393	2032	1037
IE_GSI_Karst_40K_3533	Enclosed Depression	554897	606393	2032	1037
IE_GSI_Karst_40K_2437	Enclosed Depression	548404	603250	2044	2044
IE_GSI_Karst_40K_8463	Enclosed Depression	548404	603250	2044	2044
IE_GSI_Karst_40K_15894	Enclosed Depression	557466	605929	2045	2037
IE_GSI_Karst_40K_17271	Enclosed Depression	554754	606325	2048	1020
IE_GSI_Karst_40K_8038	Enclosed Depression	554867	606401	2054	1054
IE_GSI_Karst_40K_7959	Enclosed Depression	554867	606401	2054	1054
IE_GSI_Karst_40K_7965	Enclosed Depression	548249	603417	2058	2058
IE_GSI_Karst_40K_2376	Enclosed Depression	548249	603417	2058	2058
IE_GSI_Karst_40K_15904	Enclosed Depression	555766	606677	2059	1309
IE_GSI_Karst_40K_16861	Enclosed Depression	548015	606033	2098	2098
IE_GSI_Karst_40K_2381	Enclosed Depression	550581	602169	2107	2548

IE_GSI_Karst_40K_8535	Enclosed Depression	550581	602169	2107	2548
IE_GSI_Karst_40K_8043	Enclosed Depression	548259	603290	2127	2127
IE_GSI_Karst_40K_15903	Enclosed Depression	555665	606744	2134	1348
IE_GSI_Karst_40K_15895	Enclosed Depression	557544	605981	2138	2130
IE_GSI_Karst_40K_16859	Enclosed Depression	548021	606132	2146	2146
IE_GSI_Karst_40K_2361	Spring	550219	602490	2159	2159
IE_GSI_Karst_40K_16862	Enclosed Depression	548744	606835	2182	2182
IE_GSI_Karst_40K_7957	Spring	556935	606542	2184	1912
IE_GSI_Karst_40K_2282	Spring	556935	606542	2184	1912
IE_GSI_Karst_40K_16609	Enclosed Depression	552277	606723	2185	1173
IE_GSI_Karst_40K_16860	Enclosed Depression	548011	606189	2187	2187
IE_GSI_Karst_40K_7961	Enclosed Depression	557358	606271	2205	2105
IE_GSI_Karst_40K_6851	Enclosed Depression	557358	606271	2205	2105
IE_GSI_Karst_40K_15896	Enclosed Depression	557617	606006	2210	2206
IE_GSI_Karst_40K_16549	Enclosed Depression	552334	606717	2220	1179
IE_GSI_Karst_40K_8986	Enclosed Depression	547818	603821	2244	2244
IE_GSI_Karst_40K_16654	Enclosed Depression	553045	606065	2251	778
IE_GSI_Karst_40K_16611	Enclosed Depression	548568	606820	2259	2259
IE_GSI_Karst_40K_15901	Enclosed Depression	555784	606883	2264	1512
IE_GSI_Karst_40K_16656	Enclosed Depression	553118	606084	2265	818
IE_GSI_Karst_40K_8218	Swallow Hole	557927	605624	2267	2267
IE_GSI_Karst_40K_16655	Enclosed Depression	553080	606097	2280	818
IE_GSI_Karst_40K_16648	Enclosed Depression	555430	606855	2281	1428
IE_GSI_Karst_40K_2314	Enclosed Depression	548148	603178	2284	2284
IE_GSI_Karst_40K_6059	Enclosed Depression	548171	603146	2287	2287
IE_GSI_Karst_40K_7966	Enclosed Depression	548171	603146	2287	2287
IE_GSI_Karst_40K_16481	Swallow Hole	548123	606507	2303	2303

IE_GSI_Karst_40K_15905	Enclosed Depression	555930	606940	2318	1611
IE_GSI_Karst_40K_15906	Enclosed Depression	555317	606874	2325	1447
IE_GSI_Karst_40K_16863	Enclosed Depression	548097	606567	2364	2364
IE_GSI_Karst_40K_15902	Enclosed Depression	555572	606989	2389	1573
IE_GSI_Karst_40K_17018	Enclosed Depression	555493	606981	2393	1558
IE_GSI_Karst_40K_16057	Enclosed Depression	554572	606627	2400	1351
IE_GSI_Karst_40K_17273	Enclosed Depression	553834	606410	2421	1182
IE_GSI_Karst_40K_17270	Enclosed Depression	554331	606518	2429	1225
IE_GSI_Karst_40K_15900	Enclosed Depression	555563	607044	2444	1627
IE_GSI_Karst_40K_16587	Enclosed Depression	554996	606908	2456	1521
IE_GSI_Karst_40K_16056	Enclosed Depression	554559	606697	2467	1420
IE_GSI_Karst_40K_16857	Enclosed Depression	547817	606407	2472	2472
IE_GSI_Karst_40K_17019	Enclosed Depression	555365	607071	2505	1643
IE_GSI_Karst_40K_6404	Spring	549441	602125	2547	2547
IE_GSI_Karst_40K_8453	Spring	549441	602125	2547	2547
IE_GSI_Karst_40K_2366	Spring	552072	607328	2548	1757
IE_GSI_Karst_40K_8468	Spring	552072	607328	2548	1757
IE_GSI_Karst_40K_16653	Enclosed Depression	553207	606400	2549	1146
IE_GSI_Karst_40K_16858	Enclosed Depression	547876	606629	2568	2568
IE_GSI_Karst_40K_16588	Enclosed Depression	555021	607091	2619	1698
IE_GSI_Karst_40K_17267	Enclosed Depression	555250	607284	2739	1860
IE_GSI_Karst_40K_9447	Enclosed Depression	547049	604589	2765	2765
IE_GSI_Karst_40K_17268	Enclosed Depression	555235	607347	2804	1924
IE_GSI_Karst_40K_371	Swallow Hole	559379	602106	2825	2825
IE_GSI_Karst_40K_12063	Swallow Hole	559379	602106	2825	2825
IE_GSI_Karst_40K_2404	Spring	547701	602741	2908	2908
IE_GSI_Karst_40K_8462	Spring	547701	602741	2908	2908
IE_GSI_Karst_40K_8459	Spring	548249	602210	2935	2935
IE_GSI_Karst_40K_3276	Spring	548249	602210	2935	2935
IE_GSI_Karst_40K_104	Spring	548192	602246	2939	2939

IE_GSI_Karst_40K_5761	Swallow Hole	547620	602774	2949	2949
IE_GSI_Karst_40K_8461	Swallow Hole	547620	602774	2949	2949
IE_GSI_Karst_40K_2971	Swallow Hole	547185	603214	3073	3073
IE_GSI_Karst_40K_9446	Enclosed Depression	546800	604179	3084	3084
IE_GSI_Karst_40K_11712	Spring	553090	607388	3229	2062
IE_GSI_Karst_40K_7170	Spring	553090	607388	3229	2062
IE_GSI_Karst_40K_8168	Swallow Hole	546911	603177	3334	3334
IE_GSI_Karst_40K_252	Spring	549431	608304	3403	3403
IE_GSI_Karst_40K_8450	Swallow Hole	546769	603039	3522	3522
IE_GSI_Karst_40K_6261	Swallow Hole	546762	603034	3531	3531
IE_GSI_Karst_40K_3277	Spring	553472	607473	3537	2250
IE_GSI_Karst_40K_7169	Spring	553472	607473	3537	2250
IE_GSI_Karst_40K_7963	Spring	554733	608031	3602	2672
IE_GSI_Karst_40K_2992	Spring	554733	608031	3602	2672
IE_GSI_Karst_40K_6060	Enclosed Depression	546602	603079	3656	3656
IE_GSI_Karst_40K_8449	Enclosed Depression	546602	603079	3656	3656
IE_GSI_Karst_40K_9445	Enclosed Depression	546154	604177	3714	3714
IE_GSI_Karst_40K_368	Spring	557160	608274	3866	3360
IE_GSI_Karst_40K_3388	Spring	559122	606856	3926	3926
IE_GSI_Karst_40K_7962	Spring	559122	606856	3926	3926
IE_GSI_Karst_40K_7497	Spring	546114	601767	4756	4756