Tara Mines

Environmental Impact Assessment Report (EIAR)

Tailings Facility Embankment Buttress

Appendix 6.A

Habitat and Biodiversity Management Conservation Plan

Appeal Reference Number: ABP-315173-22

Submitted: February 2024

HABITAT AND BIODIVERSITY MANAGEMENT PLAN AS REGARDS PROPOSED BUTTRESSING WORKS AT THE TAILINGS STORAGE FACILITY, RANDALSTOWN/SIMONSTOWN/SILLOGUE, NAVAN CO MEATH

UPDATED FEBRUARY 2024

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Updated February 2024 by:

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EXECUTIVE SUMMARY

Planning permission was sought by Boliden Tara Mines DAC from Meath Co. Council (Planning Reference 22/331) as regards the construction of a reinforcement buttress to sections of the extant dam walls of the Tailings Storage Facility. Meath Co. Council having granted planning permission, the decision was appealed to An Bord Pleanála. An Bord Pleanála requested further information having determined that the proposed development required the mandatory preparation of an EIAR. This document, initially prepared in September of 2022 has been updated to reflect changes associated with the biodiversity chapter of the EIAR. One of the primary additions is that an Ecological Clerk of Works (ECoW) must be appointed in advance of the proposed development to oversee the management of ecological risks on site and ensure that all mitigation measures as relating to ecological issues are implemented effectively on the ground

It is considered that maintaining and enhancing the ecological integrity of the habitats present post-works is the primary driver that must inform the management of the subject area. This is particularly relevant given the:

- *SPR-linkage between the site and the River Boyne and River Blackwater SAC/SPA;*
- *The dominant habitats occurring on the existing dam walls of the Tailings Storage Facility (seminatural grassland habitat);*
- *The species supported by this seminatural grassland habitat, which includes several ground (or near ground) nesting bird species of conservation concern (including Meadow Pipit, Skylark and Yellowhammer); and*
- *The use of the Tailings Storage Facility by an Internationally important population of Whooper Swan during the winter months.*

Appropriate management throughout the works and post-works in addition to ongoing monitoring identified within this document will maintain and indeed enhance overall biodiversity and the conservation status of Qualifying Interests of the River Boyne and River Blackwater SAC/SPA. This Habitat and Biodiversity Management Plan will be (iteratively) informed by extensive surveying pre-works and monitoring post-works of the subject area.

1 Introduction

1.1 FERS Ltd. Company background

Forest, Environmental Research and Services have been conducting ecological surveys and research since the company's formation in 2005 by Dr Patrick Moran and Dr Kevin Black. Dr Moran, the principal ecologist with FERS, holds a 1st class honours degree in Environmental Biology (UCD), a Ph.D. in Ecology (UCD), a Diploma in EIA and SEA management (UCD) a Diploma in Environmental and Planning Law (King's Inn) and a M.Sc. in Geographical Information Systems and Remote Sensing (University of Ulster, Coleraine). Patrick has in excess of 20 years of experience in carrying out ecological surveys on both an academic and a professional basis. Dr Emma Reeves, senior ecologist with FERS holds a 1st class honours degree in Botany, and a Ph.D. in Botany. Emma has in excess of 15 years of experience in undertaking ecological surveys on an academic and professional basis. Ciarán Byrne, a senior ecologist with FERS holds a 1st class honours degree in Environmental Management (DIT) and a M.Sc. in Applied Science/Ecological Assessment (UCC). Ciarán has in excess of 10 years in undertaking ecological surveys on both an academic and a professional basis.

FERS client list includes National Parks and Wildlife Service, An Bord Pleanála, various County Councils, the Heritage Council, Teagasc, University College Dublin, the Environmental Protection Agency, Inland Waterways Association of Ireland, the Department of Agriculture, the Office of Public Works and Coillte in addition to numerous private individuals and companies. FERS Ltd. has prepared a variety of Habitat and Biodiversity Management Plans for a wide range of habitats, including semi-natural grassland habitats.

1.2 The aim of this report

The aim of this report is to present a comprehensive Habitat and Biodiversity Management Plan as pertains to the proposed works with the objectives of

(1) Maximising the opportunities to maintain and enhance overall biodiversity within the proposed works area; and
(2) Providing overall conditions conducive to the maintenance and enhancement of the conservation status of the Qualifying Interests of the River Boyne and River Blackwater SAC/SPA.

1.3 Existing conditions on site

The existing walls of the embankments largely comprise seminatural grassland of a mosaic of types, depending on the existing environmental conditions. For example, in the vicinity of the Interceptor Ditch, areas of wet grassland (GS4) occur, while on south-facing slopes the grassland could be categorised as GS1, and indeed a high number of orchids, including Common Spotted Orchid and Bee Orchid occur here.

Figure 1: Slopes of the existing embankment comprise the habitat GS - semi natural grassland

Figure 2: Bee Orchid occur in suitable habitat along the embankment of the dam

The existing semi-natural grassland habitat supports numerous species of avifauna of conservation concern, including the red-listed Meadow Pipit and Yellowhammer. There has been little human intervention in the form of insecticide/pesticide within the habitats occurring along the tailings embankments/walls and as a result the habitats provide a rich habitat assemblage for invertebrates, upon which ground/near ground nesting species such as Meadow Pipit and Yellowhammer require for successfully breeding.

Figure 3: The Red-listed Meadow Pipit breeds extensively at the Tailings Facility

Figure 4: Yellowhammer are also abundant within the subject area

Grassland habitat within Ireland requires management in the form of grazing and/or mowing to maintain a sward as woodland is the climax vegetation. The existing grassland habitat is largely maintained by a healthy population of hare and rabbit (in addition to invertebrates). There are large numbers of Irish Hare throughout the subject area.

Figure 5: Irish Hare are common withing the Tailings Facility, being free from persecution

In addition, the semi-natural grassland habitat and the invertebrate population supported provides foraging for a range of bat species.

2 Description of proposed project

2.1 Background

2.1.1 Rationale

BTM has recently become a member of the International Council for Mining and Metals (ICMM) and is in the process of adopting the Global Industry Standard on Tailings Management (GISTM).

A key objective of GISTM is to address the risk of tailings embankment failure through conservative design criteria, independent of trigger mechanisms, in order to minimise potential impacts.

To this end a suitable conservative approach must be taken in terms of the factors of safety to be adopted in scenarios relating to the liquefaction / brittleness of the tailings.

The proposed buttress will be constructed against the extant embankment walls of the Tailings Storage Facility.

- The extant embankment walls have been designed and assessed to meet a target design criterion, for long-term static slope stability, with a Factor of safety (FoS) of >/= 1.5 using effective strength parameters.
- The buttressing works will increase the Factor of Safety to
    - >/=1.5 for the peak strength undrained scenario and to
    - >/= 1.1 for the residual strength undrained scenario which is now required

The Tailings Facility is located approximately 2.8 km north of the mine site in Navan. The facility is constructed as a ring-dike configuration, Stages 1 to 5 are enclosed by earth fill embankment walls constructed from locally sourced natural materials, while stage 6 is composite lined. The facility encloses an area of c. 250 Hectares. It is proposed to construct a buttress to sections of the existing embankment walls to increase their strength thus reducing the risk of failure

Figure 6: Tailings Facility layout plan

The TSF has been constructed in six main stages during the period from 1974 to present.

- Stages 1, 2 and 3 were built at ground level to a height of c.12 metres.
- Stages 4 and 5 were upstream vertical raises over Stages 1,2 and 3 (6m and 4m respectively).
- Stage 6 is a lateral extension to the north of stages 1,2,3,4 & 5.

Refer to Figure 7, Figure 8 and Figure 9.

Figure 7: Embankments side profile

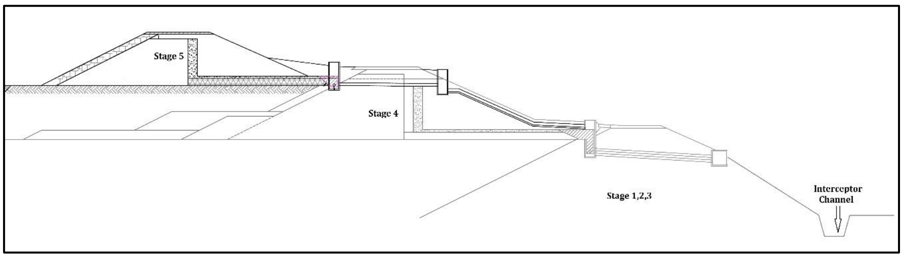

Figure 8: Cross section – extant facility embankment

The proposed buttress, to be constructed on the downstream slope of and at the crest of the Stage 1, 2 and 3 starter Embankments, see Figure 9, will provide additional support to the Stage 4 dam embankment wall in order to increase the overall stability of the upstream raises i.e. Stage 4 and Stage 5.

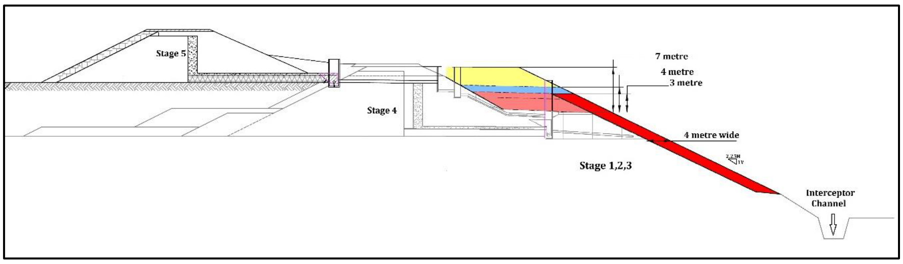

Figure 9: Cross section – facility embankment with buttress

2.1.2 Factor of Safety (FoS)

BTM has undertaken a comprehensive liquefaction assessment using Cone Penetration Tests (CPT) and laboratory testing on the existing tailings.

As with all loose tailings, the tailings at Randalstown could potentially liquefy either during dynamic or static liquefaction.

- Dynamic liquefaction occurs as a result of seismic activity, the risk of which is very low in Ireland.
- Static liquefaction occurs when the dam wall has already failed for other reasons and the tailings statically liquefy under the large strains as a result of loss of confinement.

In engineering, a factor of safety (FoS) indicates how much stronger a structure actually is compared to what it needs to be for an intended load.

The original facility design and stability analyses were undertaken using effective strength parameters and monitored piezometric levels in the stack wall which is the traditional procedure. The facility was originally designed and assessed to meet a target design criterion for long-term static slope stability of FoS > 1.5.

However, current industry best practice is to evaluate the stability using peak undrained shear strengths and with further analysis using residual undrained shear strengths. Tailings undrained strength parameters simulates excess pore pressure within the tailings and is therefore, a more conservative analysis.

The undrained stability analysis indicates that a buttress is required at the toe of the Stage 4 embankment to achieve a factor of safety of 1.5 based on peak undrained shear strength of the fine tailings.

The buttress will provide additional support to the Stage 4 dam embankment wall in order to increase the overall stability of the upstream raises i.e. Stage 4 and Stage 5.

For the stability analysis based on residual undrained shear strength, the buttress size will need to be increased in height to achieve the required factor of safety of 1.1. In order to achieve this increase in height, it is necessary to construct a buttress to the starter dam to facilitate the further increase in height.

It has been determined that the addition of a rock fill buttress at the downstream toe of the Stage 4 dam would meet the necessary requirements (endorsed by Independent Tailings Review Board (ITRB)).

- The minimum required FoS of 1.5 is achievable for all static and seismic loading conditions and all failure surface locations when the peak undrained strength of the tailings was considered.
- In order to meet the FOS of 1.1 for the residual undrained strength scenario the analysis indicated that a 4 m wide buttress to the starter dam is required for the majority of the perimeter wall. At the starter dam crest level, the height of the buttress will vary between 3 and 7 m.

The proposed buttress will be approximately 12 m wide at the base and will have an outer slope of 1 V : 2.75 H. This slope will be similar to the downstream slope of the Stage 4 dam wall as well as the downstream slope of the Starter Dams (Stages 1, 2 and 3) at most locations. It should be noted that where the Starter Dam height is greater than 14 m, the slope will be 1 V : 2.5 H. In these scenarios, the outer slope of the buttress will match the more shallow slope of the Starter Dam.

The proposed buttress would be sequenced in two phases, which may run concurrently. The works will commence at the eastern extremity of the site and proceed westward):

- Phase I will proceed on a horizontal basis along Stage 4 of the tailings dam. Works will begin at the level of the toe of the Stage 4 upstream raise against the embankment wall and will vary between 3, 4 and 7 metres in height. The material will be placed in layers along 500m sections, with each 500 m section taking approximately one month to complete. It is envisaged that the Phase I works will take approximately 30 weeks; and
- Phase 2 will proceed on a horizontal basis at ground level against the embankment wall of stages 1,2 and 3 (starter dams). The material will be placed in layers along 500m sections, with each 500 m section taking approximately one month to complete. It is envisaged that the Phase 2 works will take approximately 80 weeks.

Construction quantities:

Rock Fill (m3)	Soil (m3)	Total (m3)
265,690	295,650	561,340

2.2 Plan and Construction Sequence

The following items are designed and specified for the Works and are listed in order of the proposed

2.2.1 Sequence of Works.

1) Preparatory Works including cleaning the crest of the Starter Dams, removal of any topsoil, shrubs / scrub from the side-slopes over the footprint of the proposed buttress and to facilitate plant access; and
2) Installation of the Phase 1 Buttress (toe of stage 4)
3) Installation of the Phase 2 Buttress (at ground level starter embankments)

2.2.2 Preparatory Works

Accommodation of Monitoring Instrumentation

The construction of the buttress will require the extension or otherwise accommodation of a number of geotechnical instruments which will be impacted by the works. These instruments include Casagrande standpipes, environmental monitoring wells, vibrating wire piezometers and flow measurement weirs.

2.2.3 Clearance of Work Areas

The proposed Phase 1 buttress overlies the crest of the Starter Dams, (Stages 1, 2 and 3). The crest of this road includes a layer of rockfill material as capping and surface dressing. It is proposed that this material be salvaged where possible and where the quality of the material permits. This shall be done by either stockpiling the material temporarily for re-use or preferably, through the re-use of the material as a capping layer on a section where the buttress works have already been completed.

Removal of topsoil from the footprint of the area adjacent to the crest road, i.e. the area above the Stage 4 toe drain and the Stage 4 slope shall be completed prior to commencement of the buttressing works.

For the Phase 2 buttress, it will be necessary to remove the topsoil from the entirety of the starter dam perimeter slope as well as the footprint of the buttress at the toe.

Topsoil shall be either stockpiled temporarily for re-use or preferably, through the direct re-use of the topsoil on sections where the buttressing works have already been completed. Following excavation to the Formation Level, the footprint will require trimming, grading and compaction prior to the placement of the compacted fill. The final excavated surfaces shall be trimmed and rolled to provide a clean, even and firm foundation to permit the movement of construction vehicles without causing rutting or other deleterious effects. Benching will be employed where buttress materials are being placed onto slopes to ensure that a sufficient key-in is achieved between the buttress and the dam walls.

A specified number of passes of a suitable vibratory roller will be required for the underlying soils. Soft spots and areas of unsuitable materials identified shall be excavated and replaced with suitable material placed and compacted and / or shall be improved *in-situ* via compaction or the installation of appropriate geosynthetics as approved by the engineer.

As part of the Phase 1 buttress construction works, the material which overlies the Stage 1,2 and 3 chimney drains shall be removed intermittently. This will allow sub-surface water drainage in the section to drain into the Stage 1, 2 and 3 chimney drain. This water will then report into the Perimeter Interceptor Channel (PIC) and from there will be returned back to the tailings facility.

3 Potential impacts of proposed works on existing biodiversity

The walls of the Tailings Storage Facility are largely comprised of a complex mosaic of seminatural grassland habitats supporting a wide range of species of plant. Temporary disturbance of these habitats is unavoidable owing to the nature of the works. The primary potential medium – long-term impacts of the proposed works relates to the (inappropriate) management of the habitat post-works primarily:

- **Inappropriate seeding of the habitat**- Reseeding the area with aggressive, nutrient -hungry species such as *Lolium perenne* which make up the primary components of commercial grass mixes. Fertiliser application, which is required for the viability of nutrient-hungry, aggressively growing commercial grass species such as *Lolium perenne*, results in increased nutrient availability for plants, with the result that a low number of fast-growing species compete for light, eliminating less competitive plants and thereby greatly reducing floral biodiversity[1]. A study of lowland agricultural grassland in the UK[2] defined farms with annual fertilisation rates of greater than 50 kg N ha-1 as “Moderately Intensive”. Indeed, an examination of the impact of nitrogen on species richness of grasslands[3] found that there was a reduction of one plant species for every 2.5 kg ha-1 year-1 of nitrogen deposited. Fertiliser regimes required to maintain a commercial sward would inevitably have a significant negative impact on floral biodiversity, with concomitant impacts on the biodiversity of fauna occurring;
- **Inappropriate grazing of the habitat** - The semi-natural grassland is currently almost exclusively grazed by a population of small herbivores – largely Rabbit and Irish Hare. Inappropriately grazing as a component of any management would have serious negative implications for the biodiversity of the habitats. For example, inappropriately-timed grazing would prevent seed-set of any forbs occurring within the habitat, limiting grassland ecosystem functioning, while inappropriate species grazing could have similar impacts. A recent paper[4] discussed the importance of livestock type over intensity of grazing for conservation. The results indicate that grazing by sheep, regardless of intensity, resulted in lower multi-trait functionality, with mostly forb species disappearing from vegetation communities

[1] Plantureux S, Peeters A and McCraken D (2005). Biodiversity in intensive grasslands: effect of management, improvement and challenges. Proceedings of the 13th International Occasional Symposium of the European Grassland Federation, Tartu, Estonia, 29-31 August 2005
[2] Tallowin J, Smith R, Goodyear and Vickery J (2005). Spatial and structural uniformity of lowland agricultural grassland in England: a context for low biodiversity. Grass and Forage Science, 60, pp 225 – 236.
[3] Stevens C, Dise N, Mountford J and Gowing, D (2004). Impact of nitrogen deposition on the species richness of grasslands. Science, 303, pp 1876–1879.
[4] Toth E, Deak B, Valko O, Kelemen A, Milgecz T, Tothmeresz B Torok P (2018). Livestock type is more crucial than grazing intensity: traditional cattle and sheep grazing in short-grass steppes. Land Degradation and Development, 29, pp 231 - 239

owing to selective grazing. There are numerous studies corroborating this finding[5]. In addition to an impact on floral biodiversity, sheep grazing has been shown to have negative impacts on invertebrate populations, in particular pollinators such as bees – relative to cattle-grazing[6]. In order benefit invertebrate biodiversity in addition to overall biodiversity requires the promotion of plant species richness (both grass and forb) and sward architectural complexity[7]. Grazing, even at low stocking density, by cattle or sheep would impact on the biodiversity of this habitat.

[5] Pavlu L, Pavlu V and Fraser D (2021). What is the effect of 19 years of restoration managements on soil and vegetation on formerly improved agricultural grassland? Science of the Total Environment, 755, 142469.
[6] Carvell C (2002). Habitat use and conservation of Bumblebees (Bombus sp) under different management regimes. Biological Conservation, 130(1), pp 33 - 49
[7] Woodcock B, Potts S, Tscheulin T Pilgrim E, Rasmsey A, Harrison-CrippsJ, Brown V and Tallowin J (2009). Responses of invertebrate trophic level, feeding guild and body size to the management of improved grassland field margins. Journal of Applied Ecology, 46, pp 920 – 929.

4 Conservation Priorities and Management of Habitats and Biodiversity

4.1 Primary Conservation Priority – River Boyne and River Blackwater SAC/SPA

4.1.1 Description

Although separated from the site of the proposed works by approximately 1.5 km, the River Blackwater is connected to the site of the proposed works by a Source-Pathway-Receptor linkage. The River Blackwater is one of the primary constituents of the River Boyne and River Blackwater SAC/SPA, which is a site of international importance.

Otter, a Qualifying Interest of the River Boyne and River Blackwater SAC occur adjacent to the proposed works and were captured on camera utilising the Simonstown Stream (which discharges to the River Blackwater).

Figure 10: Trail camera footage of Otter recorded using the Simonstown Stream

Kingfisher, the Qualifying Interest of the River Boyne and River Blackwater SPA also utilise the habitats occurring adjacent to the proposed works, with Kingfisher also recorded along the Simonstown Stream, which discharges to the River Blackwater.

Figure 11: Kingfisher occurring along Simonstown stream

4.1.2 Conservation Priorities – River Boyne and River Blackwater SAC/SPA

The primary conservation priorities as regards the River Boyne and River Blackwater SAC/SPA must be:

- The proposed works have no significant negative impact on the conservation objectives of the qualifying interests of the River Boyne and River Blackwater SAC/SPA; and
- The proposed works should have no negative impact on species occurring within the River Boyne and River Blackwater SAC/SPA but for which that Natura site has not been listed (for example, Whooper Swan).

4.1.3 Management

The primary management pertaining to the River Boyne and River Blackwater SAC/SPA is to avoid/prevent any negative impact. The primary impacts identified in the EIAR (and NIS) prepared in association with the proposed development regards the potential for impacts on water quality and potential disturbance impacts during construction. Chapter 7 of the EIAR (Hydrology and Hydrogeology) details potential impacts and mitigation measures. All mitigation and monitoring as highlighted in Chapter 7 of the EIAR (and NIS) must be implemented.

4.1.3.1 Management to prevent impacts on water quality during construction

There will be a considerable quantity of construction work, primarily earth moving, etc. during the construction phase. A detailed suite of mitigation measures/monitoring are outlined in Chapter 7 of the EIAR, the objective of which is to prevent any impacts of the proposed works on water quality/hydrology during all phases of the proposed development.

4.1.3.2 Management to prevent disturbance of Qualifying Interests during construction activities

The fauna utilising the Simonstown Stream, including Otter and Kingfisher, are habituated to the regular construction noises taking place in the vicinity of the water-course associated with the day-to-day workings in the industrial setting. In order to prevent any disturbance, the construction works must be limited to the walls of the Tailings Storage Facility itself, with no activity taking place within the ecological corridor (hedgerow/treeline) associated with the water courses.

4.1.3.3 Management to prevent disturbance of non-Qualifying Interests during construction activities

An internationally important population of Whooper Swan utilise the Tailings Management Facility each year (albeit with large inter and intra-annual variation). With numbers peaking in November/December. These birds are habituated to vehicles and the regular construction noises taking place in the vicinity of the Tailings Management Facility associated with day-to-day workings in the industrial setting. The birds are, however, sensitive to disturbance by persons (individuals walking, not in vehicles) in the immediate vicinity. In order to prevent any disturbance, the construction works must be limited to the walls of the Tailings Storage Facility itself, with no activity taking place where birds habitually roost. The Whooper Swan population should be monitored on a bi-monthly basis (pre-dawn, noon and post-sunset) between October and March inclusive both during construction and post-construction for a minimum period of three years.

4.2 Conservation priorities – seminatural grassland habitat occurring

4.2.1 Description

The existing walls of the embankments largely comprise seminatural grassland of a mosaic of types, depending on the existing environmental conditions. For example, in the vicinity of the Interceptor Ditch, areas of wet grassland (GS4) occur, while on south-facing slopes the grassland could be categorised as GS1, and indeed a high number of orchids, including Common Spotted Orchid and Bee Orchid occur here. The heterogenous mosaic of habitats supports an abundance of avifauna – most notably Skylark, Meadow Pipit and Yellowhammer. The diversity of raptor species alone noted utilising the habitat during previous surveys (Peregrine Falcon, Kestrel, Sparrowhawk and Buzzard) would indicate that there is a diverse and healthy assemblage of avifauna present.

4.2.2 Conservation Priority – seminatural grassland and supported species

The primary conservation priority as regards grassland habitat mosaic and supported species should be:

- To maintain the current biodiversity value of the grassland habitats in the medium to long-term in terms of flora, resident fauna and overwintering avifauna. While an extensive amount of reprofiling works etc. are required during the construction phase, there is a seed-bank within the existing soil that will allow the area to be recolonised naturally post works. The maintenance of the floral/habitat biodiversity will maintain the diversity of fauna.

4.2.3 Management of grassland habitats

Grassland of virtually any type in Ireland requires management, as the climax vegetation across much of the country is woodland and there is a natural succession through scrub to woodland in the absence of management. Management of grassland habitats in general can be achieved through grazing or mowing or a combination of both. The form of management used can have marked impacts on the biodiversity, ecosystem services and ecological integrity of the grassland. There have been extensive losses of semi-natural grassland cover in Europe. For example, recent research[8] undertaken in Sweden has calculated that "less productive" semi-natural grassland cover decreased by over 96 % in the study

[8] Sara A, Cousins O, Auffret A, Lindgren J and Tränk (2015). Regional-scale land-cover change during the 20th century and its consequences for biodiversity. *Ambio*, **44 (Supplement 1)**, S17 – S27.

area (1652 km^2) during the 20^{th} Century. Intensification of agriculture and alteration of management practices have had a profound negative impact on biodiversity[9] and the ecosystem services provided by these habitats[10]. Notably a wholistic approach to grassland management must be undertaken in order to support overall biodiversity rather than concentrating on one species or species group[11] as this can result in unforeseen negative consequences on overall biodiversity. Indeed, agricultural intensification is considered to be the primary driver of biodiversity decline in Europe[12], [13].

The proposed works necessitate the disturbance and temporary removal of the habitat. It is, therefore, imperative, from the point of biodiversity supported, ecosystem services provided, and the ecological integrity of adjacent habitats, that the seminatural grassland habitat occurring along the existing embankments be treated in an ecologically sensitive manner during construction and permitted to regenerate naturally into species-rich semi-natural grassland through appropriate management.

4.2.3.1 Passive vs Active Restoration of grassland habitat

Broadly, there are two types of grassland restoration practices - active and passive[14].

- Active restoration such as reseeding, etc.; and
- Passive restoration, which relies on natural colonization

Active restoration, comprising reseeding the area with seed mixes requires numerous inputs (man hours, fuel for tractors, likely fertiliser, water, etc.), and will almost certainly utilise seed mixes containing non-native species. In addition, the quantity of seed required would indicate that the seed will be of non-native (or questionable) provenance.

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[9] Krauss J, Bommarco R, Guardiola M, Heikkinen R, Helm A, Kuussaari M, Lindborg R, Ockinger E, et al. (2010). Habitat fragmentation causes immediate and time-delayed biodiversity loss at different trophic levels. *Ecology Letters*, **13**, pp 597–605.

[10] Tscharntke T, Klein A, Kruess A, Steffan-Dewenter I and Thies C (2005). Landscape perspectives on agricultural intensification and biodiversity—Ecosystem service management. *Ecology Letters* **8,** pp 857–874.

[11] Tanis M, Marshall L, Beismeijer J and van Kolfschoten L (2020). Grassland management for meadow birds in the Netherlands is unfavourable to pollinators. *Basic and Applied Ecology*, **43**, pp 52 - 63

[12] Potts S, BiesmeijerJ, Kremen C, Neumann P, Schweiger O, and Kunin W (2010). Global pollinator declines: Trends, impacts and drivers. *Trends in Ecology & Evolution*, **25(6)**, pp 345–353.

13 Potts S, Imperatriz-Fonseca V, Ngo H, Aizen M, Biesmeijer J, Breeze T, . . . and Vanbergen A (2016). Safeguarding pollinators and their values to human well-being. *Nature*, 540(7632), 220.

[14] da Silva T, Lindenmayer D and Seurtegarary Fontana C (2019). Passive restoration contributes to bird conservation in Brazilian Pampa grasslands. *Journal of Field Ornithology*, **90(4)**, pp 295 - 308

The most sustainable, cost-effective and natural way to ensure the regeneration of a seminatural grassland comprised of native species **with native provenance** is through passive restoration, under which conditions vegetation communities most suited to the environmental conditions present will develop in the absence of any external inputs.

Even after centuries of cultivation in Europe, it has been demonstrated that semi-natural grasslands can be restored with passive restoration[15]. The success and speed at which passive restoration can be achieved is dependent on a number of factors[16] including two primary factors:

1) The availability of sufficient propagules; and
2) The influence of grazing management.

The vegetation occurring comprises a mosaic of semi-natural grassland types. This would indicate that there is a plentiful supply of sufficient propagules in order to satisfy the requirements of passive recolonisation in the existing soil. This site is unlikely to require passive measures such as sod transfer or hay transfer, often utilised in lowland grassland restoration[17]. Thus, the first condition required for passive restoration of semi-natural habitats is fulfilled.

The second major factor that determines the success and speed at which passive restoration can proceed is management.

4.2.3.2 Management of grassland habitat to achieve passive restoration

Invertebrates are key to the ecological integrity of grassland habitats and *vice-versa*[18]. In addition to being a fundamental component of a healthy grassland ecosystem, an abundance of invertebrates within grassland habitat is required for the successful breeding of birds such as Yellowhammer[19].

The vast majority of grassland in Ireland is managed either through intensive grazing or intensive cutting (for silage). This intensive agricultural practice results in rapid changes to sward structure, etc., causing an immediate, drastic change, which impacts negatively on invertebrate biodiversity. Invertebrates are particularly sensitive to environmental change for a number of reasons, including:

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[15] Ruprecht E ((2006). Successfully recovered grassland: A promising example from Romanian Old-fields. *Restoration Ecology*, **14(3)**, pp 473 - 480

[16] Fenshaw R, Butler D, Fairfax R, Quintin A and Dwyer J (2016). Passive restoration of subtropical grassland after abandonment of cultivation. *Journal of Applied Ecology*, **53**, pp274 - 283

[17] Sengl P, Magnes M, Weitenthaler K, Wagner V, Erdos L and Berg C (2017), Restoration of lowland meadows in Austria: A comparison of five tenchiques. *Basic and Applied Ecology*, **24**, pp 19 – 29.

[18] Eisenhauer N, Milcu A, Allan E, Mitschke N, Scherber C, Temperton V, Weigelt A, Weisser W and Scheu S (2011). Impact of above and below ground invertebrates on temporal and spatial stability of grassland of different diversity. *Journal of Ecology*, **99**, pp 572 - 582

[19] Dunn J, Hamer K and Benton T (2010). Nest and foraging site selection in Yellowhammers *Emberiza citrinella*: implications for chick provisioning. *Bird Study*, **57**, pp 531 – 539.

- The majority of invertebrates have an annual life cycle and lack long-term resting stages. Disruption of this annual cycle can cause a species to become locally extinct;
- The life cycle of invertebrates can be very complex (for example metamorphosis) with different life stages requiring different habitats – rapid habitat change can deprive a species of resources at a key life stage;
- Many invertebrate species are highly specialised – for example many Butterflies will only lay eggs on one species of larval food-plant – if this food plant is not present during the peak of the egg-laying season, the species can become locally extinct;
- Many species of invertebrate are dependent on variation in microclimates within a vegetation mosaic – mowing can result in a homogenous sward structure, depleting microclimate niches;
- Many species of invertebrate at various life stages are physically or behaviourally ill-adapted to escape rapid environmental change – for example caterpillar versus butterfly.

Vegetation structure (for example sward height, presence of tussocks, etc.) is, therefore, as important to invertebrate biodiversity as vegetation composition (plant species diversity). Even short periods of adverse environmental conditions (for example if the works were carried out within a short space of time affecting the entire habitat present), can result in local extinctions of populations of invertebrates. Fundamental to successfully managing seminatural grassland for the benefit of vegetation, invertebrate communities and those species dependent on them is to manage the habitat both temporally (timing) and spatially (where).

One of the key conservation priorities for the habitat occurring concerns the provision of suitable conditions to support the rich assemblage of avifauna occurring. it must be considered that the requirements of lowland birds as regards grassland habitats differ from season to season. For example, species such as Skylark and Yellowhammer require an abundance of cover and invertebrate prey to provide for foraging chicks[20]. The maintenance of the grassland as is present currently provides a vast supply of plant seeds and invertebrates associated with such habitat, benefiting species such as Yellowhammer, which require supplies of both seeds and invertebrates during the breeding season and which may have broods to feed beyond August.

[20] Franks S, Roodbergen M, Teunnisen W, Carrington Cotton A and Pearse-Higgins J (2018). Evaluating the effectiveness of conservation measures for European grassland-breeding waders. *Ecology and Evolution*, **8**, pp 10555 - 10568

4.2.3.3 Short-term management

The proposed works necessitate the removal of the existing seminatural grassland habitat in the short-term. The primary short-term management must aim to minimise disturbance to fauna utilising this habitat. The reprofiling of the dam walls will cause short-term disturbance as regards both flora and fauna (especially as regards invertebrates[21], which are particularly prone to impacts from acute disturbances such as reprofiling/topsoil disturbance). The optimal management in the short term is to avoid the occurrence of "Catastrophic events" by undertaking the removal of habitat in a phased manner.

In order to provide a "Core" population of both invertebrates and plants to repopulate post-works (in addition to the seed bank currently present), the works should be restricted to the area above the interceptor ditch. There is a significant area of semi-natural grassland associated with the area outside of the interceptor ditch that should be retained undisturbed. This area will provide a *refugia* for both flora and fauna during construction works, providing a core population of plants and invertebrates that will not be disturbed during the works.

The works will be undertaken on a phased basis and will commence at the eastern extremity of the site and proceed westward):

- Phase I will proceed on a horizontal basis along Stage 4 of the tailings dam Works will be at the level of the toe of the Stage 4 upstream raise against the embankment wall of Stage 4. These works will vary between 3, 4 and 7 metres in height. The works will be undertaken in 500m stretches, with each 500 m stretch taking approximately one month to complete. It is envisaged that the Phase I works will take approximately 30 weeks; and
- Phase II will proceed on a horizontal basis at ground level against the embankment wall of stages 1,2 and 3 (The starter dams). These works will extend to 4 metres in height. The works will be undertaken in 500m stretches, with each 500 m stretch taking approximately one month to complete. It is envisaged that the Phase I works will take approximately 80 weeks.

The existing soil will require to be removed prior to the placement of rock-armour. This soil is an invaluable source of seeds and perhaps even more importantly, mycorrhizal fungi, that must not be lost. Along each 500m stretch, the sod will be removed intact where possible, stored on heavy gauge polythene sheets and reinstated following the completion of works along the 500m stretch. Where it is not possible to remove the sod intact, the organic layer (soil and vegetation) will be scraped from

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[21] Nkem J, de Bruyn L and King K (2019).The effect of increasing topsoil disturbance on surface-active invertebrate composition and abundance under grazing and cropping regimes on vertizols in North-West New South Wales, Australia

the surface and stored on heavy gauge polythene sheets to redistributed evenly on surface of the dam walls following the completion of works. By proceeding in 500m stretches, the length of time each stretch will be disturbed will be minimised (approximately one month per 500m stretch from removal of the topsoil/sod to reinstatement). Where the material is removed by scraping (as opposed to removal of the intact sod), the material should be covered with heavy gauge polythene while being stored to prevent the material from washing away in heavy rainfall. These measures should be taken into account in the Construction Environmental Management Plan. The reinstatement of sod and/or scraped organic layer will minimise the time taken to re-establish the flora along the embankment slopes.

4.2.4 Management regime options for grassland habitat such as to address conservation priorities

The primary requirements to achieve a species-rich semi-natural grassland habitat that will support overall biodiversity and maintain ecological integrity in a sustainable fashion are:

- To suppress dominant species in the sward;
- To reduce competitive exclusion; and
- To create small-scale disturbances – providing regeneration niches for seed germination and establishment.

Management of grassland in Ireland is generally achieved by mowing or grazing.

4.2.4.1 Management through mowing

Management through appropriate mowing results in grasslands that are floristically rich, and mowing has been found to be the best long-term management regime to maintain semi-natural grasslands from a floristic point of view[22]. As regards a mowing only management strategy, however, there are several disadvantages that have an adverse impact on overall biodiversity and grassland ecosystem integrity as opposed to grazing[23].

There are several factors associated with grazing that are not replicated by mowing that are of key importance for species key to the ecological integrity of grassland systems. For example:

- Mowing does not create a network of bare patches, which are essential for regeneration;

[22] Tälle M, Fogelfors H, Westerberg L and Milberg P (2015). The conservation benefit of mowing vs grazing for management of species-rich grasslands: a multi-site, multi-year field experiment. *Nordic Journal of Botany*, **33**, pp 761 - 768

[23] Tälle M, Deak B, Poschlod P, Valko O, Westerberg L and Milberg P (2016). Grazing vs Mowing: A meta-analysis of biodiversity benefits for grassland management. *Agriculture, Ecosystems and Environment*, **222**, pp200 - 212

- Mowing cannot replicate the intricate structural mosaic of a sward produced by grazing (at low stocking densities) – mowing produces a uniform sward;
- Mowing is entirely non-selective, while grazing is selective, depending on the species;
- Mowing results in a more or less immediate and catastrophic removal of a large quantity of plant material, while grazing is a gradual process.

Under a mowing management regime, the lack of temporal and spatial heterogeneity and the occurrence of catastrophic events are not optimal for invertebrates or the species dependent on them. Given the Conservation Priorities of the grassland, management through mowing is not a viable option. In addition, the physical attitude of the site is not conducive to mowing.

4.2.4.2 Management through Grazing

The management of grassland can be achieved through grazing by large herbivores such as sheep and cattle, and indeed this is the management regime utilised throughout much of the Irish Agricultural landscape, even on semi-improved grassland. Although management through grazing can have beneficial impacts such as creating a network of bare patches and an intricate structural mosaic of a sward over a relatively long period of time, avoiding "Catastrophic" events, management through year-round grazing, even at low intensity[24] has negative impacts on floristic diversity, particularly on many rare species such as orchids[25]. Furthermore, grazing has a negative impact on ground-nesting bird species, including breeding waders through nest trampling[26]. Given the Conservation Priorities of the proposed grassland, management through grazing by large herbivores is not a viable option.

4.2.4.3 Optimal grassland management

The optimal management strategy for the seminatural grassland habitat currently present on the embankment walls of the Tailings Management Facility is grazing by small herbivores – the large population of rabbit and hare currently present. The optimal strategy for maintaining the seminatural grassland present post-restoration is, therefore, the continued presence of these species on site throughout the construction period and passive restoration.

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[24] Tälle M, Fogelfors H, Westerberg L and Milberg P (2015). The conservation benefit of mowing vs grazing for management of species-rich grasslands: a multi-site, multi-year field experiment. *Nordic Journal of Botany*, **33**, pp 761 – 768.
[25] Coates F, Lunt I and Tremblay R (2006). Effects of disturbance on population dynamics of the threatened orchid *Prasophyllum correctum* and implications for grassland management in south-eastern Australia. *Biological Conservation*, **129**, pp 59 – 69.
[26] Durant D, Tichit M, Kerneis E and Fritz H (2008). Management of agricultural wet grasslands for breeding waders: Integrating ecological and livestock system perspectives – a review. *Biodiversity and Conservation*, **17(9)**, pp 2275 – 2295.

4.2.5 Long term management goals of grassland habitats

Lowland grassland habitat has traditionally provided habitat for a range of birds including both resident species and overwintering species – one of the primary drivers for the decline in lowland grassland birds is agricultural intensification of grassland ecosystems[27, 28]. The semi-natural grassland habitat that is present on site, and that will be restored on site post-works is a valuable resource, providing a "Stepping Stone" of habitat for numerous species of conservation concern, including many breeding species that have become relatively rare, or have significantly declined, such as Kestrel, Lapwing, Skylark, Meadow Pipit, Yellowhammer and Curlew (most of which already breed at, or in the *environs* of the site).

The dramatic declines in lowland grassland areas and the species associated with these habitats are as a result of the loss of semi-natural grassland and replacement with modern, intensive agricultural practices. The management regime outlined will ensure the long-term persistence of the species-rich habitat and the numbers/diversity of invertebrates, providing suitable conditions for large, long-lived invertebrates and the species dependent on these resources.

In order to assess and monitor the development of habitats post-works, a system of fixed 2m X 2m quadrats should be established pre-works and these quadrats monitored post-works on an annual basis for a minimum of five years post-construction in order to monitor the success of mitigation measures. These quadrats should be located along both a vertical axis (with at least three quadrats interspersed along the slope) and a horizontal axis (at approximately 300 – 500m intervals). The comparison of pre- and post-works quadrats will give a measure of the success of restoration measures and inform the management as to whether additional measures such as the addition of green hay are required.

[27] Buckingham D, Peach W and Fox D (2006). Effects of agricultural management on the use of lowland grassland by foraging birds. *Agiculture, Ecosystems and Environment*, **112**, pp 21 - 40
[28] Barnett P, Whittingham M, Bradbury R and Wilson J (2004). Use of unimproved lowland grassland by wintering birds in the UK. *Agriculture, Ecosystems and the Environment*, **102**, pp 49 – 60.

5 Protected species -conservation priorities and management

5.1 Otter –

5.1.1 Conservation Priorities

Otter utilise the Simonstown Stream (which discharges to the River Blackwater) immediately adjacent to the proposed works. The conservation priority for this species must be in line with the NPWS conservation objectives for this species, i.e., to maintain the favourable conservation status of the species. Of note, the long-term protection of water quality will be improved through an increase in the "Factor of Safety", further minimising the risk of any potential dam breach.

5.1.2 Management

Otters are a "Multiple-habitat" utilising species. Although a riparian mammal, Otter can have an extensive home range, of the order of tens of kilometres. Otter are a flagship conservation species, and it is essential that habitat suitable for Otter be managed in such a way as to prevent any negative impacts on this species. The proposed works must be restricted to that area upstream (i.e., above) the interceptor ditch and the downstream slope of and at the crest of the Stage 1, 2 and 3 Starter Embankment to prevent disturbance to this Annex II animal.

5.2 Kingfisher

5.2.1 Conservation Priorities

Kingfisher utilise the Simonstown Stream immediately adjacent to the proposed works. The conservation priority for this species must be in line with the NPWS conservation objectives for this species, i.e., to maintain the favourable conservation status of the species. Of note, the long-term protection of water quality will be improved through an increase in the "Factor of Safety", further minimising the risk of any potential dam breach.

5.2.2 Management

Kingfisher, like Otter, are a flagship conservation species, and it is essential that habitat suitable for Otter be managed in such a way as to prevent any negative impacts on this species. The proposed works must be restricted to that area upstream (i.e., above) the interceptor ditch and the downstream slope of and at the crest of the Stage 1, 2 and 3 Starter Embankments to prevent disturbance of this Annex I bird species.

5.3 Irish Hare

5.3.1 Conservation Priorities

There is a considerable population of Irish Hare (*Lepus timidus hibernicus*) currently occurring within the Tailings Management Facility. The conservation priority for this species is to maintain the population levels of the species within the facility as this species is one of the primary grazers managing and maintaining the grassland. The primary threat to the continued presence of this species is increased disturbance.

5.3.2 Management

The proposed works necessitate the removal of the existing seminatural grassland habitat. The primary short-term management must aim to minimise disturbance to fauna utilising this habitat, including Hare. The reprofiling of the dam walls will cause short-term disturbance. The optimal management as regards this species is to avoid the occurrence of “Catastrophic events” by undertaking the removal of habitat in a phased manner. In order to provide a “Core” population of both invertebrates and plants to repopulate post-works (in addition to the seed bank currently present), the works should be restricted to the area above (upstream of) the interceptor ditch. There is a significant area of semi-natural grassland associated with the area outside of the interceptor ditch that should be retained undisturbed. This habitat will provide a *refugia* for both flora and fauna during construction works, providing a core habitat for this species that will not be disturbed during the works.

5.4 Bats

5.4.1 Conservation Priorities

All Irish bat species are protected under both European and Domestic legislation. All bats occurring in Ireland are listed on Annex IV of the EU Habitats Directive. Plants and animals listed on Annex IV of the Habitats Directive are strictly protected wherever they occur. Under Irish Law (Irish Wildlife Act 1976 and Wildlife (Amendment) Act 2000) it is a criminal offence to intentionally harm or disturb a bat in its place of rest. The conservation priority regarding bats is, therefore, to ensure that there are no negative impacts associated with the proposed works.

5.4.2 Management

The proposed works necessitate the removal of the existing seminatural grassland habitat and short-term loss of invertebrates using this habitat, which are preyed upon by bats. The primary short-term management must aim to minimise disturbance to invertebrate fauna utilising this habitat, minimising the impact on foraging bats (there are no suitable roosting sites occurring within the habitat). The reprofiling of the dam walls will cause short-term disturbance. The optimal management as regards invertebrates, and thus foraging bats, is to avoid the occurrence of “Catastrophic events” by undertaking the removal of habitat in a phased manner. In order to provide a “Core” population of both invertebrates and plants to repopulate post-works (in addition to the seed bank currently present), the works should be restricted to the area above (upstream of) the interceptor ditch. There is a significant area of semi-natural grassland associated with the area outside of the interceptor ditch that should be retained undisturbed. This area will provide a *refugia* for both flora and fauna during construction works, providing a core habitat for foraging bats that will not be disturbed during the works.

5.5 Other species of conservation concern

There are numerous species of conservation concern observed on site and in the *environs* (for example Yellowhammer, Skylark, Meadow Pipit, Kestrel, Peregrine Falcon, Pygmy Shrew, Pine Marten, Badger). The restoration of the grassland habitat post-works and management of the habitats concerned will indirectly benefit biodiversity in general.

5.5.1 Conservation Priorities

The primary conservation priority as regards the species of conservation concern occurring within/adjacent to the proposed works is to provide suitable habitat for these species.

5.5.2 Management

The habitat management measures as outlined will provide near-optimal conditions for these species on site.

6 Invasive Alien Plant Species

There are more than 30 species listed on Part 1 of the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations of 2011. Of these species, none occur within the habitats occurring in the Tailings Management Facility. NDBC records indicate that a minimum of three are found within the vicinity of the facility:

- Himalayan Balsam (Impatiens glandulifera);
- Japanese Knotweed (*Fallopia japonica*); and
- Himalayan Knotweed (Persicaria wallichii).

The management priority as regards these Alien Invasive Plant species is the implementation of a comprehensive Alien Invasive Plant Species Management and Control Plan with the primary goal of preventing the importation of any such species to the site during the construction phase, which comprise an integral component of the CEMP for the site.

7 Summary

The goal of the proposed buttressing works is to increase the Factor of Safety to:

- >/=1.5 for the peak strength undrained scenario; and to
- >/= 1.1 for the residual strength undrained scenario which is now required.

The increased Factor of Safety will further reduce any risk of a dam breach in the future, thus protecting surrounding water-quality, habitat quality and the conservation objectives of the Qualifying Interests of the River Boyne and River Blackwater SAC/SPA.

The primary conservation priorities informing the Habitat and Biodiversity Management Plan for the works should ensure that:

- The proposed works have no significant negative impact on the conservation objectives of the qualifying interests of the River Boyne and River Blackwater SAC/SPA;
- The proposed works have no significant negative impact on species that are not Qualifying Interests but are key to the ecological integrity of the site (for example Whooper Swan);
- The post-works seminatural grassland habitat will be of equal or enhanced biodiversity value to the habitats currently present; and
- Ongoing monitoring will ensure that the habitats occurring continue to provide “stepping stones” of habitat for species of conservation concern, particularly breeding birds Yellowhammer, Skylark and Meadow Pipit, all of which already occur at and adjacent to the site.

8 Monitoring

A monitoring regime must be implemented in order to assess the success of the management of the habitat restoration, and to iteratively alter the management if required (for example the use of green hay if necessary). An Ecological Clerk of Works (ECoW) must be appointed in advance of the proposed development to oversee the management of ecological risks on site and ensure that all mitigation measures as relating to ecological issues are implemented effectively on the ground. Monitoring will include (but may not be limited to):

1) Monitoring the development of the habitats within area of the works. In compliance with the Habitat and Biodiversity Management Plan, the area will be restored "Passively" – i.e., there will be no reseeding or fertilising of the habitat. This will maximise the opportunities for biodiversity. Monitoring of the progress of recolonisation will be required in order to inform the management plan as to whether additional measures, such as the importation and spread of "Green Hay", which is now commonly used in Europe in the passive restoration of species-rich seminatural grassland both on former arable land and former intensive grassland[29] are required. In order to monitor the progress of the development of the habitat, approximately 20 -30 2m X 2m permanent quadrats will established within the proposed grassland area (with pre-works relevés established) and these quadrats will be monitored on an annual basis in May/June recording the cover and abundance of all species present and photographing each quadrat from a fixed point for a minimum of five years post construction. This monitoring will permit the degree of success of the habitat restoration to be assessed, informing the management of the habitat as to whether additional measures are required;
2) The site is an important local site for breeding birds, supporting numerous species of conservation concern. Two breeding bird surveys separated by a minimum of two weeks should be undertaken annually within the zone of the works for a minimum of five years, such as to establish the degree of success of mitigation measures and to inform the management of the site; and
3) The Tailings Management Facility is an Internationally Important site for Whooper Swan. The use of the facility by this species should be monitored on a bimonthly basis (pre-dawn, noon and post-sunset) between the months October – March inclusive for a minimum of three years post construction in order to inform any management measures required to support the continued use of the habitat by this species.

[29] Wagner M, Hulmes S, Hulmes L, Redhead J, Nowakowski M and Pywell R (2020). Gren Hay transfer for grassland restoration: species capture and establishment. *Restoration Ecology*, **9.**

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- www.europa.eu – official website of the European Union, source of information on EU Directives.