Methodology Paper

for the Enhanced Decommissioning, Rehabilitation and Restoration on Bord na Móna Peatlands – Preliminary Study

Nov 2022 Version 19

Appendices

Appendix A: Cutaway peatland rehabilitation – standard approaches to meet EPA licence obligations. Examples/ Case Studies.

Appendix B: Cutaway peatland rehabilitation – Enhanced Approaches to Rehabilitation Examples/ Case Studies.

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List of Abbreviations

BoCCI	Birds of Conservation Concern in Ireland
CBS	Countryside Bird Survey
DECC	Department of the Environment, Climate and Communications
EC	Eddy-Covariance
EDRRS	Enhanced Decommissioning Rehabilitation and Restoration Scheme
EPA	Environmental Protection Agency
ER	Ecosystem Respiration
EU	European Union
F-Dom	Fluorescent Dissolved Organic Matter
GHG	Green House Gas
GPP	Gross Primary Production
GPR	Ground Penetrating Radar
IFI	Inland Fisheries Ireland
IPC	Integrated Pollution Control
IPCC	Intergovernmental Panel on Climate Change
IVC	Irish Vegetation Classification
LiDAR	Light Detection and Ranging
LULUCF	Land Use Land Use Change and Forestry
NBDC	National Biodiversity Data Centre
NEE	Net Ecosystem Exchange
NGO	Non-Governmental Organisation
NPWS	National Parks and Wildlife Service
NRRP	National Recovery Resilience Plan
PCAS	Peatlands Climate Action Scheme
POC	Particulate Organic Carbon
RES-E	Renewable Energy Source – Electricity
RRF	Recovery and Resilience Facility
SAC	Special Area of Conservation
UNEA	United Nations Environment Assembly
WFD	Water Framework Directive

1. Executive Summary

The Enhanced Decommissioning Rehabilitation and Restoration Scheme (EDRRS) was approved by the Government in November 2020. The Scheme encompasses work on approximately 33,000 hectares of Bord na Móna peatlands, spanning 82 bogs, previously harvested for peat extraction for electricity generation. Funding for the scheme of €108 million is secured through the EU Recovery and Resilience Facility (RRF), the key instrument at the heart of NextGenerationEU. At a national level, this funding is administered through Ireland's National Recovery Resilience Plan (NRRP). The objectives of the EDRRS are to rehabilitate these peatlands so that the improvements optimise climate, environmental, ecological and hydrological impacts. In undertaking this work, Bord na Móna is reassigning employees from peat harvesting activities into rehabilitation operations which aids Just Transition.

The Scheme is administered by the Department of the Environment, Climate and Communications (DECC) with the National Parks and Wildlife Service (NPWS) of the Department of Housing, Local Government and Heritage as the Regulator. Bord na Móna is the operator of the Scheme. Work under EDRRS began in early 2021 and the scheme will be completed by mid-2026, across 82 Bord na Móna owned bogs. A Memorandum of Understanding is in place between the two Departments and a set of Regulatory Controls has being agreed by all three parties.

This is a complex project, involving many diverse stakeholders including the Environmental Protection Agency (EPA), relevant NGOs (Non-Governmental Organisations) and local communities in addition to NPWS, DECC and Bord na Móna.

The purpose of this Methodology Paper is to:

- Clearly define Bord na Móna's obligated decommissioning and rehabilitation requirements under the existing Integrated Pollution Control (IPC) licences issued by the Environmental Protection Agency (EPA). For the avoidance of doubt, these costs reside exclusively with Bord na Móna and are not funded by the EU RRF.

- Clearly define the suite of enhanced improvements (additional decommission, rehabilitation and restoration), eligible to be supported *via* the EU RRF funding.

- Provide detailed descriptions and examples of both the obligated and enhanced activities. These descriptors serve a dual purpose. First, unambiguously defining improvements that are eligible for funding versus those that are not. Secondly, developing Integrated Pollution Control (IPC) Licence rehabilitation plans using the same nomenclature employed in this Methodology Paper ensures that there is alignment between the EDRRS enhanced improvements and the obligated requirements under the existing EPA licences.

- Provide the background and context for funding the enhanced improvements – including, but not limited to, Bord na Móna's *Brown to Green* Strategy, the socio-economic impact of the Just Transition in the Midlands, and opportunities afforded to Ireland in terms of flexibilities under the EU's Effort Sharing Regulation.

- Detail the benefits of delivering the enhanced improvements. These includes Climate Action benefits from Green House Gas (GHG) mitigation through reduced carbon emissions, carbon storage and accelerated carbon sequestration. The enhanced improvements will also enrich the State's natural capital, increase eco-system services, strengthen biodiversity, improve water quality and storage attenuation, develop the amenity potential of the peatlands as well as providing employment opportunities as part of a Just Transition in the Midlands.

- The enhanced improvements and associated enhanced monitoring program will also lead to the development of a best practice manual for future projects. As set out in the Regulatory Control for the Scheme, this manual will be prepared by Bord na Móna and peer reviewed by NPWS.

This Methodology Paper has been updated following the completion of one year of enhanced rehabilitation.

2. Introduction

2.1. Methodology Paper

Bord na Móna have obtained funding of €108m from the European Union Recovery and Resilience Fund (RRF) to develop a series of measures for the enhanced decommissioning, rehabilitation and restoration of peatlands formerly developed for peat production. The funding for the scheme is administered by the Department of Environment, Climate and Communications (DECC) and the scheme is regulated by the National Parks and Wildlife Services (NPWS). The scheme is referred to as the Enhanced Decommissioning, Rehabilitation and Restoration Scheme and will be referred to as EDRRS throughout this document. On the Bord na Móna website and in other documentation Bord na Móna also refer to EDRRS as the Peatlands Climate Action Scheme (PCAS), however EDRRS will be used throughout this document.

The fund for EDRRS also includes a robust monitoring program and will deliver benefits across climate action (GHG mitigation through reduced carbon emissions and acceleration towards carbon sequestration), enrich the State's natural capital, increase eco-system services, strengthen biodiversity, provide employment, improve water quality and storage attenuation as well as developing the future amenity potential of the peatlands It is expected that the scheme will also lead to the development of best practice guidelines for future projects.

At present, Bord na Móna is the only entity in the State licenced by the EPA for the harvesting and extraction of peat, however Bord na Móna formally announced the cessation of peat extraction in January 2021. Under its EPA licences and following cessation of peat extraction, Bord na Móna is mandated to decommission its operations by removing materials *'that may result in environmental pollution'* and establish that rehabilitation measures have environmentally stabilised peat production areas.

The existing costs associated with both the removal of potentially polluting materials and the environmental stabilisation of the peatlands resides with Bord na Móna. However, the expenditure necessary to deliver the additional and enhanced decommissioning, rehabilitation and restoration and the benefits that flow from these improvements will funded by EDRRS. As both the EPA licence-mandated interventions and the additional enhanced improvements may take place concurrently, it is necessary that there is an objective, transparent and unambiguous methodology to allocate the respective costs to Bord na Móna and the proposed funding.

This Methodology Paper sets out a detailed list and description of the interventions required to discharge Bord na Móna's EPA licence conditions. In addition, this Paper also sets out a detailed list and description for the additional enhanced decommissioning, rehabilitation and restoration measures supported by the proposed funding.

The Methodology Paper is a reference and guidance document for the support of the preparation of rehabilitation plans and other reports required by the EPA and NPWS. It is intended that this will be a living document that will be updated during the lifetime of the scheme to take account of any learnings gained from the implementation of the scheme.

2.2. Relationship between this Methodology Paper and the EDRRS Regulatory Controls

The controls to regulate the delivery of the scheme are as set out in the Regulatory Control Document and all associated documentation as listed in Annex 1 of the Regulatory Control Document. The structure for the delivery of the scheme is as per this Regulatory Control document. The Scheme shall also be operated in accordance with the Funding Agreement for the Enhanced Decommissioning, Rehabilitation and Restoration Scheme executed between the Minister for the Environment, Climate and Communications and Bord na Móna Energy Ltd.

The Regulatory Control document and the EDRRS Funding Agreement include details of the following regulatory requirements for the scheme:

- Submission of Condition 10 Plans to the EPA
- Preparation of Ex-ante budgets for submission to NPWS
- Delivery of the EDRRS improvements
- Preparation of Ex-post reports on completion of the improvements
- Certification of Bord na Móna's eligible costs and submission of grant claims for the scheme
- The responsibilities and roles of DECC, Bord na Móna and NPWS in the implementation of the scheme.

It is important to note that the timescale of EDRRS, from 2021 to 2026, will not be sufficient to demonstrate all the climate action benefits and co-benefits, i.e. actual reductions in GHG emissions, future sequestration, habitat and biodiversity gains, that the supported improvements will ultimately deliver. Therefore, during the lifetime of EDRRS, the objectives and deliverables will be those enhanced improvements (both decommissioning and rehabilitation) planned and implemented by Bord na Móna which are above those that would be required under the EPA licences. These will be reflected in the Greenhouse Gas and Biodiversity Indicators which are currently being established for the Enhanced Decommission and Rehabilitation improvements.

In addition, the EDRRS Funding Agreement respects Bord na Móna's role as a commercial semi-state company and its discretion, in line with national policy, to develop renewable energy and associated projects with national climate and sustainability objectives on its estate. In Section 11 of this Methodology Paper, the initial list of peatlands identified by Bord na Móna for inclusion in EDRRS are outlined. In accordance with the Scheme's Regulatory Controls, the exact areas and individual bogs may change however, it is intended that this will not negatively impact on the final aggregate area (32,779 ha) included in the scheme. While committed to the delivery of the Scheme, for the avoidance of doubt and without prejudice to the role of the Scheme regulator and existing statutory obligations, Bord na Móna will develop the rehabilitation plans in line with the regulatory controls; Bord na Móna will not be unilaterally directed, under the Scheme, to carry out Enhanced Decommissioning or Rehabilitation improvements on specific lands in its estate.

Finally, Section 7 of this Methodology Paper details the enhanced rehabilitation measures that have been, and will be, included as part of the programme and the rationale to determine where these Rehabilitation measures will be delivered.

2.3. Bord na Móna's transition away from harvesting Peat

Bord na Móna has now formally ended all peat harvesting on its lands and as part of the Brown to Green strategy, Bord na Móna is undertaking a number of highly significant actions in support of climate and energy policy. These actions involve a radical transformation and decarbonisation of nearly the entire Bord na Móna business; including approximately 33,000 ha of enhanced peatland rehabilitation identified specifically under this programme. In addition, Bord na Móna's pipeline of renewable energy projects, also to be developed on the estate, are aligned with Government climate and energy policies in relation to climate mitigation and adaption and will complement and co-exist on some sites with the proposed enhanced decommissioning and rehabilitation improvements described in this document. For the avoidance of doubt, no area developed for renewable energy projects (the specific renewable energy infrastructure footprint) will be subject to support from the scheme albeit they may lie on adjoining areas or within the same site. It is expected that climate action, ecosystem services and biodiversity will be the primary land use on peatlands rehabilitated under EDRRS, and that no other land uses will be integrated, unless deemed compatible, apart from some sites where the potential co-location of renewable energy and EDRRS measures have already been identified. If other national climate or sustainability objectives are proposed for an area rehabilitated under the scheme, Bord na Móna will be required under the terms of the EDRRS Funding Agreement to provide substitute lands and demonstrate at a minimum that they have equivalent benefits. Any such proposals are subject to the agreement of the Minister and the Minister may not allow the Activities if the Scheme Regulator is not satisfied that the substitute lands provide at least equal benefits.

Following on from these enhanced decommissioning and rehabilitation improvements there is the opportunity for further enhanced improvements on the remaining Bord na Móna lands, not included in EDRRS, and potentially other (non-Bord na Móna) peatlands at a future date. This transformation will be driven by unlocking the full potential of our land and creating significant value for Ireland and the Midlands in particular.

Bord na Móna is an integral part of the economic, social, and environmental fabric of Ireland and Irish life. As a key employer in the Midlands, the company is conscious that its obligations go beyond purely commercial and environmental – there is also a social responsibility to employees and the communities served by Bord na Móna. It is the company's role and absolute priority to ensure that its long-term strategy delivers on these important areas in a robust and balanced way.

Bord na Móna is following a decarbonisation programme aimed at reducing the carbon emissions from its activities. The company aims to further develop its existing renewable energy and resource recovery markets as well as developing new sustainable business opportunities with a key objective of reducing the carbon intensity of all products. In addition, the carbon emission mitigation benefits associated with the post-peat extraction rehabilitated peatland following re-wetting, revegetation and colonisation of significant areas with native peatland, wetland and woodland habitats will make a significant contribution to achieving the State's carbon emission reduction targets.

The Decommissioning and Rehabilitation of industrial peatlands is regulated through Integrated Pollution Control Licences to harvest peat, which are administered and enforced by the Environmental Protection Agency. Bord na Móna is required to prepare and implement a plan, as defined by Condition 10 of each of the EPA licences, with the key objectives being the removal of material that may result in environmental pollution and the stabilisation of the former peat production areas. Prior to the commencement of the EDRRS scheme, Bord na Móna had rehabilitated approximately 20,000 hectares of cutaway peatlands. Enhanced rehabilitation was carried out on 9,649 hectares from the commencement of EDRRS to the end August 2022.

Supply of Industrial milled peat to ESB Lough Ree and Shannonbridge Power Stations has now ceased and both peat-fuelled stations have stopped electricity generation. All industrial peat extraction has now ceased on Bord na Móna lands. However existing stockpiles of peat extracted prior to 2020 will continue to be used to co-fire the Edenderry Power Plant along with biomass until the end of 2023. The use of peat for electricity will completely cease at the end December 2023. As industrial peat production has ceased and as peat stocks are cleared from the bogs a significant proportion of the Bord na Móna estate and its internal resources are available for rehabilitation and decommissioning.

EDRRS will significantly go beyond what is required to meet rehabilitation and decommissioning obligations under existing IPC licence conditions. The proposed improvements will mean that environmental stabilisation is achieved (ensuring EPA obligations are met), however in addition, significant other benefits particularly in relation to climate action will accrue.

EDRRS will support activities and improvements, including:

- Decommissioning and removal of infrastructure, which if left *in situ*, would not give rise to the risk of environmental pollution.
- More intensive management of water levels and re-wetting through drain-blocking and bunding to optimise conditions for development of suitable vegetation.
- Wetlands management including modifying outfalls, provision of berms and managing overflows water levels with overflow pipes.
- Re-profiling of peatland to maximise re-wetting that will deliver suitable hydrological conditions for development of wetlands, fens and bog habitats.
- Seeding of targeted vegetation such as reed innoculation.
- Proactive targeted inoculation of suitable peatland areas (such as areas with deep peat) with *Sphagnum* to optimise climate action and associated benefits.

The key to optimising climate action benefits is the restoration of suitable hydrological conditions on the peatlands *via* more intensive intervention.

In addition, to the climate action benefits of increased carbon storage, reduced carbon emissions and acceleration towards carbon sequestration, it is expected that EDRRS will also have benefits accruing from biodiversity provision, water quality and storage attenuation. The scheme will also facilitate increased monitoring of Green House Gas (GHG) fluxes in areas where the improvements will accelerate the trajectory towards a naturally functioning peatland ecosystem.

This Methodology Paper details:

- Bord na Móna's obligated decommissioning and rehabilitation requirements under the existing EPA licences.
- The suite of enhanced improvements supported by the proposed funding.
- Descriptions and examples of both the obligated and enhanced improvements.
- The benefits associated with the improvements.
- Monitoring proposals for the Enhanced Rehabilitation.

In addition, this Methodology Paper will act as the reference document, effectively linking plans submitted to the EPA in compliance with Condition 10 of the respective licences. The agreed improvements (obligated and additional) are detailed in this Methodology Paper.

2.4. Peatland Decommissioning, Restoration and Rehabilitation

There is a world-wide consensus that re-wetting peat and restoration of hydrology in damaged peatlands can improve carbon storage, water storage and attenuation and help support biodiversity both on the site and in the catchment (Minayeva et al. 2017). Several international peer reviews of scientific literature published on various aspects of peatland restoration make this conclusion (Minayeva et al. 2017, Anderson et al. 2017, Grand-Clement et al. 2015). Gunther et al. (2020) concludes that postponing rewetting of degraded peatlands increases the long-term warming effect through continued CO_2 emissions. Re-wetting peat is the key action to retain and maximise the value of peatland as a carbon store, to promote carbon absorption by the peatland vegetation and to restore sites on a trajectory to becoming carbon sinks (Anderson et al. 2017).

Researchers in Ireland have also reached the same conclusion for Irish peatlands. The Environmental Protection Agency funded the BOGLAND project (Renou-Wilson et al. 2012) and concluded that restoration and the managed re-wetting of Irish bogs was essential for returning damaged peatlands on a trajectory towards becoming peat-forming ecosystems again. The EPA-funded CarbonRestore Project (Renou-Wilson et al. 2017) also reported that actively managed rewetting of drained peatlands in Ireland can lead to restoration of functional peatland, such as the return of typical plant and animal species, which in turn may lead to the restoration of peat-formation and the Carbon-sink function. Renou-Wilson et al. (2018) also state that re-wetting peatlands and organic soils should now be carried out without further delay, and that re-wetting now was one measure to mitigate against the negative impacts of future climate changes on Irish peatlands.

Irish peatlands are a huge carbon store, containing more than 75% of the national soil organic carbon (Renou-Wilson et al. 2012). Peatland drainage and extraction transforms a natural peatland which acts as a modest carbon sink (taking in 0.1 to 1.1 t of carbon as CO_2-C /ha/yr) into a cutaway ecosystem which is a large source of carbon dioxide (releasing 1.3 to 2.2 t of carbon as CO_2-C /ha/yr) based on Tier 1 Emission factors (Evans et al. 2017). Renou-Wilson et al. (2018) reported losses of between 0.81 – 1.51 CO_2-C /ha/yr from drained peatlands located in Ireland.

Re-wetting of dry peatlands will increase methane emissions (Gunther et al. 2020) as a consequence of the anoxic conditions within the peat body that provide a suitable environment for the microbial breakdown of plant litter and root exudates. Tanneberger et al. (2021) describes how peatland management has to choose between CO_2 emissions from drained peatlands or increased methane (CH_4) emissions from rewetted industrial peatlands. However, when radiative effects and atmospheric lifetimes of both GHG gases are considered and modelled, postponing rewetting increases the long-term warming effect of continued CO_2 emissions (Gunther et al. 2020). This means the increase in methane due to rewetting of dry peatlands is still negated by the CO_2 emissions reductions. Further, Wilson et al. (2022) confirmed the benefit of rapid rewetting to achieve strong carbon reductions and potentially altering the warming dynamics from warming to cooling depending upon the climate scenario.

Tanneberger et al. (2021) described as a true milestone the United Nations Environment Assembly (UNEA) resolution on “Conservation and Sustainable Management of Peatlands,” adopted by all UN member states in 2019. The United Nations has also recognised the current decade 2021-2030 as the Decade of Ecosystem Restoration. Tanneberger et al. (2021) summarizes how peatland re-wetting, which is described as a nature-based solution can have multiple environmental and ecological benefits.

National and EU Policy

This international research and scientific understanding is now reflected in key Irish national policy and strategy documents such as the **National Raised Bog Special Areas of Conservation (SACs) Management Plan 2017 - 2022** (Department of Arts, Heritage and the Gaeltacht 2017), **The National Peatland Strategy** (Department of Arts, Heritage and the Gaeltacht 2015), The **National Biodiversity**

Action Plan (National Parks and Wildlife Service 2017), The **National Climate Action Plan** (Department of the Environment, Climate and Communications 2021), **The River Basin Management Plan for Ireland 2018-2021** (Department of Housing, Planning and Local Government 2018), and the **Biodiversity – Climate Change Sectoral Action Plan** (Department of Arts, Heritage and the Gaeltacht 2019). Each of the national plans, which are also complemented with the recently published EU Green Deal communication on **Biodiversity Strategy for 2030** (COM 2020) have overlapping objectives and actions that focus on the restoration of peatlands damaged by turf-cutting, drainage and other impacts, as well as the re-wetting of Bord na Móna industrial peat extraction bogs.

Peatlands rehabilitation and restoration is referenced in Section 17.3.3 of the Land Use, Land Use Change, Forestry and Marine Chapter of the **National Climate Action Plan 2021** as follows:

"The rehabilitation of degraded peatlands to a condition in which they regain their ability to deliver specific ecosystem services has considerable potential for initial mitigation gains, and future carbon sequestration. Additional benefits of peatland restoration include positive socio-economic outcomes for the Midlands, increased natural capital, enriched biodiversity, improved water quality, and flood attenuation."

The scheme is included as Action 33 in the **Climate Action Plan 2021 Annex of Actions** - *Deliver the Enhanced Decommissioning, Rehabilitation and Restoration (EDRR) Scheme for Bord na Mona Peatlands.*

EDRRS is also referenced in the **Climate Action Plan 2021** as a measure to deliver a Just Transition in the Midlands.

While not specifically identified as a restoration implementor, EDRRS objectives are in line with those of the United Nations **Decade on Ecosystem Restoration 2021-2030** of Preventing, Halting and Reversing the Degradation of Ecosystems worldwide.

EDRRS is also in line with the EU Commission proposal for a **Nature Restoration Law** which will apply legally binding targets for nature restoration in different eco-systems to every Member State. The aim is to cover at least 20% of the EU's land and sea areas by 2030 with nature restoration measures and eventually extend these to all ecosystems in need of restoration by 2050.

State of Knowledge

Ecological restoration can in general be defined as "*the process of re-establishing to the greatest extent possible the structure, function and integrity of indigenous ecosystems and the sustaining habitats they provide*" (SER 2004). Defined in this way, restoration encompasses the repair of ecosystems (Whisenant 1999) and the **improvement of ecological conditions in damaged wildlands** through the **reinstatement of ecological processes**. There is an increasing understanding that while some ecosystems such as Bord na Móna cutaway peatlands cannot be restored back to raised bog in a short timeframe as their environmental baseline has changed so radically (with the removal of the acrotelm – the living layer and much of the peat mass), they can be returned to a **trajectory** towards a naturally functioning peatland system (Renou-Wilson et. al. 2012). This means that if techniques for repairing abiotic factors and processes such as hydrology and carbon balance are implemented effectively, they will also contribute to biodiversity restoration. Kreyling et al. (2021) reviewed restoration success of 230 re-wetted fen sites in Europe and found that re-wetting did not return these degraded habitats to their former condition but that new novel habitats were more prevalent.

The various reviews of international scientific literature of peatland restoration point out that no single approach can be taken towards peatland restoration due to the wide variability of different starting points (after peat extraction) and different environmental conditions (Minayeva *et al.* 2017, Anderson *et al.* 2017, Grand-Clement, *et al.* 2015, Thom et al. 2019). This is a key issue for Bord na Mona sites as there is a wide variety of environmental conditions including a wide range of peat depths and differing hydrological regimes. Renou-Wilson et al. (2012) describe how conditions for spontaneous *Sphagnum* regeneration occur less naturally in Irish Midlands milled peat bogs as the environmental conditions have been changed very significantly, hence the need for proactive and intensive restoration improvements.

Some peatlands in Canada, Europe and particularly in the Irish midlands have been cut down to the fen peat layer and mineral subsoils. In this situation fen vegetation may establish more successfully than bog vegetation, particularly when there is less acidic groundwater geochemistry (Minayeya et al. 2017, Thom et al. 2019). At some Canadian sites where peat extraction had exposed minerotrophic (fen) peat, re-vegetation was relatively rapid but important genera (e.g. *Carex* and *Sphagnum* spp.) failed to colonise spontaneously (Graf *et al*. 2008) so that measures to artificially introduce these key species were still required.

Renou-Wilson et al. (2012) stress that the first option for after-use of cutaway peatlands should be to promote, where possible, the return to a natural functioning peatland ecosystem. The favoured management option should therefore involve re-wetting. Rewetting of drained peatlands can lead to restoration of functional peatland aspects, such as the return of typical peatland species, which in turn may lead to the restoration of peat-formation and the carbon sink function. This is not possible in all degraded peatland sites but is a practical and a relatively simple measure in some sites (Renou-Wilson et al. 2017). More recently Renou-Wilson and Wilson (2019) recommend that new methods of peatland re-wetting be investigated to maintain necessary water levels to sustain as much ecological services as possible.

Not all extracted peatlands will return to nutrient poor bog habitat in the short term because the geo-hydrological conditions have been altered. Wetland mosaics with open water, reedbeds and swamp may be the only viable target for some sites for restoration to a self-sustaining wetland ecosystem (Minayeva et al. 2017). This will at least set a course that could eventually result in the establishment of a new peat-forming ecosystem in the future. This means that a flexible peatland restoration management approach should be taken to deal with sites with differing environmental conditions. While, in general, the main objective will be to re-wet peat where possible and to maximise the restoration of natural function of each peatland site and its climate action potential – there will be different habitat outcomes. While it is not possible to physically replace the peat which has been extracted from the Bord na Móna estate, other habitats compatible with the underlying environmental conditions and the surrounding landscape can be developed.

Even following enhanced rehabilitation and restoration of former industrial cutaway bog with bare peat surfaces, reversion back towards a naturally functioning peatland ecosystem will take variable amounts of time (e.g. centuries), particularly when environmental conditions are not suitable. Some of the earliest rehabilitated areas in Oweninny and Lough Boora Discovery Park are still in places at a pioneer habitat phase (30 years after peat extraction ceased). Peat forms at a relatively slow pace (1mm per year on average). NPWS estimate that peat-forming habitats on cutover bog on the margins of raised bog sites could take up to 50-100 years to establish and develop into Active Raised bog (EU Habitats Directive – reference code 7110) Annex I priority habitat (NPWS 2019). So, while pioneer peat-forming habitats could develop into the right conditions – potentially after 10 years (e.g. Oweninny) – it will take some time for this to develop into a naturally functioning poor fen/embryonic bog habitat.

Rehabilitation and restoration approaches applied by Bord na Móna have already been shown as being effective for climate action in Ireland. Practical rehabilitation measures, such as the standard rewetting programme at Bellacorick, resulted in a sharp decrease in CO_2 emissions and small methane emissions from bare-peat areas (Renou-Wilson et al. 2018). This study has demonstrated that a previously drained but undeveloped Bord na Mona bog in Co. Galway, 8 years post bog restoration and drain-blocking, is now a net carbon sink in rewetted areas. Further research (Wilson et al. 2022) at Moyarwood Bog found that overall the site will have a warming effect on the climate until 2085 but then will have a cooling impact. This study concluded that rapid rewetting of drained peatland sites is important to (a) achieve strong carbon emissions reductions, (b) establish optimal conditions for carbon sequestration and (c) set the site on a climate cooling trajectory. This takes account of climate scenarios and different fluxes from re-wetted raised bog and raised bog habitat in poorer condition.

An example of where *Sphagnum*-rich vegetation has established naturally is at Timahoe Bog, Co. Kildare, approximately 20-30 years after peat extraction ceased. Timahoe Bog is an example of the potential of re-wetting deep peat cutaway and developing *Sphagnum*-rich vegetation that is analogous to vegetation that has been demonstrated to be a GHG sink at Bellacorrick. In Figure 2.1 below *Sphagnum*-rich vegetation at Bellacorrick has been shown to have already become a GHG sink, after rehabilitation was carried out (Wilson et al., 2018).

Figure 2.1. Sphagnum-rich vegetation on rehabilitated blanket bog cutaway at Bellacorrick , Co. Mayo (left). Research has found that this vegetation type is now a carbon sink for greenhouse gases. Sphagnum-*rich vegetation on raised bog cutaway at Timahoe North, Co. Kildare (right). This vegetation has developed naturally over a period of 20-30 years. The main objective of enhanced rehabilitation is to maximise hydrological conditions on suitable deep peat sites to restore this type of vegetation.*

Bord na Móna Peatlands Bord na Móna's total estate is circa 79k ha of which 71k ha is in the midlands. Prior to the commencement of EDRRS, decommissioning and rehabilitation was already completed on circa 15k Ha in the Midlands (20,000 ha overall). In the original scheme proposal, this 15k Ha was not included and a further 12k Ha was deemed out of scope. This left 47k Ha in scope for support under the proposed Scheme for Enhanced Decommissioning and Rehabilitation. All of these lands were considered suitable for Enhanced Decommissioning however the area available for rehabilitation was less than this. In terms of rehabilitation only, 4.97k Ha was excluded as this was considered marginal land where additional/enhanced rehabilitation improvements would be of limited benefit, while a further 4.87kHa was ring-fenced for future Renewable Energy Source – Electricity (RES-E) developments. Finally, 4.7k Ha was originally excluded on the basis that these lands were part of Substitute Consent applications before An Bord Pleanála at the time the scheme proposal was prepared. (These applications were subsequently not progressed by Bord na Móna.) This left a total of 32.8kHa (32,799Ha) available for Enhanced Rehabilitation and this was the figure used in the Financial Model for the scheme.

Since EDRRS commenced Bord Na Móna have made a decision to permanently cease industrial peat extraction thereby making more peatlands available for Enhanced Rehabilitation and Decommissioning under the scheme. Additional RES-E projects have also been announced by Bord na Móna and as the detailed design of the rehabilitation measures has progressed, the available or suitable areas has also altered on each individual peatland. While the proposed overall figure for Enhanced Rehabilitation of 32,779 hectares has not changed, the spread and location of the rehabilitated areas has been and will continue to be amended with the prior agreement and approval of NPWS and DECC.

2.5. Benefits of an enhanced decommissioning, rehabilitation and restoration approach

The rehabilitation and restoration of peatlands to a condition in which it regains its ability to deliver specific ecosystem services is often a highly ambitious task demanding substantial (including financial) resources. This is especially the case for sites where the acrotelm and a significant percentage of the peat mass has been removed (the Irish midland situation), where complex re-vegetation techniques of bare peat are employed (Grand-Clement et al. 2015), or where complex hydrological conditions exist. To justify such investment, each initiative should have a clearly formulated goal and an adequately developed strategy for achieving it (Anderson et al. 2017, Minayeva et al. 2017).

Glenk and Ortega (2018) reviewed the economics of peatland restoration in Scotland, and suggest that peatland restoration is likely to be welfare enhancing and deliver significant multiple benefits, with the benefits of publicly-funded peatland restoration exceeding the costs. This strengthens the economic rationale for climate change mitigation through improved peatland management.

Renou-Wilson and Wilson (2019) examined cost effectiveness of peatland re-wetting in Ireland. They outline several key issues such as that it is difficult to consider all benefits economically, that benefits of re-wetting will be realised over a much longer period compared to the incurred costs and that discount rates should be applied, and uncertainty over climate change. They calculated the cost-effectiveness in euros (€) per tonne of CO_2 equivalent avoided of rewetting various Bord na Móna peatlands (Bellicorrick, Moyarwood, Blackwater) for a 50-year period (based on costs in estimated in 2016). They found that the CEA (Cost-effectiveness analysis) varied between €1 - €7 depending on which Emission Factor (site specific vs Tier1) was applied. They recommended that the rewetting of industrial cutaway and cutover bogs is a low-cost intervention supporting immediate and effective mitigation measures.

It is too early to assess the actual cost benefits of EDRRS in relation to carbon and other benefits. However, it should be noted that one of the economic benefits is the provision of employment for those formerly involved in peat production as part of a Just Transition process.

EDRRS Strategy

EDRRS will:

- develop a programme of simple, clear rehabilitation and decommissioning goals and targets,
- take account of the current baseline conditions and site variability, targeting those sites where maximum climate action and other benefits can be developed and embryonic peat-forming

habitats could potentially be developed (deeper peat cutover bog sites may restore to raised bog type habitat, while shallower peat sites may develop to fen type and other wetland habitats),

- seek to improve environmental conditions through re-wetting but would then, guided by site investigation and monitoring, apply innovative and more intensive re-wetting techniques to manage water levels and maximise the area of suitable environmental conditions that would set the particular site towards a trajectory of a naturally functioning peatland ecosystem,
- examine best practise internationally and take more intensive intervention to accelerate the re-vegetation of bare peat through the targeted introduction of plant material and seed from donor sites, while all the time being mindful of maintaining optimum environmental conditions.
- take a flexible, adaptable and iterative approach with the key principle of "doing the right things in the right places" (different objectives, actions and targets for different cutaway environments). It will also carry out robust scientific monitoring following best practise guidelines (Gann et al. 2019) to determine that pre-defined targets (e.g. reduction in bare peat cover and establishment of suitable habitats including *Sphagnum*-rich vegetation, creation of suitable hydrological conditions, reduction in GHG emissions, reduction in fluvial carbon emissions, improvements in water quality) have been reached and allow comparative analysis of costs and benefits of various approaches.
- Seek to maximise the cost/benefit of the applied resource spend to maximise climate action benefits for the state.

This scheme is innovative for Ireland and will have multiple additional benefits for further management of other Irish peatlands.

2.6. Valuing the GHG saving element of the total benefits accruing from EDRRS

First, it must be stressed that estimating carbon fluxes in general and subsequently taking cognisance of the additionality of the proposed enhanced improvements is subject to a range of different assumptions regarding the outcomes. This is also complicated by the variability of cutaway environment, which is a mosaic of different residual peat depths and types, topographical & hydrological conditions, nutrient status, influence from adjacent rivers flooding regimes/dynamics and vegetation cover. Furthermore, while GHG fluxes from some peatland habitats in Ireland have been well-established, gaps still remain in the knowledge of GHG factors and fluvial carbon emissions from particular degraded peatland types. This is currently being addressed by the SMARTBOG project (www.smartbog.ie), EPA-funded projects starting in 2022 looking at the dynamics of carbon dioxide, methane and the EDRRS monitoring program. This means that calculating carbon emissions and removals of the proposed enhanced improvements and predicting benefits over the next decade is subject to a degree of uncertainty and should be reported as a range. Further monitoring and research (e.g. modelling studies) will help reduce uncertainty.

Any climate benefits that may become realisable from carbon storage and carbon emissions reduction must be seen only as a component in the overall package of benefits that will accrue from the proposed additional funded measures. Additional benefits that include positive socio-economic outcomes for the midlands, increased natural capital, enriched biodiversity, and improved water quality, as described above.

Approach taken to estimating carbon storage benefits

In 2019 NPWS estimated that an enhanced rehabilitation program for *circa* 6,000 Ha of deep peat raised bog and cutover bog habitats will re-wet these habitats and keep 28 million tonnes of carbon stored in the ground. Adapting a similar approach and adjusting for the different categories of Bord na Móna peatlands, and peat depths within the project area, it was estimated at the commencement of the scheme in 2019 that the enhanced improvements supported under the proposed project, would result in the equivalent storage of over 109 million tonnes of carbon. This was updated in 2022 based upon new research.

Using updated peat characteristics from Renou-Wilson et al. (2022), the carbon stock of the area of peatlands included in EDRRS was re-calculated to reflect the most up-to-date data available. Renou-Wilson et al. (2022) provided measurements of typical peat properties like bulk density, % Carbon and organic fraction of dry mass (%) as they relate to cutaway peatlands. In addition, using peat depth obtained from recent Light Detection and Ranging (LiDAR) surveys combined with existing GPR data, an analysis was completed to identify the range of peat depths within the EDRRS sites. Carbon stocks were calculated using the output from this analysis, updated bulk density, organic matter and % Carbon content from Renou-Wilson et al. (2022). The carbon stocks associated with EDRRS sites were found to range from 62 to 78 million tonnes of carbon.

Approach taken to estimating avoided carbon emission benefits

The alternate approach (i.e. measuring fluxes as opposed to carbon stocks) establishes a value on the avoided carbon from the 33k Ha between 2020 and 2050 following the completion of the improvements. The appropriate emission factors[1] from the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories to the various categories of Bord na Móna peatlands in the proposed project area were used to establish baseline carbon fluxes in 'year 0'. The enhanced improvements are assumed to take place during years 1 – 5, and associated reductions in emissions are calculated using high, median and low estimates – the results discussed below are based on the median case. A forecasted logistic curve, see Figure 2.2, is provisionally used to characterise the growth in emission reductions over the project area in the time-period to 2050, the trend of this curve will be confirmed by the monitoring program associated with the enhanced improvements supported by the proposed funding.

[1] Notwithstanding, the use of IPCC Guideline figures for the calculation of GHG reductions, the basis and assumptions underpinning the out-turns will be agreed with relevant stakeholder

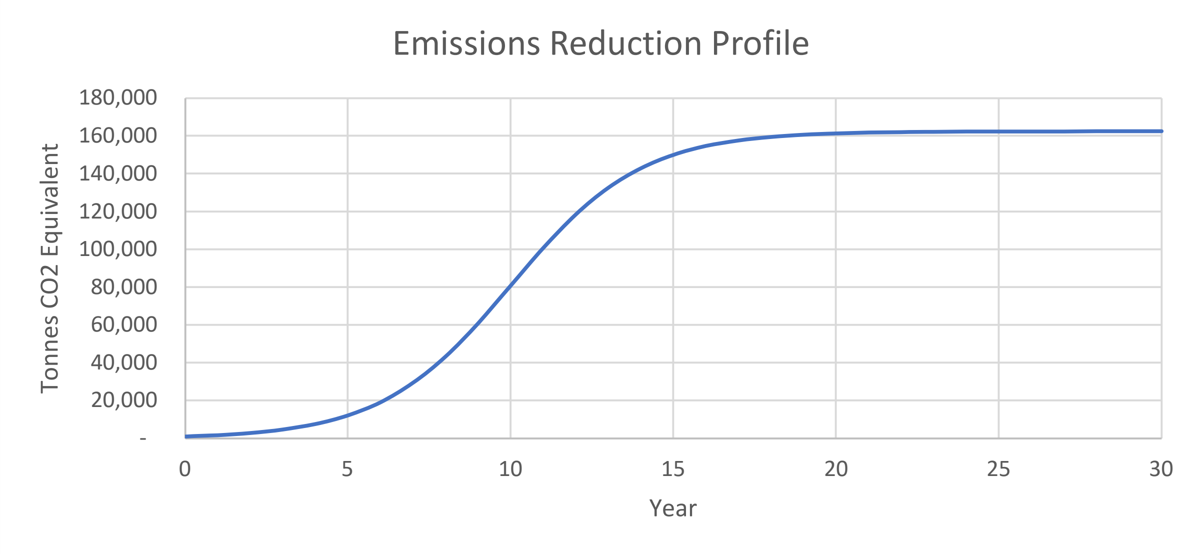

Figure 2.2. Modified Gompertz logistic curve for the proposed enhanced improvements.

It was estimated in 2019 that over 30 years, EDRRS would result in the net reduction of 3.3 million tonnes of CO_2-eq, from emissions avoided and future sequestration, *via* the implementation of enhanced rehabilitation measures and rewetting. At the commencement of the scheme the EPA confirmed that the estimated emissions presented for the Bord na Móna land-bank were broadly consistent with the calculations produced by the EPA for the 2018 GHG Inventory.

In summary, versus no rehabilitation, the Scheme is currently estimated to deliver:

Table 2.1. Estimated climate benefits of the scheme

Carbon Storage versus No Rehabilitation	62-78m tonnes
Tonnes of CO_2 avoided	3.3m tonnes

These figures in Table 2.1 are indicative and as carbon monitoring is carried out under EDRRS and results become available these figures will be reviewed and updated.

Approach to update avoided carbon emission benefits

The approach to estimating the avoided carbon benefits involves utilising baseline and future habitat maps and then assigning representative emission factors based upon EDRRS carbon monitoring, in addition to utilising existing emission factors from other monitoring programs and research. This approach facilitates a cost effective, reliable, and scientifically robust means of estimating carbon fluxes from peatland ecosystems.

GHG emission factors will be developed for the most common habitats found on Bord na Móna peatlands. The methodology followed is similar to approach 3 outlined in Penman et al. (2003). Approach 3 requires the estimation of landcover (habitat) at 'Time 1' (e.g. pre-rehabilitation) and 'Time 2' (e.g. post rehabilitation) and the application of relevant emission factors developed for these land cover classifications. The difference between the aggregate emissions/removals represents the flux of GHGs from the geographic area under investigation. To achieve this, geographically explicit habitat maps are required in addition to future habitat maps to provide land cover changes from degraded to rehabilitated areas.

To estimate the changes in carbon, three broad monitoring techniques will be deployed. These techniques include utilising the closed chamber method, the eddy covariance method and using flumes in conjunction to fluorescent dissolved organic matter (F-Dom) sensors to measure Dissolved Organic Carbon (DOC) exported from the site. The closed chamber will be used to gather spot measurements from habitats identified as covering large geographical areas and in conjunction to meteorological data the net ecosystem exchange (NEE), ecosystem respiration (ER) and gross primary production (GPP) will be modelled. Real time continuous data will be collected from both the flume and DOC sensor and the eddy covariance towers. The primary aim of the flux towers is to estimate real time fluxes of bare peat and subsequently rewetted peatlands. This will also collect meteorological data. Lastly, the flume and DOC sensor (operating using F-Dom) will measure flows and DOC export while Particulate Organic Carbon (POC) samples will be analysed via laboratory analysis.

3. Background, current obligations and proposed additional improvements

3.1. Peatland decommissioning and rehabilitation - Bord na Móna's existing obligations under its EPA licences

Although now ceased, Bord na Móna is licenced by the Irish Environmental Protection Agency (EPA) for the extraction and processing of peat. As part of the licence conditions, following cessation of peat extraction, Bord na Móna is obligated to decommission its operations by removing materials that *'that may result in environmental pollution'* and rehabilitate the industrial peat production area to ensure '*environmental stabilisation'.*

In some areas where Bord na Móna's industrial production activities has ceased, the decommissioning obligation has been successfully discharged by the emptying and cleaning of oil bunds, de-sludging interceptions, disconnecting substations etc., and demonstrating there is no residual risk of environmental pollution, from the previous activities. In terms of discharging the rehabilitation licence requirement, demonstrating environmental stabilisation has been achieved by the process of blocking field drains which results in slowing the movement of surface water across the cutaway, the creation of mini-silt traps, re-wetting the peatlands and improving conditions for vegetation establishment through natural colonisation.

In bogs where cessation of peat production is more recent and where they are included in EDRRS, Enhanced Decommissioning and Rehabilitation will be carried out under the scheme.

3.2. Enhanced Peatland Decommissioning, Rehabilitation and Restoration – New improvements supported under EDRRS

The funding provided under EDRRS is for Bord na Móna to carry out Enhanced Peatland Decommissioning, Restoration & Rehabilitation, additional to and over and above that which is required to meet its obligation under its existing licence conditions. The funding will support activities and improvements which accelerate the original timelines (albeit limited to the time value of money for these accelerated activities[2]) or which are extra and in addition to those decommission and rehabilitation obligations in the respective EPA licences.

[2] The proposed funding will support activities and costs incurred over and above that which would arise in the normal discharging of its EPA licence conditions. In order to carry out these obligated and enhanced improvements in a given bog area, Bord na Móna will have to have completed the decommissioning requirements mandated in its EPA licence for that bog area. However, in the absence of the proposed funding support, Bord na Móna would not plan to complete these mandated decommissioning activities for several years. Therefore, on commencement of the supported and funded enhanced improvements, Bord na Móna, will start incurring 'immediate' costs that would otherwise have been delayed for several years; equity requires that Bord na Móna be remunerated for this early and accelerated call on its cash flow. For the avoidance of doubt, Bord na Móna is not seeking compensation for the 'capital' spend associated with the accelerated decommissioning activities. Instead the proposed funding will recognise as a recoverable and eligible cost the 'time value of money' (TVM) for the accelerated activities necessitated under proposed funding arrangement. The 'time value of money' for the accelerated activities will be calculated using a NPV approach with an agreed discount rate and tenor.

3.3. Criteria for selection of Peatlands included in the scheme.

The Bord na Móna land bank consists of circa 80,000 hectares and these lands generally consist of peatlands where peat extraction, or development for peat extraction, has taken place under an IPC licence issued by the EPA. When EDRRS was announced in 2020 a list of 82 bogs was included in the scheme and while the overall area of these 82 bogs was 47,000 hectares, 32,779 hectares was included in EDRRS for enhanced rehabilitation. This list of 82 bogs is set out in Table 11.1 in Section 11 of this report.

The original list of bogs, and the area to be rehabilitated under EDRRS was developed using a number of criteria including availability of peatlands following an assessment of proposed and existing commercial activities, proposed and existing Bord na Móna Renewable projects, proposed peat production and alignment with broader climate and energy policies. Other criteria included the suitability of the peatlands for rehabilitation and previous use for electricity generation.

When developing the original list, a shortlist of bogs in the Midlands that were suitable for rehabilitation was prepared and the area of each bog was identified. This list consisted of peatlands that would benefit from enhanced rehabilitation, peatlands that had been used for the supply of peat to electricity power stations and peatlands that were not at the time identified for future peat extraction.

Substitute Consent Applications

In May 2020 Bord na Móna lodged a number of applications for Substitute Consent for peat extraction as at this time, and as part of the Bord na Móna Brown to Green strategy, it was intended to move away from peat extraction in a planned, orderly and just manner by continuing peat extraction on a small scale to 2025. As such the peatlands, or areas of the peatlands, that were included in these Substitute Consent applications, and where future peat production was proposed, were excluded from the original 32,779 hectares.

Subsequent to the commencement of EDRRS, Bord na Móna made the decision to permanently end all peat harvesting on its lands, marking a key milestone in its transformation into Irelands leading climate solutions company. This announcement made some additional peatlands available for inclusion in EDRRS and this is further addressed below.

Renewable Projects

Bord na Móna's vision, which is aligned with the Climate Action Plan, is for a climate neutral Ireland by 2050. The development of Bord na Móna Renewable Energy projects such as windfarms and solar projects on our peatlands will underpin Ireland's energy independence by developing green, sustainable energy sources to assist with Ireland's commitment to generate 70% renewable electricity by 2030. Bord na Móna have proposed a number of such renewable projects and their location was considered when preparing the original list of bogs for inclusion in the scheme. The infrastructural footprint of a windfarm is very small relative to the overall size of the peatlands (circa 5-10%) and where such infrastructure is proposed the area available for rehabilitation and included in EDRRS on these bogs was reduced. The areas outside of the windfarm and solar farm infrastructure footprint can be rehabilitated, however it is preferable to rehabilitate these areas when the infrastructure such as the turbine bases and roads have been constructed. As an example, rehabilitation is currently being carried out on Cloncreen Bog and this rehabilitation commenced while the turbine erection was still ongoing.

Other Activities

Other activities that reduced the area available for rehabilitation in this original list was third party forestry plantations, commercial or agriculture leases and existing turbary rights. Peatlands areas where rehabilitation had previously been completed and areas where no rehabilitation was possible were also not included in the scheme.

Additional Peatlands

A number of additional peatland sites have been added to the Scheme to date and these are set out in Table 11.2 in Section 11 of this report. These included additional bogs that were added to the scheme following Bord na Mona's decision to permanently cease peat production and also some bogs that had been ditched but no extraction had taken place. The inclusion of these bogs will not result in any material difference in the expected climate action benefits, biodiversity or ecosystem services enhancements which the overall Scheme will ultimately deliver rather, as these bogs have significant depths of peat, it is expected that their inclusion will increase the overall benefits of the scheme.

Any proposal to include additional bogs in the scheme has been submitted to NPWS in advance and has only been included in the Scheme with their approval. While additional peatlands have been added to the scheme the overall area to be rehabilitated under EDRRS will not exceed the original 32,779 hectares. As the scheme progresses bogs or areas of bogs will be removed from the scheme to satisfy this requirement.

Bogs to be rehabilitated each year

The bogs to be rehabilitated each year under EDRRS are selected on a rolling year by year basis. These bogs are selected from the original list set out at the scheme announcement and the additional bogs included in the scheme as set out above. The selection is based on a number of criteria including the estimated intensity of proposed rehabilitation measures matched with the available resources and equipment, the geographical location of the peatland taking into account the dispersed nature of the Bord na Móna workforce, the levels of stock remaining on the bog and the availability of specific peatlands for rehabilitation. Enhanced rehabilitation carried out under EDRRS on all bogs will provide carbon and climate benefits.

The Bord na Móna bogs in the Midlands extend through seven counties with significant travel distances between some bogs. All bogs included in EDRRS are allocated to one of three Works Areas namely Mountdillon (Longford, North Roscommon and Westmeath), Boora Blackwater (West Offaly, South Roscommon, Galway and South Westmeath) and Derrygreenagh (East Offaly, Kildare, Laois and Meath). A major consideration for the selection of bogs for rehabilitation each year is to ensure bogs from each Works Areas are included in the work programme. This allows for the workforce in each Works Area to be accommodated and ensures maximum efficiency by reducing operative travel time and facilitating the management of the rehab measures and the maintenance of the equipment.

Detailed Design

It should be noted that the areas to be rehabilitated in each bog was based on preliminary information that was available prior to the commencement of the scheme. As the detailed design of the rehabilitation measures is progressed and information on water levels, peat depths, topography etc. on each bog is gathered, the areas of each bog identified for rehabilitation will vary somewhat from that in the original list.

3.4. Relationship between the Enhanced Improvements and the IPC Licences

Bord na Móna is developing, in consultation with relevant stakeholders, including the NPWS, rehabilitation and decommissioning plans referred to as 'Condition 10' plans for given peatlands and submitting these plans to the EPA. Condition 10 of the Bord na Móna IPC licences sets out Bord na Móna's decommissioning and rehabilitation obligations. These 'Condition 10' plans detail the measures (decommissioning, rehabilitation and restoration) necessary to discharge the licence obligations and are independently approved by the EPA. For bogs included in EDRRS the rehabilitation plans comply with the requirements of the 'Condition 10' plans but also include details of the enhanced rehabilitation and decommissioning measures proposed under the scheme. All rehabilitation plans are being prepared in accordance with the EPA document *Guidance on the process of preparing and implementing a bog rehabilitation plan.* Separately the EPA have also reviewed an earlier version of this document, and provided comments which have been accepted in full, adopted and included in the earlier version of the Methodology Paper. The plans for the EDRRS bogs will outline the enhanced improvements proposed to be undertaken following the grant of funding and confirm that the costs of these enhanced improvements will be supported by the proposed funding[3]. Note that in the absence of this external funding, Bord na Móna would not be carrying out the enhanced improvements but would instead only carry out the decommissioning and rehabilitation activities required by the licence. The enhanced decommissioning improvements detailed in the 'Condition 10' plans will be aligned with the description of these activities in this 'Methodology Paper'.

In the case of bogs rehabilitated under EDRRS a Decommissioning and Rehabilitation Plan detailing the proposed enhanced improvements will be submitted to the EPA for approval. It should be noted that it is not practical to initially carry out standard rehabilitation on a bog and then follow this with enhanced rehabilitation and this Plan will be approved (or rejected, as the case may be) by the EPA in whole, not in part, including the outline programme for activities provided therein. A number of these Plans for EDRRS bogs have been submitted to the EPA and have been approved as complying with the Licence 10 conditions even though enhanced improvements are proposed.

Bord na Mona will, as required by condition 10 of the various IPC Licences for peat extraction, provide a validation report that rehabilitation is complete and licence obligations are addressed, ultimately leading to IPC licence surrender. IPC Licence surrender is a statutory process governed by section 95 of the EPA Act 1992 as amended. Noting the EPA's regulatory independence, in such instances and following engagement with the licensee, the EPA may acknowledge that the enhanced improvements, once completed, will discharge the licence obligations.

The following sections describe Bord na Móna's obligated (Condition 10) requirements and enhanced decommissioning and rehabilitation/restoration improvements.

[3] Under the proposed funding, specific cost elements of accelerated activities shall also be deemed an eligible cost for support. Accelerated activates are activities that while mandated under 'Condition 10' of the applicable EPA licence, would not, in the absence of the proposed funding, have been carried out for several years into the future. The eligible cost elements for accelerated activities will be limited to only the 'time value of money' calculated using a NPV approach with an agreed discount rate and tenor; however, for the avoidance of doubt, the 'capital' spend associated with the 'accelerated activities' will not qualify and be excluded as an eligible cost.

4. 'Condition 10' Decommissioning – mandated and enhanced

A common condition attached to each of the seven Bord na Móna IPC licences relates to the decommissioning and rehabilitation of the licensed peatlands sites. Specifically, licence Conditions 10.1.1, see below, is triggered after '*the termination of use or involvement of all or part of the site in the licensed activity'.*

> *10.1.1 Decommission, render safe or remove for disposal/recovery, any soil, subsoils, buildings, plant or equipment, or any waste, materials or substances or other matter contained therein or thereon, that may result in environmental pollution.*

As Bord na Móna has transitioned its business away from peat harvesting, programs of work designed to comply with this licence condition, and where applicable other necessary consents, are being prepared for discrete bog areas (within the licensed sites) across Bord na Móna's land holdings. As Condition 10.1.1 is an existing legal requirement on Bord na Móna flowing from the extant EPA licences it holds, Bord na Móna cannot be funded to carry out the activities associated with this decommissioning element of Condition 10.

For the sake of clarity, Bord na Móna is not entitled nor will the Company attempt to seek recompense for the real costs associated with discharging the decommissioning requirements under Condition 10.

However, both mandated requirements and improvements under the existing licence, where the costs are allocated to Bord na Móna's own account, and enhanced improvements supported under the proposed funding will be carried out in parallel, it is therefore important that there is a clear delineation as to how the respective expenditures are allocated. It is for that reason, necessary to clearly set out in this Methodology Paper those Condition 10.1.1 requirements that are mandated under the licence, and hence the responsibility of Bord na Móna to carry out, these are listed in section 4.1 below. All other decommissioning activities, listed in section 4.2 , if appropriate and required for the overall rehabilitation and restoration of the particular bog area are eligible for support under the proposed funding.

4.1. Condition 10.1.1 – Decommission activities required to be carried out by Bord na Móna

This section of the Methodology Paper lists the decommissioning of plant, equipment, materials, wastes and infrastructure that come under the remit of Condition 10.1.1. All real expenditure associated with activities necessary to discharge Condition 10.1.1. fall directly on Bord na Móna and are not eligible for support under EDRRS.

(Note the non-sequential numbering is not an error, but rather an internal reference to Bord na Móna's own list of improvements and to the numbering sequence in the EDRRS Financial Model)

1. Decommissioning and removal of pumps

Industrially harvested peatlands have either gravity or pumped drainage. For gravity drained peat fields, no pumping infrastructure is required to be removed, but for pumped bogs, any infrastructure installed to facilitate maintaining the hydrology of the bog for peat production and that is deemed a risk to the environment is required to be removed. It is not Bord na Móna's intention to create areas where pumping will be required in the long-term to support rehabilitation. Pumps will be retained only where there are potential issues for adjacent lands and for supporting other land-uses. Any pumping infrastructure required to be retained will be maintained with suitable management to ensure environmental protection. This infrastructure includes power supply, pump controls, pumps, pipework and sumps. Of this infrastructure, the pump and pipework and any associated transformers are the only items deemed a risk to the environment if not decommissioned and removed. In some cases, steel prefabricated sumps will be lifted out for reuse or recycling, with all other steel and timber supported sumps backfilled with suitable clean peat materials to remove any health and safety hazards.

The process for decommissioning the pump and sump is to divert the inlet outfall, de-energise the pump site, isolate and remove the electrical panel, isolate and remove the pipework, prepare pump for removal by lift in whole or in sections. Where a steel sump is lifted out the remaining hole is backfilled with clean peat material. For timber and steel shuttering, these are left in place and backfilled.

The pumps and pipework are transferred to the nearest location for reuse, recycle or disposal.

5. Emptying of septic tanks

All septic tank contents are required to be removed. A suitable and permitted waste contractor will be engaged to de-sludge the tanks and provide the necessary waste records. Any existing *puraflo* units will also be emptied by a suitable permitted contractor.

6. Decommission of septic tanks

The remaining concrete septic tank structure will then be backfilled with clean suitable material and capped with peat. Any percolation area pipework will be left in situ with any de-sludged *puraflo* units lifted out for recycling/disposal off site. However, any cleaned foul water treatment infrastructure may be retained to support any defined amenity afteruse.

7. Yard Interceptors/Pipework

All site hydrocarbon interceptors will be de-sludged and cleaned using a suitable hazardous waste contractor, with required certifications and waste records maintained. As the interceptors are either constructed of steel or concrete, once these have been cleaned and decontaminated, and if they are not required to be retained as a site asset, they will be backfilled with suitable clean material and capped to remove any health and safety hazards.

All associated site drainage pipework from hard stands servicing these interceptors will be jet cleaned into the interceptor before de-sludging.

8. Fixed fuel tanks (workshop and bog areas)

All workshops within the licensed area contain fuel tank compounds/bunds used to service production and supply chain operations. This infrastructure consists of fixed tanks contained within concrete bunded walls as per condition 9 of the EPA Licence. Condition 9 of the IPC licences relates to surface and groundwater protection in workshop areas and depots. These tanks are first emptied of any usable fuel and then degassed using a suitable hazardous waste contractor, with appropriate certification provided. The tank is then either removed for reuse or recycling or retained within the bund as a site asset.

In addition, the concrete bund is cleaned and any hazardous wastes generated are removed by hazardous waste contractor.

Any remaining concrete bunds, once cleaned and deemed as an infrastructural asset to the site, will be retained.

10. Decommissioning of Production area masonry welfare facilities (Bord na Móna Tea-centres)

Bord na Móna Tea-centres were used to provide canteen and welfare facilities for bog operations and are either a concrete building, a portacabin or older prefabricated older bee hive units and typically contain tables and chairs, a fridge, lockers, cabinets, sinks and other fixtures and fittings.

All basic fixtures and fittings will be retained with all other general waste or unused items removed and disposed to skips for removal off-site. Bord na Móna will also review the viability of retaining particular structures into the future for the support of other land-uses (e.g. amenity).

11. Masonry Tea-centres, removal where necessary

Beyond removing the contents and removal of any compromised asbestos roofs, to satisfy licence obligations and remove any environmental risk, any unsuitable Tea-Centre buildings will be demolished and removed with the concrete pad and foundations retained to support amenity opportunities.

This process will involve the disconnection of any services and the demolition of the building into construction and demolition skips. Any asbestos roofs would be surveyed and taken down using appropriate external asbestos contractors with the required disposal documentation.

12. Production area portacabins

These units will have all services disconnected and removed from the production area in the bog.

14. Peat stockpile decommissioning

Any peat stockpiles that are unsalable will be required to be decommissioned and rehabilitated into the adjoining fields, from where it was originally harvested following an existing and established procedure for peat stockpile decommissioning. This process first involves the associated silt pond being cleaned if necessary, the pile field drains blocked to capture any run-off, with blockages every 100m. The peat is then deposited by dozer onto the adjoining field and blocked drain, where it is cambered and compacted.

15. Bog Area clean-up

These bog areas include the parking spaces for production plant and equipment, locations for storing rail line, drainage pipes and stockpile covering. All old and unused polythene will be collected and depending on condition will be recycled or disposed. Any remaining older and immobile plant will be brought in from bog and removed off site. Any hazardous waste oils, fluids and batteries will be removed off site by qualified appropriate hazardous waste contractors. All unused drainage pipes will be gathered up for reuse, recycling or disposal. All unused rail line sections will be collected from the bog and stored at the main access location for dismantling.

16. Workshop yards

These are typically located adjacent to production bogs and contained more permanent buildings for the service and maintenance of bog operations and supply chain activities. The yards are used to store plant and materials. All unusable machines, plant and equipment will be gathered up for dismantling and recycling. All other plant and equipment will be removed off site.

17. Workshops buildings

These typically contain workshop equipment, hydraulic oils, service pits and stores facilities.

All unused material, oils, stores parts etc. will be removed to main works for reuse. Any remaining waste items not deemed suitable for retention as assets or for reuse or recycling will be disposed of to an appropriate waste contractor. All buildings will be left empty and secured.

18 & 19 Oils store buildings.

Once all oil barrels and associated bunded trays have been removed, these stores could be demolished. This will involve the removal of the roof and demolition of the concrete fabric, windows etc. All waste generated will be deposited and removed in C&D waste skips.

19. Oil stores buildings with asbestos roofs.

Any such buildings will be assessed by asbestos contractors and removed and disposed of with appropriate waste documentation.

21. Offices

These are buildings adjacent to main workshops and house the main administrative function for the associated group of bogs. The typically contain tables, chairs, filing cabinets, IT equipment and services and associated welfare facilities. As these are not items whose retention would present a risk to the environment, these will be retained for the duration of the decommissioning and rehabilitation activities, and once completed will have all contents removed for reuse, recycling, disposal or retention elsewhere, as may be required for record retention or GDPR.

32. Electrical Substations.

This will involve the removal of oils/coolants and associated switchgear and electrical equipment, with the building being removed, or retained once any asbestos roofs have been assessed for integrity.

35. Stripping peat stockpiles.

Any existing and unsalable peat stockpiles which are required to be 'decommissioned' will have protective polythene removed. This will involve the stripping of the polythene cover as per standard procedure where the polythene is rolled/baled by a polywrapper for transport to the area hardstand for removal off-site.

70. Mobile fuel tanks (rail and road supply chain)

Mobile railed mounted and road going fuel tanks were used to fuel bog operations and contain a fuel tank, hydraulic oil barrels, air compressor, and greasing units. Decommissioning will involve the compressor and degreaser being stripped from the wagon, with all oil barrels removed into stock. The remaining fuel tanks will be treated the same as the fixed tanks i.e. emptied of usable fuel, degassed and certified and all lifted from the rail line and removed off-site. Some mobile tanks will be required for peatland restoration and will be decommissioned when restoration improvements are completed.

71. Bog area compounds

These are fenced compounds for the safe storage of plant and equipment at bog areas. These compounds will have had all plant and equipment removed under the licence obligation, but further aesthetic works would include the removal of these compound fencing and gates.

4.2. Enhanced Decommissioning Activities

Notwithstanding the IPC licence requirement to remove any infrastructure or items that may pose a risk to the environment, additional decommissioning can deliver benefits in terms of enhancing natural capital opportunities, increasing biodiversity, supporting bog amenity and eco-system services. Such additional or enhanced decommissioning improvements would be eligible for support under EDRRS.

Again, it is therefore necessary to clearly set out in this Methodology Paper (see below) those additional or enhanced decommissioning improvements which are eligible for support under the proposed funding. The list of allowable cost items included in the scheme is set out in the EDRRS Contract Cost Register.

(Note as per the Section 4.1 the numbering system refers to Bord na Móna's own list of improvements and to the numbering sequence in the EDRRS Financial Model)

3 & 4. Rail line removal

Peat is transported to the main energy customers by rail line. This rail line is narrow gauge rain, laid on stone ballast and where necessary geomembrane. Internally in the bog, temporary rail line is also laid to gain access to stockpiles. The continued presence of rail-line in the licensed areas does not pose a risk of environmental pollution. However, to align with the enhanced plans and with the support of the proposed funding, rail line will be removed, with the underlying bed retained for potential amenity afteruse.

Rail line is lifted much in the same method as initially laid. The bulkhead, or joints where rail sections are connected to each other, are cleaned by machine to expose the fishplate connectors and associated bolts. The bolts are then cut and the section of rail line lifted using a suitable lifter or excavator and appropriate rail lifting frame, onto bogies to be transported along the same line to a workshop or suitable accessible location for reuse or recycling. The rail bed will then be retained.

22. Large rail bridges.

These are rail bridges over rivers/streams, used to transport peat to the customer, and are usually constructed from concrete or steel. While these don't pose a risk to the environment under the licence obligations, they can be modified and maintained to provide improved access across waterways in the future.

This could involve; replacing any damaged or unsuitable decking, providing suitable pedestrian handrails and installing octoblocks to prevent unauthorised vehicular access.

23. Small rail bridges

These are smaller more localised bridges, they will be modified and maintained to provide improved access across waterways in the future. This may involve, repairing / replacing decking and providing / upgrading handrails.

24. Small rail bridge removal (Canal swing/lift bridge)

These are rail bridges over the canal to facilitate peat transport. They are either swing or lift and are operated only by a trained Bord na Móna transport, adhering to a defined protocol. As these bridges are required to be mechanically moved into place to facilitate rail traffic and then lifted again to allow right of way to canal traffic, but do not pose a risk of environmental pollution, it is intended that these are dismantled and removed, but these will be considered on a case by case basis.

25. Decommissioning Machine Bridges

These are specific bridges for allowing machine access from bog to bog over streams and rivers. These again are not a risk to the environment and can be repurposed for future access.

27. Underpasses.

These are concrete box culverted or constructed road underpasses for rail traffic. These will also be secured, repurposed and used for future access requirements. This could involve repairs to guarding and the installation of vehicular access restrictions.

28. Piped culvert underpasses.

These served the same purpose as concrete underpasses (but were constructed with pipes and serve no drainage function). These will be secured and restricted as above.

29. Guarded level crossings

These are rail crossings on public roads, which contain gates, signage and wigwag lights and bollards. They do not pose a risk to the environment and can be repurposed to facilitate future access across public roads. This could involve the removal of the lights and signage, level crossing gates and the provision of fencing to prevent unauthorised vehicular access, dumping/fires etc.

30. Unguarded level crossings.

As above but on local minor back roads, but without gates, signage etc. These would be treated the same as the guarded level crossings in terms the provision of fencing all on a case by case basis.

31. High Voltage power lines

Older sod peat operations and present day pump sites all required a significant network of high voltage internal powerlines. While these are not required to be removed under the licence obligation, if removal was deemed to align with the broader rehabilitation and restoration efforts, they could be considered for removal.

This process would involve de-energising the line using internal electrical resources and ESB networks services, and then dropping the powerline and associated poles. The line would be rolled and transported back to the yard for recycling and poles disposed of as timber waste or repurposed if required.

33 & 34 Fencing of Selected Silt Ponds and Access locations

In areas where there is potential for the general public may gain access to an enhanced rehabilitation site, it will be necessary to secure the ingress and silt pounds in the immediate facility with suitable fencing.

5. Preparation for Peatland Rehabilitation

Significant preparation is required for peatland rehabilitation. Baseline information, from both Desk and Field studies (sections 5.1 and 5.2 respectively) is needed for the planning phase requiring information relating to topography, residual peat depths, type of peat, hydrology, hydrogeology, ecology and pioneer habitats, protected species, water quality, flooding regimes and other environmental data. Consideration of other issues, including but not limited to Bord na Móna future land-use, land management, external hydrology, neighbouring land-use, turbary rights, archaeology, adjoining nature conservation designations and receiving water and catchments is also essential. Consultation with key stakeholders and affected parties (as per Condition 10 requirements) also feeds into the baseline information and planning future improvements.

Planning peatland rehabilitation needs to take account of different scenarios and different potential outcomes. The cutaway environment can be very heterogeneous and environmental variables can vary widely from one site to another. In addition to improving ecosystem benefits, and other socio-economic dividends, the key objective will be to optimise the area of suitable hydrological conditions for climate action benefits (re-wetting peat and keeping water levels close to the peat surface) across heterogeneous landscapes that include:

- Cutaway peatlands with variable environmental characteristics including topography, hydrology, peat depths and underlying sub-soils. In general, they are underlain by alkaline sub-soils.
- Deep peat >2m – drained bog with or without vegetation (may have potential to restore embryonic *Sphagnum*-rich peatland communities).
- Shallow peat – may be interspersed with revegetated cutaway already (usually fen peat exposed).
- High and dry peat (travel paths; peat remaining on headlands; high and dry high fields).
- Complex topographies and varying slopes and elevations, with mounds and ridges of newly exposed glacial sub-soil.
- Complex hydrogeology.
- Pumped drainage: Sites likely to be suited to the establishment of more extensive wetland habitats or water bodies if pumping is reduced/stopped.

The ecological and site information collected during the Bord na Móna ecological baseline survey, additional site visits, stakeholder input, topographical surveys, LiDAR surveys and monitoring and desktop analysis form the basis for the planning of peatland rehabilitation, along with:

- Experience of 40 years of research on the after-use development and rehabilitation of the Bord na Móna cutaway bogs (Clarke, 2010; Bord na Móna, 2016).
- Significant international engagement during this period with other counties in relation to best-practise regarding peatland rehabilitation and after-use through the International Peatland Society and the Society for Ecological Restoration (Joosten & Clarke 2002; Clarke & Rieley 2010; Gann et al. 2019).
- Consultation and engagement with internal and external stakeholders.
- GIS Mapping.
- Bord na Móna drainage surveys.
- Bog topography.
- Hydrological modelling.
- Archaeological Impact Assessments.

Planning peatland rehabilitation also takes account of research, experience and engagement with other peatland restoration and rehabilitation projects and peatland research including Irish, UK, European and International best practice guidance (see Section 10 – References).

5.1. Baseline Information – Desk Study

The desktop study involves collecting all relevant environmental and ecological data for the target area. LiDAR topographical data is used to map the topography and to highlight areas that may be suitable for re-wetting such as basins and flat areas, and areas that would be more difficult to re-wet such as slopes, mounds and ridges. This is best demonstrated using the example below for Corlea Bog.

Figure 5.1. GIS maps of Corlea Bog: LIDAR (left) and remaining peat depths (right).

The LiDAR map demonstrates topography of Corlea Bog (higher topography is blue, lower is red). It indicates that there are two main topographical basins (the yellow area at the North East part of the site and the main red-orange area) separated by a ridge of high ground (the blue) area. Wetland habitats would be expected to develop in the basins while Birch woodland will develop on the ridge. More detailed hydrological modelling can be carried out using this LiDAR data in association with topographical field surveys of outfalls to model future water levels and to plan future water levels that will maximise climate action benefits. Modelling of hydrological flow-paths can also highlight areas that are more suitable for re-wetting. Peat-depth data is important in highlighting sites where there is significant residual peat remaining, which, with re-wetting has potential to develop *Sphagnum*-rich peat forming habitats. The map below indicates that the majority of the peat in Corlea has been removed and residual peat deaths are generally 0-0.5m.

Other relevant on-line resources used to gather baseline environmental information on each bog include:

- Review of the National Biodiversity Data Centre (NBDC) webmapper;
- Inland Fisheries Ireland (IFI) Reports;
- Environmental Protection Agency database (www.epa.ie);
- Bord na Móna's Integrated Pollution Control Licence's & Annual Environmental Reports
- EPA Guidance on Requests for Alterations to a Licensed Industrial or Waste Activity

- BirdWatch Ireland online data (including I-WeBS and CBS datasets; www.birdwatchireland.ie);
- Geological Survey of Ireland - National Draft Bedrock Aquifer map;
- Geological Survey of Ireland - Groundwater Database (www.gsi.ie);
- National Parks & Wildlife Services Public Map Viewer (www.npws.ie) and other relevant datasets;
- Water Framework Directive catchments.ie/maps/ Map Viewer (www.catchments.ie);
- OPW Indicative Flood Maps (www.floodmaps.ie),
- CFRAM Preliminary Flood Risk Assessment (PFRA) maps (www.cfram.ie),
- River Basin Management Plan for Ireland 2018 – 2021
- Teagasc Soils and Subsoils maps
- Met Eireann – Long term average annual rainfall data (1981 – 2010)

5.2. Baseline Information – Field Studies (Ecology)

Bord na Móna carried out a baseline ecological survey of all properties in 2009-2012 and developed habitat maps. Habitat mapping followed best-practise guidance from Smith et al. (2011). Map outputs including all habitat maps and target notes were produced in-house, using GIS software application packages (ArcGIS Version 10.4.1). General marginal habitats and other habitats that had not been modified significantly by industrial peat extraction were classified using Fossitt et al. (2000). Plant nomenclature for vascular plants follows Stace (2019), while mosses and liverworts nomenclature follows identification keys published by the British Bryological Society (2010). A more detailed Bord na Móna classification system was developed for classifying pioneer cutaway habitats as Fossitt categories were deemed not to be detailed enough for cutaway bog (much of cutaway bog could be classified as Cutover Bog - PB4). Much of the pioneer cutaway vegetation is still at an early stage of its development and cannot be assigned to Fossitt Level 3 categories yet.

This baseline ecological survey is an invaluable dataset as the pioneer vegetation cover can be a key indicator of the current environmental conditions on site, how a site will develop in the future and where targeted rehabilitation is required to help enhance natural colonisation. Additional field surveys can be invaluable in relation to understanding site drainage and considering different rehabilitation scenarios.

5.3. Baseline Information – Hydrology

Hydrological conditions in peat can be highly variable, both between and within different types of bogs. Nonetheless, having an understanding of these properties underpin the capacity of rehabilitation works to generate hydrological supporting conditions required to re-wet residual peat and develop best hydrological outcomes for shallow cutaway areas to optimise climate action benefits.

Hydrological monitoring is carried out within each of the proposed rehabilitation sites, for the following key interlinked purposes:

a) Collect baseline data on the hydrological setting of each site to inform rehabilitation design (through characterisation of hydrological conditions)

b) Collect data prior to, during and post-rehabilitation to assist in determining the impact of specific rehabilitation measures (to inform future rehabilitation measure design)
c) Collect data prior to, during and post-rehabilitation which can be extrapolated across representative sections of the site to ensure that the site is on the correct anticipated trajectory.

The monitoring network is typically comprised of a phreatic (free water table) well and a deep piezometer installed within 50cm of the base of peat . The phreatic wells are 2.0m in length with a 1.5m screen, which is considered to be the maximum depth to water table that is likely to be encountered. Deep piezometers have a 50cm screen length. In cases where peat depth is <2m typically only a phreatic well is installed as it is anticipated that there is potential for overlap in screened interval and there will be limited benefits to the monitoring programme. The purpose of the piezometer nest is to enable vertical hydraulic gradient to be estimated which will assist in understanding if there is a greater risk of increased rates of vertical infiltration through the peat to depth or to determine if groundwater is a source of water in shallow peat areas. Following piezometer nest installation each well is surveyed (top of casing, ground surface) using a survey-grade GPS. Where possible piezometers are installed one year in advance of the commencement of rehabilitation to provide baseline data.

The hydrological monitoring network is designed to consider a number of key factors including rehabilitation measure, peat depth and anticipated water levels post-rehabilitation, while also ensuring adequate spatial coverage across the site to assist in characterising the hydrological profile in transects across each bog. A number of practical considerations have also been included in the decision making process, including the ability to access and undertake routine monitoring into the future. As a result, most of the monitoring points are located adjacent to high fields, which will remain dry post-rehabilitation and, in areas expected to become wetlands, monitoring points are located close to the edge of the anticipated waterbody. Known archaeology is also considered in the location of piezometers and where practical and possible piezometers are located in close proximity to such archaeology.

Monitoring of the piezometers consists of a combination of manual monitoring of water levels and use of automated loggers. Manual monitoring will involve monitoring visits in summer and winter. A number of automated loggers (In Situ Rugged Troll 100) are available and these have been prioritised across each of the rehabilitation sites to areas considered most important for monitoring. In general piezometers are monitored for three years, with a proportion of the piezometers to be retained and monitored for the lifetime of the scheme. It should be noted that due to the short timeframe the piezometers for the Year 1 bogs were not installed a full year in advance of rehabilitation.

At the end of August 2022, a total of 1563 piezometers have been installed in 51 bogs and 430 of these piezometers have been equipped with automated loggers.

5.4. Baseline Information – Drainage Management Plans

Drainage Management Plans are prepared for all bogs prior to the commencement of rehabilitation. The main objective from an engineering stand point is to manipulate the hydrology to promote the required environmental conditions however an equally important objective is to mitigate any impact to adjoining landowners that have either come to rely on the drainage network of the relevant bog or to ensure the rise in water levels does not extend to their lands. This is achieved through detailed sub-catchment delineation to identify flow paths and likely vulnerable areas which in turn informs the use of intervention measures such as the use of existing or new drains which act as hydraulic breaks (by bringing the water level down to its original level), rehabilitation exclusion zones or a reduction in intensification of the rehabilitation measures close to the boundaries.

5.5. Baseline Information – Stakeholder Engagement

It is important to engage and consult with stakeholders in relation to the scheme. Consultation is also a requirement of the IPC Licence. This requirement is set out in section 2 of the EPA document Guidance on the process of preparing and implementing a bog rehabilitation plan. A website has been developed setting out information on the scheme and this can be found at https://www.bnmpcas.ie/.

As bogs are identified for rehabilitation, a Draft Rehabilitation Plan is prepared, and a copy of this plan is uploaded to the website. A list of stakeholders is compiled for each bog and an email issued to inform these stakeholders of the Draft Rehabilitation Plan. Submissions are also invited in this email. The list of stakeholders consists of Local Authorities, NGOs, Government Bodies, Elected Representatives, Farming Organisations, Community Groups and any other relevant stakeholders identified. A letter and brochure in relation to the scheme is also delivered to households located within a kilometre of the proposed rehabilitation area. Any submissions received are addressed in the Final Rehabilitation Plan which is also made available on the website. A Community Liaison Officer has also been appointed and he is available to take calls and facilitate meetings and site visits.

There is also a statutory consultation process for any bogs that require a Natura Impact Statement.

5.6. Other Baseline Data

Other baseline information used to obtain data on the peatlands includes, but is not limited to site specific coring completed as part of the piezometer installation programme, (recorded peat thickness, substrate content and water level readings), ground penetrating radar (GPR) data, LiDAR topographical data, surface water monitoring data, flood mapping, topographical and other information obtained from Engineering and Surveying site visits and any other relevant and available information pertinent to each bog.

6. Cutaway peatland rehabilitation – standard approaches to meet EPA licence obligations

6.1. Introduction – Standard Rehab Measures

In addition to the mandated decommissioning provisions arising from Condition 10.1.1, and discussed in Section 4 of this 'Methodology Paper', the EPA licences also require Bord na Móna to prepare Rehabilitation Plans (Condition 10 plans) for the Cutaway Peatlands.

> "*The licensee shall prepare, to the satisfaction of the Agency, a fully detailed and costed plan for permanent rehabilitation of the cutaway boglands within the licensed area.*"

This key objective of this section (Section 6) is to set out **standard rehabilitation** measures to differentiate these measures (and the cost of these measures) from **enhanced rehabilitation measures** that will only occur if supported by funding. The cost of **standard** rehabilitation measures is not covered by EDRRS. Standard rehabilitation measures will only be implemented when there is no additional external funding to support enhanced rehabilitation measures.

The primary goals and outcomes of the various individual site rehabilitation plans are to (1) meet condition 10 requirements and (2) optimise climate action and other ecosystem service benefits from enhanced rehabilitation measures.

The EPA document *Guidance on the process of preparing and implementing a bog rehabilitation plan* sets out the process to be followed by licensees when preparing and implementing a bog rehabilitation plan. There is a requirement in this document (Section 3.6) and in the IPC licenses (Section 10.3.2) to outline the criteria which define successful rehabilitation. In the past Bord na Móna applied a range of different measures to peatland rehabilitation, all related to the overall objective of **environmental stabilisation.**

Environmental stabilisation of cutaway peatland is identified by a number of critical success factors:

- stabilising silt run-off/erosion (wind/water erosion).
- slowing movement of water off the bog (reduce the erosive force of water).
- setting the bare peat cutaway on a trajectory towards developing full vegetation cover and naturally functioning habitats that reflect the underlying environmental conditions.

This is achieved by:

- Assessment and planning of re-wetting scenarios and hydrological management coupled with field surveying (baseline and mapping surveys).
- Field drain blocking with outfall modification or realignment where possible/necessary coupled with decommissioning of pumps where necessary.
- Targeted berms if and only if necessary.
- Fertiliser application if natural vegetation colonisation is deemed to be slow (on high and dry peat areas such as travel paths).

Bord na Móna's primary rehabilitation strategy has been to re-wet peat, where possible, and to work with nature. Targeted measures, such as drain-blocking encourage natural colonisation and lead to the development of a mosaic of natural habitats including wetlands, fen, reed swamp, heath, embryonic bog, grassland and birch woodland that reflect underlying environmental conditions. These habitats will eventually merge and blend into the surrounding landscape.

Different environmental scenarios can lead to different outcomes. For example, much of the older Bord na Móna cutaway has had the majority of its peat removed and the water chemistry tends to be more alkaline (due to the underlying sub-soils) leading to the development of a mosaic of wetland habitats including fen and reed swamp and wet woodland (particularly where there is pumped drainage). In contrast, other sites have deeper residual peat and have developed embryonic *Sphagnum*-rich peatland communities and heather-dominated vegetation similar to communities described by Smith and Crowley (2020), which are typical of cutover bog around raised bogs.

Critical success factors will be established on a site by site basis to measure and validate successful rehabilitation to meet EPA IPC licence conditions. These will be determined on a site by site basis but in general will include:

- Demonstrating the delivery of the rehabilitation programme through site visits and through updated available aerial/satellite imagery photography (indicating delivery of measures and re-wetting).
- Stabilising potential emissions from the site (silt run-off). The critical success factor will be developing a stable or downward trajectory of water quality indicators (e.g. suspended solids and ammonia) towards what would be typical of a re-wetted cutaway bog.

These critical success factors will inform a validation report that rehabilitation is complete and IPC licence obligations are addressed, ultimately leading to IPC licence surrender. Additional critical success factors will be established to measure and validate the benefits of enhanced rehabilitation measures for other goals and outcomes (e.g. setting the site on a trajectory towards establishment of a mosaic of compatible habitats and for climate action in relation to reduced carbon emissions – See Section 7).

This diversity and range of starting conditions requires that all sites be considered independently in relation to the planning and delivery of rehabilitation. Typical considerations include:

- Adjoining landowners/access (rehabilitation will be carried out in a manner that avoids impact on neighbouring land).
- Future potential land-use.
- Future hydrological regime.
- Receiving waters/catchments.
- Any adjoining nature conservation designations and habitats.
- Species of conservation value already using these sites (Curlew, Marsh Fritillary, Lapwing, etc.).
- Private turf cutting may be ongoing on adjacent turbary land.
- Existing known peatland archaeology.

Note that this list should not be considered complete or exhaustive, but rather indicates the range of issues that require consideration on a site-by-site basis. All rehabilitation plans also need to take cognisance of key legislation and national strategies and plans, including:

- EPA Licensing
- Wildlife Act
- Environmental Impact Assessment Directive

- Water Framework Directive
- EU Habitats Directive
- National policy documents, including but not limited to National Climate Change Strategy, National Planning Framework, National Peatland Strategy, National Raised Bog Conservation Management Plan 2016-2022, National Biodiversity Action Plan, etc.

Goal setting is one of the more important aspects of developing a peatland rehabilitation plan, particularly for validating rehabilitation and the outcomes of the plans. Setting goals for rehabilitation and defining criteria for successful rehabilitation is influenced by the differing environmental conditions and other issues that influence the scope of peatland rehabilitation (listed above), as are the actions required to achieve successful rehabilitation. This will be carried out on a site by site basis and will be cognisant of differing starting points, varying environmental conditions, different potential outcomes and other external factors.

It is important to note, for reasons outside the scope of this Methodology Paper, the range of rehabilitation measures that were applied by Bord na Móna in the past frequently **went beyond** what was required to meet the conditions of the EPA Licence. For the avoidance of doubt, there was no expectation or requirement on behalf of the EPA that these additional interventions were required as part of the licence obligations. For example, past interventions included raised bog restoration following NPWS raised bog restoration guidelines (1 peat dam per 10cm fall in topography) at sites like Clonboley and Killeglan. Less intensive drain blocking at these sites would have met the conditions of the EPA Licence (environmental stabilisation) but would not have been as effective in achieving the additional objectives of raised bog restoration and encouraging the development of active raised bog.

Bord na Móna took an innovative, flexible and iterative approach to peatland rehabilitation of cutaway peatland. Below is a description of the key standard approaches to peatland rehabilitation that will meet the key rehabilitation requirement of the EPA Licences. These standard measures are outlined in this way to make a contrast between **standard approaches to rehabilitation** and **enhanced approaches to rehabilitation** which is eligible for support under EDRRS and is set out in Section 7.

In general, these **standard approaches to rehabilitation**:

- **are less** intensive (less effort, resources and cost per ha).
- will be adapted to the underlying environmental conditions and will be 'nature-based' (nature based solutions in this context are solutions that are supported by nature i.e. rewilding).
- will manipulate water levels to a limited degree.
- are targeted.
- will depend on natural colonisation to develop pioneer vegetation.
- **will not** significantly manipulate the topography of the cutaway.
- **will not** introduce seed or other vegetative material.

The measures outlined below describe the main standard rehabilitation measures that would be applied to different types of cutaway to meet the conditions of the EPA Licence if enhanced measures were not funded. Similar measures can be applied to bogs with different environmental characteristics and will have different outcomes.

6.2. Modify main outfalls and managing water levels using outfall pipes to re-wet cutaway

Water levels across cutaway bogs can be raised relatively easily by modifying the main outfall and then allowing water levels to rise across the cutaway.

Cavemount Bog and Lodge Bog are examples of **targeted drain-blocking** that was carried out prior to EDRRS and further details are provided in Appendix App A1. In Cavemount Bog modifying of the main outfalls has resulted in the eastern side becoming re-wetted and developing as a wetland. The development of vegetation has been influenced by the more alkaline sub-soils that were exposed, leading to the development of fen type pioneer vegetation.

Additional enhanced rehabilitation was carried out in Cavemount in 2021 and in Lodge Bog in 2022 under EDRRS.

6.3. Turn off or reduce pumping and re-wet cutaway

Many of the pumped bog sites are already located in basins that are partially below the surrounding surface water-level. Turning off or reducing pumping allows the basin to fill with water (rain-water, ground-water or combination). The water level can be managed at the outfall in a similar way to the above measure to maximise suitable hydrological conditions for the development of wetland vegetation (the creation of emergent wetland vegetation leading to fen, reedbeds and wet woodland). This management option is particularly effective for re-wetting larger areas of cutaway. In general, the target summer water level is c.100mm ± 50mm to keep residual peat wet during the summer and encourage the development of mosses and reed cover.

In general, these sites will be subject to winter inundation and natural seasonal water level fluctuations, with higher water levels present in the winter period. One key issue to avoid, where possible, is the development of permanent deeper water levels with large bodies of open water. At some sites this is inevitable due to the heterogeneous topography and deeper pools will develop. Hydrological modelling can help identify suitable water levels that would maximise the overall area with optimal water depths. Levels are set to minimise the extent of deeper water, where possible.

The two key parts of this management option include (1) removing or reducing pumping and then (2) managing water-levels via the development of a new gravity outfall as above. In some cases, the general water level can be adjusted again after several years to increase or reduce water levels, where appropriate.

In some cases, pumping may be reduced rather than stopped completely. This may happen where there is a risk that ceasing pumping completely will have adverse impacts on external lands from rising water levels. Hydrological modelling and flood risk assessment will be used to assess potential impacts of different pumping regimes and to determine the most sustainable new regime of water level management that will balance requirements to avoid adverse impacts to neighbouring land while improving hydrological conditions within the cutaway.

Corlea Bog is an example of this standard rehabilitation methodology with further details set out in Appendix A, Section App A2.

6.4. Regular field drain-blocking with a machine (Dozer) to re-wet cutaway (3 peat dams/100m)

This approach is particularly effective for bare peat areas that are not prone to flooding. The primary objective here is to block field drains using peat dams. This creates mini silt ponds in the former drains – trapping mobile silt. It also raises water levels and re-wets peat – encouraging natural colonisation. This approach can be applied to cutaway bog areas that are dominated by bare peat. It can be applied to residual peat of various depths including **deep cutover peat**. It is not suitable for areas that are too wet for using machinery safely. However, these areas will develop wet habitats naturally.

Peat dams are installed efficiently by a bulldozer generally operating at a perpendicular direction to the field drains. A 'key' is formed first by cutting out peat from the both sides of the edge of the drain with the dozer. Peat is taken from the centre of the peat field and then pushed into the drain and consolidated by the dozer driving over the peat dam. A 'speed bump' peat dam is created to allow for peat subsidence and to prevent water from flowing over the peat dam and eroding it before it becomes stabilised. Peat dams are generally constructed at intervals about 30m apart (c. 3 blocks per 100m of field drain). It should be noted that these "speed bumps" are only keyed in at the top of the drain using the dozer and this key does not extend to the sides and base of each drain block. An excavator is required to install a fully keyed in drain and this is considered enhanced rehabilitation as it is a more intensive and slower process.

Derryvilla Bog and Carrickhill Bog are examples of bogs where this rehabilitation measure has been carried out and details are included in Appendix A – Section App A3.

In these bogs water still flows across this re-wetted landscape according to the prevailing slopes, but now flows across the peat surface and generally avoids the new peat dams. Hollows and drains across this new re-wetted landscape remain wet. A key issue on these milled peat bogs is the uneven topography of the peat fields. This means that when drains are blocked, hollows become wet while other higher areas remain dry. The variation in topography between adjacent peat fields can be significant (0.5 - 1m). Typical peat fields are also cambered and are higher in the centre and lower towards the drains, helping drainage of the fields but limiting the re-wetting of the central area.

This more regularised approach to blocking drains and re-wetting cutaway is effective at reducing silt from leaving the cutaway by creating mini silt ponds, helping environmental stabilisation. Re-wetting peat will also encourage development of natural vegetation. The type of natural vegetation will reflect the underlying environmental conditions.

6.5. Case Study – The Environmental Stabilisation of Derries Cutaway Bog

The development of Derries cutaway bog is an example of the targeted rehabilitation and natural colonisation acting together to develop pioneer habitats and stabilise former industrial peat production bog. This rehabilitation was carried out prior to EDRRS and further details of this rehabilitation are included in Appendix A – Section App A4.

7. Cutaway peatland rehabilitation – Enhanced approaches

7.1. Introduction

This section outlines a series of cutaway rehabilitation measures to derive and optimise additional ecosystem service benefits, particularly in relation to optimising carbon storage of residual peat, reducing GHG emissions, accelerating the development of carbon sequestration with *Sphagnum*-rich vegetation, reducing fluvial losses of carbon (via water) and setting sites on an accelerated trajectory towards developing natural peatland, wetland and woodland ecosystems.

This key objective of this section (Section 7) is to set out **enhanced rehabilitation** measures to differentiate these measures from **standard rehabilitation measures**.

In general, these enhanced measures will bring accelerated and enhanced environmental stabilisation. These additional improvements are designed to incorporate and subsequently enhance the measures of standard peatland rehabilitation outlined in Section 6.

In general, these **enhanced rehabilitation measures:**

- are more intensive (more effort, resources and cost per ha).
- will be adapted to the underlying environmental conditions and will be 'nature-based', stable and with a low risk of failure – likely that more novel improvements will be trialled before widespread deployment.
- will take a more intensive approach to planning and design of enhanced peatland rehabilitation using hydrological modelling informed by a robust field monitoring programme and other available data.
- will significantly manipulate water levels via drain-blocking, bunding and outfall modification.
- will significantly manipulate the topography of the cutaway to maximise the area of optimal water levels by levelling surfaces where possible.
- will further slow the movement of water through these sites.
- will introduce seed or other vegetative material to promote and accelerate natural colonisation to develop pioneer vegetation.
- will optimise ecosystem service benefits of peatland rehabilitation, particularly climate action and water quality.

The objective of these enhanced rehabilitation actions is to optimise suitable baseline hydrological conditions for climate action benefits, to slow the movement of water across these landscapes and to accelerate environmental stabilisation via natural colonisation. This means re-wetting peat with the most optimum water levels (generally at or slightly above the surface of the peat) for the development of vegetation that suits the underlying environmental conditions, setting these areas on a trajectory towards naturally functioning wetland and peatland. In some instances, this will mean taking a more engineered approach to create a new landscape that maintains optimised hydrological conditions for the development of raised bog, fen and wetland vegetation. In other areas, this will mean established conditions that favour the development of fen, reed swamp and wet woodland habitats. While in deeper peat regions, the potential to promote embryonic *Sphagnum*-rich vegetation communities can be realised because water chemistry will be relatively more acidic.

The enhanced rehabilitation measures detailed in the Condition 10 submission to the EPA will require more detailed "top down" assessment, planning and design. Different rehabilitation methodologies will be applied due to different cutaway environments and underlying ground conditions as previously described in section 5 (dry cutaway, wetland cutaway, deep peat cutaway). In general, there is no 'one size fits all' approach as each cutaway bog will have different rehabilitation challenges and different hydrological environments. The over-arching and guiding principle for the enhanced rehabilitation measures detailed in the Condition 10 submission to the EPA will be to 'do the right thing in the right place' (integrating the most suitable objectives, actions (improvements) and targets with heterogeneous environments and differing environmental conditions between cutaway bogs so as to optimise ecosystem service benefits.

As stated previously in Section 6, critical success factors will be established on a site by site basis to measure and validate successful rehabilitation to meet EPA IPC licence conditions. Additional critical success factors will be established to measure and validate the benefits of enhanced rehabilitation measures for other goals and outcomes. In addition to the critical success factors outlined in Section 6 (e.g. targets set for the stabilisation or improvement in water quality parameters), these will include, for example:

- Re-wetting of cutaway bog with optimal hydrological conditions based on site specific environmental parameters for climate action (target set for % cover of suitable water levels).
- Demonstrating that bare peat cover is reducing and that natural stable vegetation cover is increasing (target is a reducing % cover of bare peat and indicators of pioneer vegetation development).
- setting sites on an accelerated trajectory towards establishment of a mosaic of compatible naturally functioning peatland habitats (targets set for establishment of various habitats).
- reducing and stabilising carbon emissions from these sites (based on emission factors to be developed under EDRRS).

The enhanced rehabilitation measures will be delivered on the ground through **rehabilitation packages or methodologies** which seek to combine one or more of the rehabilitation measures together to deliver the rehabilitation work in a strategic, co-ordinated and integrated way. The following table (Table 7.1) lists the Rehabilitation packages and the land types that they are used in.

Table 7.1 Rehabilitation Methodologies in each Land Type Categories.

Rehab Methodologies and associated Land Type Categories			
Deep Peat Cutover Bog		**Wetland**	
DPT1	Deep Peat Type 1	WLT1	Wetland Type 1
DPT2	Deep Peat Type 2	WLT2	Wetland Type 1
DPT3	Deep Peat Type 3	WLT3	Wetland Type 1
DPT4	Deep Peat Type 4	WLT4	Wetland Type 1
DPT5	Deep Peat Type 5	WLT5	Wetland Type 1
DPT6	Deep Peat Type 6		
Dry Cutaway		**Marginal Land**	
DCT1	Dry Cutaway Type 1	MLT1	Marginal Land Type 1
DCT2	Dry Cutaway Type 2	MLT2	Marginal Land Type 2
DCT3	Dry Cutaway Type 3		
Additional Work			
AW1	Additional Work 1		
AW2	Additional Work 2		

Each of the above rehab packages consists of a combination of rehab measures and the following sections describe each enhanced rehabilitation measure individually. While the prescribed rehabilitation measures are designed to be relatively straight-forward and repeatable, they can be adapted at different sites to optimise benefits.

Below, sections 7.2 - 7.15 describe the key approaches to **enhanced** peatland rehabilitation that align with, but go beyond, the requirements of the EPA Licence. These measures are outlined in this way to make a contrast between **standard approaches to rehabilitation,** see section 6, and **enhanced approaches to rehabilitation** which will be undertaken under EDRRS.

7.2. Drain-blocking with an excavator to re-wet cutaway

This enhanced measure can be applied to cutover bog, cutaway bog and drained raised bog with different environmental characteristics. It can be applied to residual peat of various depths including deep cutover peat. The main objective is to block drains with peat dams to raise water levels, re-wetting peat and slowing water movements through the site. Slowing water movement will have additional benefits of reducing fluvial carbon loss (via water) and also eventually improving water quality leaving the site by reducing emissions of silt and ammonia.

These drains blocks are used in a number of enhanced rehabilitation methodologies including DPT2, DPT3, DCT3, WLT4, WLT5, MLT2 and AW2. They are also used at the cell berm locations for the DPT4 and DPT5 methodologies. Reference Table 8.2 in section 8 for rehabilitation methodologies.

The number of peat dams per 100m is determined by the topography of the site, but an allowance has been estimated at a minimum of 4 per 100m and a maximum of 7 blocks per 100m of field drain. The number of drain blocks is dictated by the gradient of the drain and the blocks are set out at every 100mm fall up to a max of 7 blocks per 100 metres. In the case of wetland methodology WLT4 the maximum number of drain blocks is 4 per 100 metres regardless of the gradient. The methodology follows NPWS guidelines published by the National Parks and Wildlife Service (Mackin et al. 2017) and in line with methodologies originally developed by McDonagh (1997), however the drain block frequency differs as the NPWS guidelines has a maximum of 10 blocks per 100 metres. This method requires the cutting of a 500mm key along the side and base of the drain and the compaction of peat in layers when forming the drain block. This method of forming drain blocks along with the increased number of drain blocks (compared with the standard measures) benefits re-wetting, traps silt on cutaway with slightly greater slopes and further slows the movement of water from these sites.

Where areas are heavily vegetated with scrub/trees, it is not always possible to install the number of drain blocks in accordance with the above methodology without damaging existing vegetation. In some cases, a tree felling licence would be required as small trees may be established. In these situations, targeted drain blocking is carried out and drain blocks positioned in more accessible less vegetated areas. This allows for some rewetting of these areas with minimal interference to existing ecology and biodiversity.

An example of the application of this enhanced drain blocking rehabilitation measure is at Ballysorrell Bog and further details on this bog are included in Appendix B section App B1.

Drain blocks have been provided in circa 3700 ha of the Bord na Móna peatlands as part of the Year 1 rehabilitation under the scheme. These drain blocks are performing successfully to date and some examples are shown below.

Figure 7.1. Kellysgrove Bog June 2021. Drain Blocks being formed.

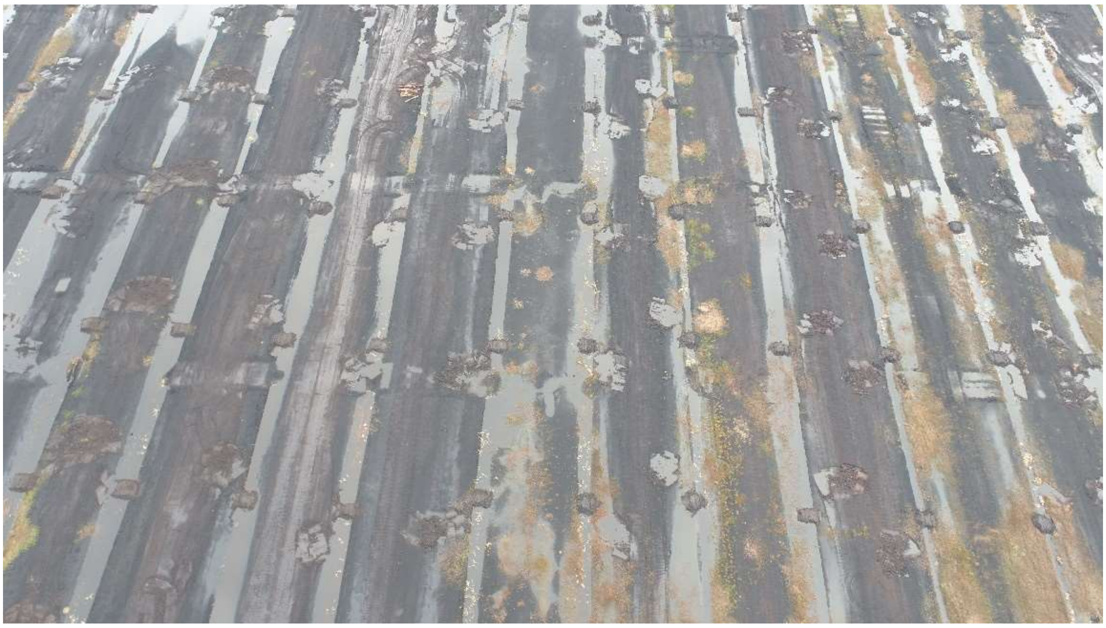

Figure 7.2. Image of drain blocks in Cavemount Bog showing the water levels close to the surface of the bog.

Figure 7.3. Drain blocks in Derrycolumb Bog.

7.3. Field re-profiling to improve the overall topography and optimise re-wetting

This enhanced measure had not been extensively used prior to the commencement of EDRRS by Bord na Móna for cutaway peatland rehabilitation. Bord na Móna had however gained valuable knowledge, following the completion of several small-scale trials to improve baseline topography and to 'flatten' discrete peat fields.

The concept of field re-profiling is to level the surface of the individual peat production fields to allow more uniform coverage of water at an ideal depth (c.100mm ± 50mm) for vegetation colonisation and in particular the development of mosses that will accelerate the trajectory towards naturally functioning peatland ecosystems. It can be applied to residual peat of various depths including deep cutover peat. The development of *Sphagnum*-rich, peat-forming vegetation requires a flat topography and the removal of the production field camber in areas with deeper residual peat is proposed to provide a flatter topography.

Peat production fields generally have a convex camber toward the edges and have a heterogeneous topography. It is usual for the drains and edges of the fields to become wet whilst the high centres of the fields remain dry. Small hollows within the peat fields will retain surface water for longer. This enhanced measure targets the development of a flat or concave topography that helps the retention of shallow surface water. This approach is combined with other measures such as drain blocking to re-wet peat to increase the cover of shallow surface water and re-wetted peat on the former production fields. In general, peat production fields will still have a prevailing slope (they will be flatter or convex, but not level).

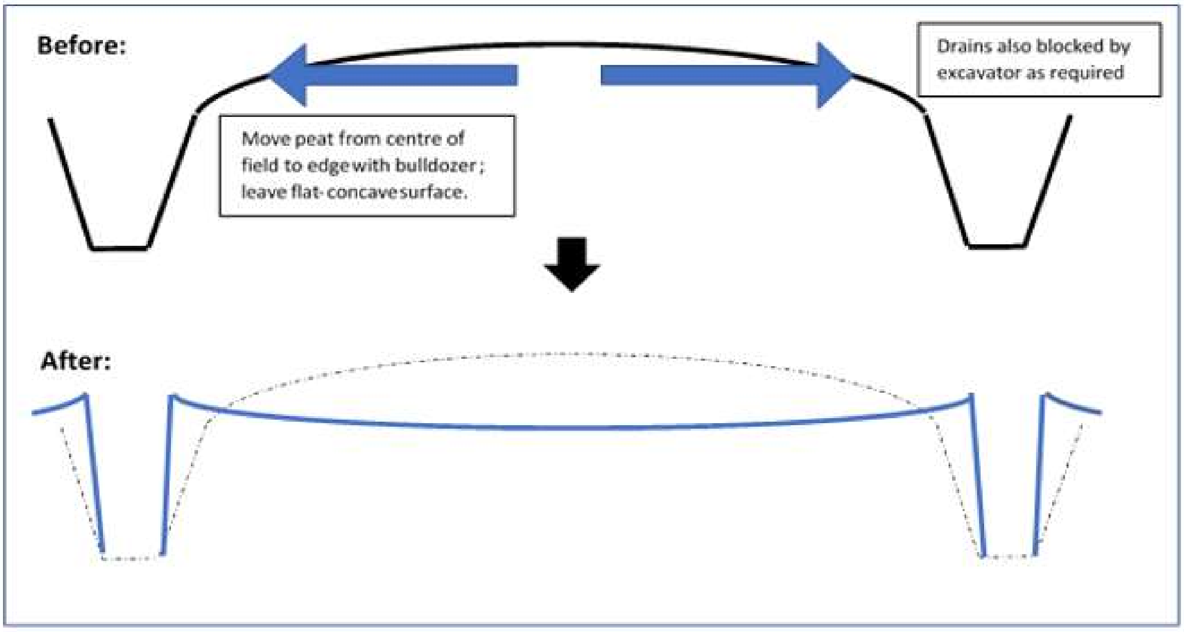

Figure 7.4. Indicative methodology for field profiling.

Figure 7.5. Screw-leveller removing the camber of peat-fields at Castlegar Bog.

Figure 7.6. Levelled peat fields with camber removed.

Figure 7.7. Dozer removing the camber of the production field in Castlegar Bog.

This method uses a bulldozer to remove the high central camber from individual production fields and deposit the peat on the lower-lying edges of the same production field and partially in the drains (see Figure 7.4). It is not intended to completely infill the drains but the drains are blocked with peat dams at intervals of 4 to 7 blocks per 100 metres as set out in Section 7.2 above. It is planned to create a final profile with a largely flat or slightly concave surface. This will depend on the general topography and slope. On cutaway with increased slopes it is more advantageous to create shallow depressions. Any depressions will be 10-20cm deep, and a maximum of 20m long (although natural topography may require flexibility in sizing). Depressions can be separated by a strip of undisturbed peat 1-2m wide.

A screw leveller is also used to remove the camber from these production fields. This equipment, which consists of a long horizontal rotating screw towed by a tractor, was used in the past by Bord na Móna to create the camber in the production field. When used in the opposite direction it removes the camber. As it is towed by a tractor rather than a tracked machine, the ground conditions need to be firm and relatively dry and depending on these conditions it may need to be used in conjunction with a dozer.

In general, water still flows across the surface of the re-profiled peat field depending on the prevailing slope but is retained for longer in the depressions, encouraging the development of wetland habitats or embryonic raised bog vegetation on sites with deeper residual peat. The increased depression expands the area of optimal hydrological conditions. On more level ground, it is more straightforward to re-wet larger areas with a more homogenous topography. Slowing water movement has additional benefits of reducing fluvial carbon loss (via water) and also improving water quality leaving the site by reducing emissions of silt and ammonia.

This combination of field re-profiling and drain blocks is referred to as Deep Peat 3 (DPT 3) methodology. Field reprofiling is also used in the WLT5 rehab methodology in conjunction with drain blocks. Reference Table 8.2 for the rehab methodology descriptions.

Field re-profiling has been carried out as part of the DPT3 methodology in the rehabilitation of Castlegar, Esker, Mountlucas, Derrycolumb and Edera bogs in Year 1 of the scheme. The image below shows field re-profiling and drain blocks that was carried out in Derrycolumb Bog in 2021.

Figure 7.8. DPT3 Rehab methodology Derrycolumb Bog November 2021.

7.4. The use of berms and field re-profiling to optimise re-wetting

Although not extensively used as an enhanced measure by Bord na Móna prior to the commencement of EDRRS, several small-scale trials were carried out to improve cutaway re-wetting using berms.

This enhanced measure creates large (e. g. 45m x 60m) flat areas or cells of shallow water on bare peat, across multiple fields that are enclosed by shallow berms to retain shallow surface water. The creation of cells will help retain surface water, keeping peat wet and will further slow water movement through the cutaway. This methodology is referred to as Deep Peat 4 (DPT4) methodology.

The width of each cell is typically four fields wide, however this is subject to the location of high fields in the vicinity of the cells. In some cases, drains within the cell are infilled however in some locations, drains are left open where there is not sufficient peat available. In locations where the peat depth is shallow and there is an apparent deeper mineral groundwater influence these drains are filled, however this also depends on the availability of the peat which is generally dictated by the height of the camber and the difference in the level of adjacent production fields.

A bulldozer is typically used to level and flatten the base of the cell and to infill the drains, where appropriate. The bulldozer removes the camber from the former peat production fields to create this flat and level cell base and the aim is to achieve a maximum fall across the base of each cell of 0.5%. Where bog timber is encountered in the base of the cell, this timber is left in-situ and the cell base formed around it.

Berms are created across or perpendicular to the fields. These berms are relatively shallow and at least 4-5m wide to accommodate an excavator and other equipment and also to provide suitable protection to resolve the anticipated hydraulic forces within the cells. These berms will act to enclose the cell and to retain shallow surface water. A drain block, which is keyed in, is installed at each location where a berm crosses a drain to ensure no subterranean flow paths within the drains are retained. Pipes or plastic sheet piles are used to manage overflows between cells and promote the ideal water depths within the cell. At the commencement of the scheme it was proposed to utilise pipes to regulate the flow between cells and to optimise the water levels within the cell. A trial was carried out on the use of sheet piles as an alternative to pipes to regulate this flow and a summary report on this trial is included in Appendix C. Figure 7.9 below shows an example of how sheet piles are used to regulate the flow between cells.

Figure 7.9. Sheet piles to regulate flow between cells – Belmont Bog.

The berms are formed using an excavator and the berms installed at a target height of 0.5 metres. This allows for some future settlement so that the final level of the berms is not less than 300mm. The berms are formed using a bulldozer to push the peat into place and the berms are then shaped using an excavator. In some instances, the berm heights can be slightly greater than 500mm where surplus peat is placed within the berm formations.

The exact dimensions of the cell is dependent upon the topography of the site and the heights of the various peat fields. For example, it may be appropriate to have cells that are only two fields wide where two low fields have higher fields on either side. Existing high fields, formerly used for peat stockpiles, are utilised as berms where possible and reduces the number of berms to be formed. The size of the cells is dictated to some extent by the spacing between these existing high fields.

It may not be appropriate to equalise the levels of two adjacent fields where there is a significant height difference. The length of the cells may be shorter if the fields are on a steeper gradient to that the base of the cells is flat to retain water. Such flexibility is essential to maximise water retention on site and minimise machinery and peat movements. This enhanced measure requires more intensive planning to adapt it towards varying topography. The following figure shows a schematic cross section of this cell formation showing the original production fields and field drains.

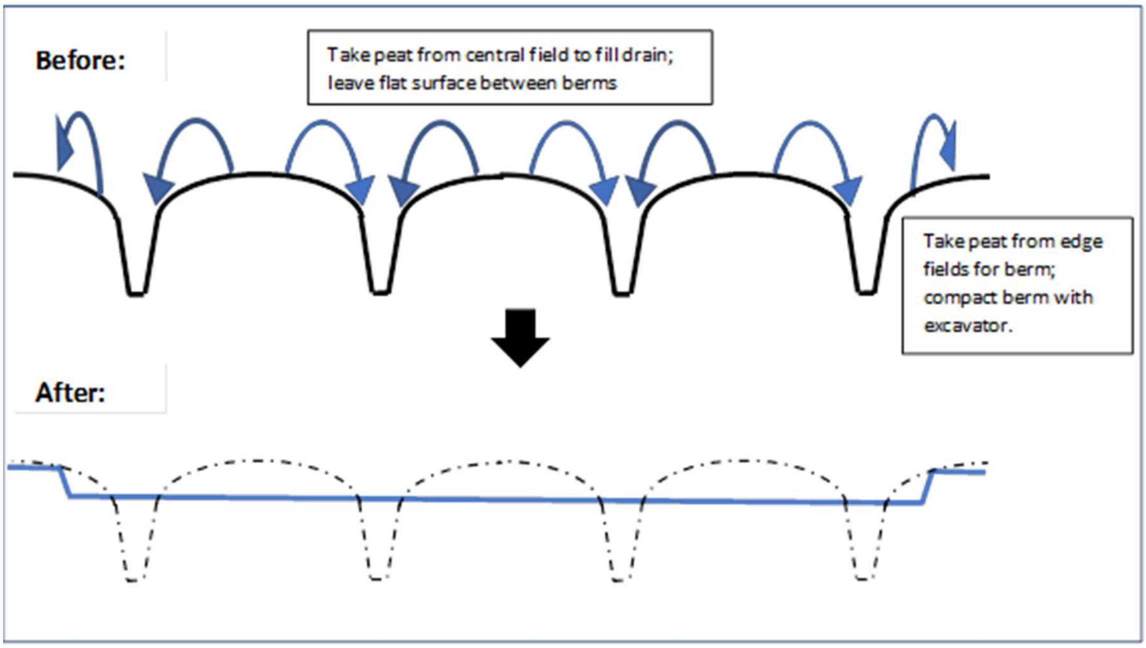

Figure 7.10. Indicative methodology for surface profiling with berm; note that berms perpendicular to the production field pattern are also required as dictated by the slope of the site. Also please note that all drains may not be infilled.

Prior to the commencement of EDRRS, Bord na Móna constructed bunds/berms at Lodge Bog as part of a re-wetting trial (bunding only, not re-profiling). Further details on this trial are set out in Appendix B - Section App B2.

At the end of July 2022, field re-profiling and the provision of berms to create these larger cells had been completed on 1400 hectares, with 730 of these hectares completed in Year 1 of EDRRS. While it is too soon to be definitive, these Year 1 bogs appear to have re-wetted and the water levels appear to have risen based on initial piezometer readings. This DPT4 methodology was carried out on significant areas in Ummeras, Esker, Pollagh and Castlegar Bogs and photos of the rehabilitation in Esker and Pollagh Bogs are shown below.

Figure 7.11. Esker Bog December 2021. Rehabilitation commenced Summer 2021.

Figure 7.12. Pollagh Bog November 2021. Rehabilitation commenced May 2021.

7.5. Formation of Small Cells to re-wet deep peat cutover bog

Prior to the commencement of EDRRS, this enhanced measure has been used with success by Bulrush in Co. Antrim (Sluggan Bog) to re-wet former industrial production bog and encourage the development of *Sphagnum*-rich embryonic plant communities. Bulrush harvest horticultural peat from former small raised bogs in north Antrim and Derry, including at Sluggan Bog (50 ha). The original cutaway landscape had regular peat fields and drains in a similar configuration to Bord na Móna bogs. Peat was harvested using the milled peat production. Further details on the rehabilitation of this bog is set out in Appendix B Section App B3.

This is an intensive engineering approach to peatland rehabilitation that looks to modify the topography substantially to optimise suitable hydrological conditions for the development of peat-forming communities. It also has additional benefits of reducing fluvial carbon loss (via water) and also improving water quality leaving the site by reducing emissions of silt and ammonia.

The small cell approach aims to create 'saucers' or flat bunded areas (cells) on peat with berms to hold shallow water at appropriate levels. Each cell is approximately 30m x 30m and as cells are formed production field drains are infilled with peat where peat is available to do so. Cells are sized relatively small to prevent wave erosion affecting the development of moss growth. This combination of the use of berms to form small cells and re-profiling is utilised in the DPT5 methodology.

Bunds are formed using an excavator at a level approximately 50cm higher than the cell floor and will be about 4-5m in width. This allows for some future settlement so that the final level of the berms are not less than 30cm. The berms are formed using a bulldozer to push the peat into place and the berms are then shaped using an excavator. When the bund is formed, it is compacted by the excavator's tracks to ensure that the bund retains shallow water in the cell. Figure 7.13 below shows a schematic cross section of this small cell rehab measure.

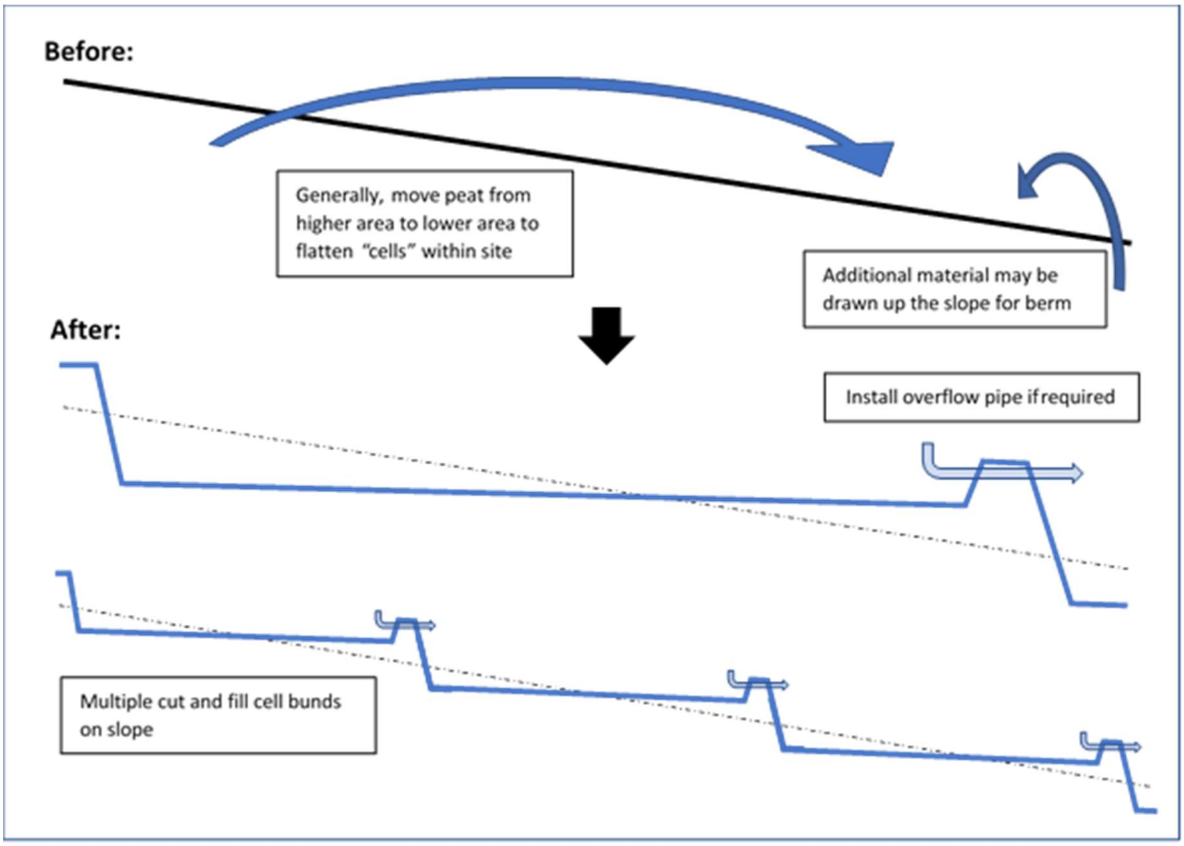

Figure 7.13. Indicative methodology for small cell formation; typically, peat is taken (cut) from the upper slope to raise and flatten (fill) the lower part of the slope, but note that peat may be drawn uphill to create the berm if required and where appropriate site conditions exist. The flatness of the cell and height of the berm/overflow pipe are crucial.

The bull-dozer is used to remove the camber from the former peat production fields and to create a flat and level surface and the aim is to achieve a maximum fall across the base of each cell of 0.5%. Where bog timber is encountered in the base of the cell, this timber is in situ and the cell base formed around it.

When bunds are being created, drainage pipes are added (1 per cell) to channel flow from pond to pond down the site gradient. The drainage pipes include a 90-degree elbow and a section of straight pipe on the up-flow side to control the level of water in the cell at the desired level below the top level of the berm. Drainage pipes are important to prevent erosion of the bund during initial phases, however, once the bunds are stabilised, the pipes became redundant as the vegetation within the pond establishes to a point where it hinders water flow to the pipe. Similar to the methodology outlined in Section 7.4, plastic sheet piles, as shown below in Figure 7.14, may also be used as an alternative to pipes to control flow between the cells. A trial on the use of these plastic sheet piles was carried out in Belmont Bog and a copy of this summary report is included in Appendix C. This trial concluded that the sheet piles were an effective means of controlling the water level in the cells when compared with the use of pipes. The costs of using these plastic sheet piles are very similar to the use of pipes.

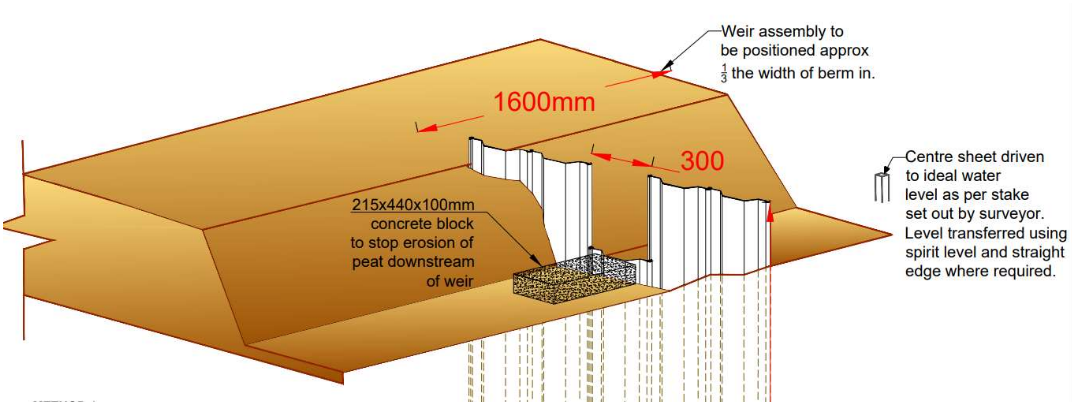

Figure 7.14. Schematic of sheet piles to control flow between cells.

As part of the Year 1 rehabilitation under EDRRS, field re-profiling and the provision of berms to create these smaller cells as part of the DPT5 methodology have been carried out on circa 200 hectares. While it is too soon to be definitive, these areas appear to have re-wetted and the water levels appear to have risen based on initial piezometer readings. This DPT5 methodology was carried out on significant areas in Ummeras, Esker, Clonad and Garryduff Bogs.

Figure 7.15. View of DPT4 and DPT5 cells in Ummeras Bog.

7.6. Using controlled weir outfalls to manage water levels on cutaway

Controlled weirs can be used to help manage water levels at a site. It can be desirable to change water levels at a site over time, e.g. to increase water levels as a site becomes increasingly vegetated or to facilitate access for management purposes. Controlled weir outfalls can also be important to ensure the maintenance of berms or bunds where overflow is anticipated with the subsequent risk of erosion of the bund. A number of different control options and designs have been widely used in wetland management and some examples of use in the management of peatland rehabilitation projects are provided in Appendix B4. Having the option to retain more water in the winter also increases the flood attenuation capacity of these wetlands. Hydrological modelling is key to design these controlled weirs. This enhanced measure will be combined with other measures described in this section to optimise ecosystem service benefits by stabilising the water levels. Having the option to retain additional water for longer will also have additional benefits by reducing fluvial carbon loss (via water) and also improving water quality leaving the site by reducing emissions of silt and ammonia.

Although not regularly employed by Bord na Móna, this type of enhanced measure, using Drop-board sluices as weir option were used in the rehabilitation of cutaway peatlands at Bellacorrick in Co. Mayo by Bord na Móna and further details are included in Appendix B – Section App B4.

This enhanced rehabilitation measure will allow greater control of water levels across various cutaway sites and also gives more flexibility to manage sites in different ways. For example, it can be beneficial to keep water levels lower in the summer during the pioneer phase to encourage vegetation establishment. At some sites, it may be beneficial to use control weirs to store water during the summer and prevent some sites drying out where there is a hydrological deficit. These options will be important for optimising climate actions benefits will also be beneficial for potential positive biodiversity management (keeping water levels high in winter for wetland birds and lower in summer to encourage habitat development). Having greater control of water levels will also benefit water quality leaving these sites and will help manage fluvial losses of carbon (via water flows).

While controlled weirs have not been used in EDRRS to date, in the rehabilitation of the Year 1 bogs, flow is managed by re-configuring the outfall pipes at a suitable level to facilitate re-wetting. An example of this is Mountlucas Bog where a new outfall pipe was installed in a deep drain at a higher invert than the original drain invert. Further information on this is provided in Section 7.8 below. Consideration of impacts on upstream and downstream third party lands are critical to the use of controlled weirs or raised outfall pipes.

7.7. Creating new drainage routes to manage excess water (high field taps)

New drainage routes are appropriate to help manage larger volumes of water at large sites during high rainfall events. The main objective is not to drain any residual peat but to manage excess water and prevent significant flooding. High field taps or swales (shallow wide drainage channels) are a common measure used in the design and construction of constructed wetlands. They may only get occasional use during the year during periods of high rainfall.

At some Bord na Móna sites, once drains and pipes are blocked water can rise to inappropriate levels due to the localised topography (basins). Permanent deeper water can inhibit the development of wetland or peatland vegetation and large open bodies of water are not encouraged, where possible.

This enhanced measure will allow greater management of water levels across the cutaway, the benefits of which are listed above. This enhanced measure will be combined with other measures described in this section to optimise ecosystem service benefits. Hydrological modelling will be key to the design of these new drainage channels. Where the high fields need to be used for future access the drain through the high field is piped for a 6m length.

An example of this approach was implemented at Baunmore Bog prior to EDRRS and further details are set out in Appendix B Section App B5. High field taps have also been successfully provided as part of the Year 1 rehabilitation measures and Figure 7.16 below is an example of such a high field tap. This tap is partially piped to allow vehicle access along the high field.

Figure 7.16. Example of a high field tap.

7.8. Re- Configuration of outfalls within a site to re-wet cutaway

The key objective with the application of this enhanced rehabilitation measure is to re-wet peat but to manage water-levels at an appropriate level for the development of wetland and peatland vegetation in order to optimise conditions for climate action and ecosystem benefits. This enhanced measure will help optimise re-wetting of the cutaway. It will be combined with other measures described in this section to optimise ecosystem service benefits. This enhanced measure will also have additional benefits of reducing fluvial carbon loss (via water) and also improving water quality leaving the site by reducing emissions of silt and ammonia.

Targeted configuration of outfalls is suitable for sites that have already had a period of natural colonisation, minimising disturbance to pioneer habitats that are already developing. It is also appropriate for sites where there is establishing habitats and where former drainage infrastructure is already starting to break down. Hydrological modelling and an understanding of site drainage is required to identify appropriate locations for targeted drain-blocking to maximise re-wetting. Drains are blocked at these locations using an excavator by lifting pipes and filling holes with peat or local sub-soils.

Again, the key objective is to manage water-levels at 0-10cm above the peat surface for as much of the year as possible. Some deeper water is inevitable due to heterogeneous topography of the cutaway. This measure can be particularly effective as outfall pipes generally run perpendicular to field drains to catch and transport water off the bog. The outfalls have been piped through high fields. Blocking pipes at the high fields means that the high fields can be converted to natural berms or embankments, creating a compartmented wetland.

The north-east basin of Corlea is an example of where this approach was applied prior to EDRRS. Further details are set out in Appendix B Section App B6.

Where pumps are turned off and the hydrological design determines that it is appropriate to do so, outfalls can be deepened to reduce standing water in a bog basin. Other re-configurations include the raising of outfall pipes to re-wet the peatlands. Impact on third party lands is considered prior to the implementation of any of these measures.

Modification of outfalls have been carried out on the EDRRS Year 1 bogs as part of the rehabilitation and an example in Mountlucas Bog is shown below. The outfall of an existing drain at Mountlucas was raised and this successfully facilitated the water level on the upstream side to be significantly higher than that downstream. See Figures below for images of re-configured outfalls.

	
Figure 7.17. Original outfall configuration at Mountlucas.	Figure 7.18. Original outfall configuration at Mountlucas.

Figure 7.19. Outfall modifications at Mountlucas. The outfall was blocked and a pipe was used to manage water-levels at a higher level.

Figure 7.20. New water level in the outfall at Mountlucas.

Figure 7.21. View of raised water level upstream of modified outfall.

7.9. Using larger berms to re-wet cutaway

Larger berms can be a particularly effective measure to help re-wet cutaway. The main objective is to build a berm that can hold back water at a larger scale and re-wet a larger area at an appropriate level. At some sites the remaining high fields will act as berms to compartmentalise a wetland area. Berms can also be constructed perpendicular to the field orientation to create large compartments. This measure may be more suitable for wetland cutaway with relatively large areas with uniform topography at slightly higher elevations. The construction of a single berm has the potential to control water across a larger area. This enhanced measure can be combined with other measures described in this section to optimise ecosystem service benefits from more intensive management of water levels. Hydrological modelling will be important to design these large wetland compartments to optimise re-wetting.

An example of this proposed approach can be seen at Ballycon Bog and further details are included in Appendix B Section App B7.

This methodology has been successfully used in a number of wetlands area in the Year 1 EDRRS bogs including Edera and Kilmacshane Bogs. The image below shows a berm created at Kilmacshane Bog to rewet some of the higher wetland areas and create shallow summer surface water.

Figure 7.22. Larger berm at Kilmacshane Bog.

7.10. Using a boundary berm to help re-wet cutaway

This proposed enhanced rehabilitation measure is quite similar to the above measure but focuses on the edges of the cutaway or re-wetted area. Typically, berms are banks of locally-sourced material which, on peatlands, will often be peat or sub-soil taken from the immediate locality of the berm, within the site. In some cases, this is necessary to benefit the re-wetting of a relatively large wetland or cutaway area where the topography means that surface water escapes. Hydrological modelling is important to identify areas where bunding is required and to plan and design the required bunds.

For any berm, it is important that the base is "keyed" or "trenched" into the existing surface be this peat or subsoils. The depth for keying depends upon the presence of subsurface flows, and the function of the berm, but could be up to 2m deep on peatlands where the trenching method is used. The berm should be 5-10 metres wide. Similarly, the height of the berm will largely be dependent upon the desired depth of the water that the berm will retain and the local topography, although it is not advisable to attempt to retain water and depths greater than 0.5m. Installation of overflow pipes in the top of the berm is recommended to avoid damage to the berm from high water levels eroding channels through the top of the berm.

Examples of this measure was carried out at Lullymore Bog and Ardagullion Bog prior to EDRRS. Details of these are included in Appendix B Section App B8. This method has not been deployed for EDRRS to date.

7.11. Trench drain blocking to re-wet cutaway

Trench drains on Bord na Móna sites are drains that are much larger and deeper than field drains and can be similar in size to main outfalls. It can be advantageous to block these drains as this can increase water levels across large areas. Hydrological modelling is important to plan and design these trench drain dams to create suitable water levels. As stated previously, the target water level is shallow to encourage emergent wetland and peatland vegetation. This enhanced measure can be combined with several of the other enhanced rehabilitation measures described in this section.

Bord na Móna bogs developed during early years of bog development were drained using large trench drains. This drainage method was used in association with turf-cutting using bagger machinery. This was the main method of producing fuel peat prior to the switch to industrial milled peat extraction. A series of regular trench drains were developed across the bog, draining water from the surrounding fields or bays towards the main silt ponds and outfalls. Some bogs were then developed for milled peat production and retained the original trench drains as the main outfalls and as silt control. In general, these trench drains have been left open at some cutaway sites to act as silt ponds.

Trench drains can be 5-10m wide and 3-5m deep and can be surrounded by high fields or by tall piles of former spoil extracted from the trench. Blocking these large deep drains can have a significant impact across a relatively large area. However, blocking these larger drains presents other challenges in creating a drain block that is strong enough to hold a significant volume of water. In general, the same approach is taken to blocking these deeper larger drains as the drain blocking method set out in Section 7.2. The main factor is to create a large drain block that is strong enough to hold water back. It is important to remove residual vegetation with an excavator and create a 'key' for the drain block. This key should be 5-10m wide. The dam should be between 5m to 10m wide depending on the amount of water that is held by the drain. It is important to camber the drain block so that water does not flow across it but around it. Some of these trench drains have been cut though glacial gravel ridges and mounds. The spoil from these excavations is generally located close by. This spoil can then be reused in the trench dam to block the trench. Mixed glacial till is particularly effective as a material to block trench drains as it contains a mixture of marls and gravels. Examples of this measure are set out in Appendix B Section App B9.

This measure is utilised as part of the DPT6 methodology in Glenlough Bog and is also proposed for some wide trenches in Timahoe South Bog. Due to the relatively small size of the trench drains to be blocked the width of the drain blocks are proposed at 5 metres in this bog. An example of a completed trench drain in Glenlough is shown below in Fig 7.23.

Figure 7.23. Trench drain at Glenlough Bog.

7.12. Fertiliser application to accelerate natural colonisation of vegetation

Natural colonisation of vegetation is generally the best and most sustainable method for stabilising bare peat surfaces. This means that species that are suited to the underlying environmental conditions colonise specific areas. In some instances, however, cutaway bog areas are very slow to colonise naturally. For example, some areas of Drumman Bog remained devoid of vegetation for at least 15 years after industrial peat production ceased. These areas where vegetation is slower to naturally colonise tend to be drier areas such as headlands and high fields that dry out in the summer, or areas that are prone to water fluctuations.

Trials at Drumman Bog, Cavemount Bog, Ballycon Bog and Lullymore Bog have shown that a key limiting factor that inhibits natural colonisation of these specific bare peat areas is the nutrient status of the peat, in particular Phosphorous. Addition of fertiliser to bare peat areas has accelerated natural colonisation at these sites and images of the results of this fertilisation are shown in Figures 7.24 to 7.26 below. Seed of pioneer species (Rushes and Bog Cotton) have not been a limiting factor. It is likely that the increased nutrients support seedling establishment and growth during the autumn and spring growing season and these larger plants are better able to survive during the sometimes harsh summer conditions when drought becomes inhibiting. Pioneer vegetation will then act as a “nurse crop” and will naturally develop into other habitat types through ecological succession.

Fertilisers have been used by other peatland restoration and rehabilitation projects in Canada, UK and Germany. It is accepted that while the application of fertiliser can bring a short-term risk of potential negative downstream impacts on water quality and can also affect the nutrient status of the peat and favour non-target species (weeds), this is balanced by the positive impact of environmentally stabilising bare peat areas, creating pioneer vegetation, reducing silt loss from these areas, accelerating the trajectory towards naturally functioning peatland ecosystems and having positive impacts on downstream water quality in the longer-term. The potential environmental risks of fertiliser use can also be mitigated in several ways with the use of slow-release fertilisers (Rock Phosphate), targeted use of fertiliser (to specific areas) and phased applications to different areas in different years (to reduce the overall fertiliser load in a single years). Fertiliser application has followed guidelines produced by the Forest Service (2000) for the protection of water quality in relation to for the application of fertiliser on peat and further mitigation will be applied. For example, Phosphate trigger levels at discharge points may be necessary to keep discharge concentrations at levels that are protective of water quality downstream

In general, the use of fertiliser should be minimised where possible, will be considered on a site by site basis and will only be used where deemed necessary. Long-term fertiliser use is not considered as a desirable or sustainable management option. Fertiliser applications would only be applied in a targeted manner to a portion of the overall site. Fertiliser application will be subject to suitable environmental assessments, where required, (which will be included in the rehabilitation plan). Fertiliser application will **not** take place where there is any risk of potential residual down-stream impacts.

It is proposed to use fertiliser to help accelerate natural colonisation on headlands (the area around the edges of the production bogs) and on high fields (former stockpile fields). Both areas are prone to drying in the summer, inhibiting vegetation establishment and growth. It is also proposed to use fertiliser to help accelerate the natural colonisation of newly formed bunds. Accelerating vegetation growth on these newly formed bunds will help consolidate, stabilise and strengthen them, increase their functionality and help them retain water within cells. This enhanced measure will be combined with other measures described in this section to optimise ecosystem service benefits.

Figure 7.24. Drumman Bog. Pictures of high fields from 2010 and from 2013 (right). This area had remained bare since 2000. Fertiliser was applied in 2010. This supported the natural colonisation of rushes and other pioneer vegetation, environmentally stablishing this bare peat area.

Figure 7.25. Cavemount Bog. Pictures of fields from 2015 and from 2016 (right). Fertiliser was applied in 2015. This supported the natural colonisation of rushes and other pioneer vegetation, helping to stablish this bare peat area.

Figure 7.26. Ballycon Bog. Pictures of marginal headland from 2013 and from 2016. The headland remained unvegetated since 2005. Fertiliser was applied in 2013. This supported the natural colonisation of rushes and other pioneer vegetation, environmentally stablishing this bare peat area.

In EDRRS, it is proposed to use slow-release fertiliser in particular instances to accelerate natural colonisation and the development of pioneer vegetation cover. Suitable areas for fertiliser applications include headlands, high fields and newly formed berms. The limited availability and increased cost of fertiliser due to external world events may impact on the extent of fertiliser to be utilised under the scheme.

Rock Phosphate Fertiliser will be applied to the Year 1 bogs in August and September 2022. It is likely that due to the seasonal nature of fertiliser application the fertiliser will be applied the year following on from the rehabilitation implementation.

7.13. Inoculation of Reeds and other vegetation from donor sites to accelerate vegetation establishment

Bord na Móna's rehabilitation strategy has generally been to re-wet cutaway, where possible, and encourage **natural colonisation** of species that are compatible with the underlying environmental conditions. In general, natural colonisation of cutaway vegetation occurs relatively quickly when peat extraction ceases and this is a key part of environmental stabilisation. The rate of natural colonisation is dependent on factors such as the locations of seed sources and underlying environmental conditions. Re-wetting peat tends to accelerate natural colonisation, as does the availability of nearby natural vegetation to provide seed. Species such as Rushes, Bog Cotton, Willow and Birch are excellent pioneer species and colonise the cutaway readily.

One key constraint to rapid **natural colonisation** and establishment of naturally functioning peatlands in cutaway and cutover bogs can be the **supply of seed**. The scientific literature reports many instances of seed-rain shortage constraining the success of restoration projects; for example, the small dispersal range of heather (*Calluna vulgaris* L.) seed was found to be a strong limiting factor for re-vegetation of bare peat in the UK uplands (Gilbert & Butt 2010). However, many other wetland creation projects prefer to use donor material (seeds, plants, rhizomes) to establish and accelerate the development of natural vegetation in association with natural colonisation (Eades et al. 2003, McBride et al. 2011).

The various reviews of peatland restoration (Minayeya et al. 2017) outline that two main approaches can be taken:

(1) Managing the environmental conditions to make them more suitable for peatland restoration (re-wetting and hydrology management).
(2) Re-introducing plant material or seeds to speed up the restoration process.

Reed inoculation is viewed as suitable management option for cutaway bogs that have had pumped drainage during industrial peat production and cutaway bogs that are likely to develop as wetlands in the future. This enhanced measure can be combined with several of the other enhanced rehabilitation measures described in this section.

Reed or other vegetation inoculation is particularly suitable for large areas of bare peat cutaway where there are currently limited natural seed sources. Introduced material can then establish and then provide additional seed sources to accelerate natural colonisation. There is potential to establish and diversify selected small areas with target species (Reeds, Bulrush, Saw Sedge), which in turn (and in combination with natural colonisation) can then naturally colonise the remaining bog area.

Details of reed bed inoculation carried out prior to EDRRS is included in Appendix B Section App B10. Reed bed inoculation has not been deployed in EDRRS to date, however its use will be reviewed over the lifetime of the scheme.

7.14. *Sphagnum* inoculation to accelerate vegetation establishment

Bord na Móna's standard rehabilitation strategy in the past has generally been to re-wet, where possible, and encourage natural colonisation of species that are compatible with the underlying environmental conditions. The rate of natural colonisation is dependent on factors such as the locations of seed sources and underlying environmental conditions. The main objective of this enhanced rehabilitation intervention is to accelerate the rate of natural colonisation of *Sphagnum* moss at suitable sites by introducing donor material. The presence of *Sphagnum*-rich vegetation on peatlands brings significant benefits as this is a potential carbon sink.

Many peatland restoration projects in the UK now apply both of the above approaches. The Conserving Bogs – Management Handbook (Thom et al. 2019) outlines many different peatland restoration projects on the UK that now take a more intensive restoration approach towards bare peat areas and re-introduce peatland plants and mosses through harvested plant material, transplanting seed and other sources. Numerous projects in the UK and now re-introducing *Sphagnum* moss (Wittram et al. 2015). This is also the approach taken in Canada where the the re-introduction of desirable species, often onto bare peat where the primary surface has eroded or been removed, by spreading propagules or planting cuttings and seedlings (e.g. Quinty & Rochefort 2003, Carroll et al. 2009, Théroux Rancourt et al. 2009).

Bog restoration in Canada (Canadian Moss Transfer Method), Germany and the UK used more intensive bog restoration techniques and inoculated cutaway or degraded bare peatland with *Sphagnum* rather than waiting for it to colonise naturally. In Canada, the main objective was to accelerate and enhance *Sphagnum* colonisation and the development of naturally functioning peatland ecosystems. Some sites in the UK were located in a very degraded landscape where it was thought there were no natural donor sites for seed to naturally dispense to the target site. The UK have used a series of new products including BeadaMoss, BeadaGel and Beadaplugs (Carroll et al. 2009, Hinde et al. 2010, Wittram et al. 2015, www.beadamoss.co.uk). The BeadaMoss acts as a *Sphagnum* 'seed''. (It is not actually seed but a tiny fragment of *Sphagnum* encapsulated in an organic gel that will dissolve when transferred to the target site and allow the tiny *Sphagnum* fragment to colonise the peat).

Sphagnum has the capacity to naturally colonise Bord na Móna cutaway with deeper peat that are water-logged and have more acidic water chemistry, and create *Sphagnum*-rich vegetation. The Bord na Móna baseline survey has shown that *Sphagnum* can colonise the cutaway naturally when the environmental conditions are suitable (water-logged conditions and suitable water chemistry). *Sphagnum*-rich peat-forming habitat is found at particular sites such as Templetouhy, Timahoe North, Derryounce and Balivor, although in relatively small areas, and its presence can be correlated with deeper peat and water-logged conditions. Deeper peat is likely to be influencing the water chemistry, with more acidic residual peat still present and less influence from exposed underlying sub-soils (which are more alkaline). The rate of development of these vegetation communities is dependent on the underlying environmental conditions.

All of the scientific research indicates that *Sphagnum* inoculation should only be used in association with appropriate environmental conditions (water-logged, deep peat with stable water levels and with more acidic water chemistry). Bord na Móna has always focused in the past on developing suitable hydrological conditions on suitable deep peat cutover bog sites for the natural colonisation of *Sphagnum* mosses. Hydrological conditions and field analysis of water chemistry will be important to establish suitable areas for Sphagnum inoculation. Bord na Móna has established several *Sphagnum* inoculation trials and details of these trials are set out in Appendix B section App B11.

These inoculation techniques are relatively expensive, vulnerable to poor establishment rates when environmental conditions are not suitable and not a panacea for large areas. It is not proposed to completely inoculate tens of thousands of hectares of deep peat cutover bog. However, there is potential to use *Sphagnum* inoculation to establish and diversify selected small areas on target sites with *Sphagnum* species, which in turn, and in combination with natural colonisation, can then naturally colonise the remaining deep peat cutover bog area. *Sphagnum* inoculation should only be used in appropriate environmental conditions (water-logged, deep peat with stable water levels and with more acidic water chemistry).

There are significant benefits for climate action from establishing *Sphagnum*-rich peatland vegetation communities. These have been found to quickly develop as carbon sinks (> 10 year). This enhanced measure will be used in combination with some of the other enhanced re-wetting measures (cut and fill cell bunding) to accelerate and optimise the development of *Sphagnum*-rich vegetation on suitable deep peat cutaway sites.

It is proposed to carry out *Sphagnum* inoculation trials in October and November 2022 on several bogs that have been rehabilitated in Year 1 of the scheme. Irish-origin Sphagnum donor material has been propagated by BeadaMoss in the UK (https://beadamoss.com/) to develop *Sphagnum* plugs. The selected *Sphagnum* species are a range of poor fen and raised species, including those that have been found naturally colonising on Bord na Móna cutover bog. It is planned to plant these *Sphagnum* plugs in suitable areas of residual deep peat in damp areas amongst pioneering vegetation. 20 ha in total will be inoculated across several different sites. The objective of this inoculation will be to quickly introduce *Sphagnum* to the pioneer vegetation so that in time this can naturally spread at these sites.

To implement this trial, 100,000 *Sphagnum* plugs have been ordered and will be delivered in early October 2022 on a batch basis. The *Sphagnum* plugs will be supplied rolled in 20 clumps per roll, with 20 rolls in a plastic bag with all bags clearly labelled with the relevant species mix. (mix name, code and component species). This method was developed to suit the requirements of people undertaking the planting, with a bag of 400 *Sphagnum* plugs weighing only approximately 3-4kg, well under the 10kg maximum specified for handling. Each *Sphagnum* plug is big enough to handle, big enough to be resilient but also quick and easy to plant into a dibbered hole. The resources required to plant these plugs, the variations between the sites (hydrological conditions, pioneer vegetation etc.) and the success of the planting will all be monitored and assessed prior to carrying out any further *Sphagnum* inoculation.

7.15. Install Solar Powered Pumping System to elevate water within site

For specific enhanced improvements, in particular the development of water retaining cells/ponds on certain peatlands, type 4 and type 5 deep peat areas (see Table 8.2), their success is dependent on the cells having a defined level of water throughout the year. In some locations, it is expected that the water present in the bogs will ensure that those cells do not dry out. However, in areas where either gravity or evaporation cause these cells to dry up in the summer, it will be necessary to replace existing pumps with low capacity solar pumps to top up these cells/pond during such periods.

This methodology has not been utilised to date under the scheme.

7.16. Monitoring and Verification

Bord na Móna is obliged to establish a monitoring program designed to meet the conditions of the EPA licences, again and in keeping with all other existing obligations flowing from Bord na Móna's IPC licences, the cost of this compliance monitoring will be borne by Bord na Móna. However, in addition and over and above the requirement of the IPC monitoring program, a **monitoring program for the enhanced rehabilitation programme**, has been put in place as part of EDRRS.

The EDRRS Monitoring Programme has been and will be established to validate/verify the benefits of the proposed enhanced measures to optimise climate action. This will focus on a collecting a range of scientific data that can then quickly be adapted and into metrics that can be used to measure changes in various ecosystem services.

These can include

- Carbon fluxes (carbon emissions and removals, GHGs and fluvial carbon losses)
- Water quality (suspended solids, ammonia, DOC etc)
- Hydrology (water levels, water flows, water attenuation etc)
- Vegetation (bare peat, habitat mapping, *Sphagnum* cover, condition assessment etc)
- Biodiversity (breeding bird populations, pollinator indicators)

The development of the EDRRS Monitoring programme will, where appropriate, follow best practise for monitoring peatland restoration (Bonnett et al. 2011, Renou-Wilson et al. 2012, Thom et al. 2019, Mackin et al. 2017). Several researchers in the UK are also developing a standardised monitoring protocol for measuring the condition of peatlands in the UK (Radbourne, 2019[4]). A significant amount of research has been and is currently being carried on the condition of peatlands in Ireland (SMARTBOG, WETPEAT, CAREPEAT, SWAMP), funded by the EPA and by others, and supported by Bord na Mona and others. Several of these research projects are already establishing various research and monitoring programmes for various environmental data on Bord na Móna sites. There is also other water quality monitoring programmes being carried out by the EPA and others to support the Water Framework Directive (WFD). The EDRRS monitoring programme will take account of this research and ongoing monitoring programmes will follow best practise and will develop a robust and efficient monitoring scheme that will efficiently measure various benefits that will flow from the enhanced rehabilitation improvements during its initial phases (implementation phase) and longer-term trends after the cessation of industrial peat production (post implementation), and will effectively measure and demonstrate cost/benefit.

NPWS has undertaken a comprehensive vegetation, hydrology and GHG emissions monitoring programme within 12 designated sites as part of the Living Bog – Raised Bog Restoration Project (Project Reference: LIFE14 NAT/IE/000032. See website:

https://webgate.ec.europa.eu/life/publicWebsite/index.cfm?fuseaction=search.dspPage&n_proj_id =5321 .)

Furthermore, habitats and GHG emissions monitoring work is done by NPWS as part of the implementation of the National Raised Bogs Restoration Programme. In addition, NPWS undertakes raised bog habitats monitoring surveying every 6 years within a large proportion of designated raised bogs. This programme includes the assessment of the results of previous restoration projects. This NPWS monitoring has, and will be, used to inform the EDRRS monitoring programme.

The timescale of this monitoring programme will be important as the development of peat-forming habitats and the re-establishment of carbon sinks on previously bare peat can take a significant length

[4]https://www.iucn-uk-peatlandprogramme.org/sites/default/files/header-images/2019%20Conference/3%20A.Radbourne_IUCN_Assessment_Protocols.pdf)

of time. The monitoring programme must be robust enough to take account of changes to the peatland landscape over this time period.

It is proposed that the monitoring programme be stratified, that is, not everything will be measured at every site. Various environmental proxies will be developed such as matching various pioneer habitats with different GHG emission factors. The overall GHG reduction can be estimated by monitoring how key habitats or the condition of key habitats will change in the long-term and applying specific emission factors to different habitats and emission factors. Other monitoring can be correlated at particular sites (e.g. vegetation quadrats and water-depth monitoring using piezometric tubes at static chamber GHG monitoring points). This will further strengthen and develop key condition metrics for the developing cutaway.

The monitoring programme will track the variation in ecosystem service benefits that will accrue from the various rehabilitation measures. This will allow the comparison of cost/benefits of different rehabilitation approaches and ultimately inform a "Best Practice for Enhanced Cutaway Rehabilitation and Restoration" that will make conclusions about the best approaches and outline lessons learnt during the enhanced rehabilitation programme.

Design and implementation of the EDRRS monitoring programme will take account of the overall project scope, data quality, and differentiate between the basic and enhanced monitoring. The development of the enhanced rehabilitation monitoring programme will also take account of consultation with key stakeholders (EPA NPWS, NBDC).

A high level overview of the IPC Compliance Monitoring Program and the Enhanced Monitoring Program are outlined in the below sections respectively.

7.16.1. IPC Compliance Monitoring Program

Although the IPC Compliance Monitoring Program will be bespoke for each bog area and included in the Condition 10 Plan submitted to the EPA for that given bog area, in general, the following has been and will be included in the programme:

- A water quality monitoring programme at the bog has been established. The main objective of this water quality monitoring programme is to establish a baseline and then monitor the impact of peatland rehabilitation on water quality from the bog. Monitoring of key environmental variables will include: Ammonia, Phosphorous, Suspended solids (silt), pH conductivity and DOC. Water quality samples are collected from the silt pond outlet before water leaves the site. Water quality samples are collected at monthly intervals, where samples are available, and sites can be safely accessed during winter flood periods.
- The baseline ecological condition of the site will be established by using habitat maps (already developed – updated if necessary), aerial photographs (drone surveys), to establish the condition of the site and the baseline of key indicators of rehabilitation success (e.g. extent of bare peat), and other assessments, where required.
- If, after two years, key criteria for successful rehabilitation are being achieved and critical success factors are being met, then the water quality monitoring programme will be reviewed, with consideration of potential ongoing research on site. The water quality data will be submitted to the EPA annually and as part of the final validation report.
- If, after two years, key criteria for successful rehabilitation have not been achieved and critical success factors have not been met, then the monitoring programme will be considered for extension for another two year cycle, based on the results to date and the status of the

receiving water body at this time. The rehabilitation measures and status of the site will be evaluated and enhanced, where required. This evaluation may indicate no requirement for additional enhancement of rehabilitation measures but may demonstrate that more time is required before key criteria for rehabilitation has been achieved. Monitoring of water quality will then also continue for another period to be defined.

7.16.2. EDRRS Enhanced Monitoring Program

The following section sets out the enhanced monitoring program to be carried out under the EDRRS scheme.

Carbon fluxes

GHG emission factors will be developed for Bord na Móna vegetation classifications as described in Vegetation and Carbon Monitoring Plan (2022). The methodology follows approach 3 outlined in Penman et al. 2003. Approach 3 requires the estimation of landcover at 'Time 1' (e.g. pre-rehabilitation) and 'Time 2' (e.g. post rehabilitation) and the application of relevant emission factors developed for these land cover/vegetation classifications.

The difference between the aggregate emissions/removals from pre-restoration and post-restoration represents the impact of rewetting on GHGs from the geographic area under investigation. To achieve this, geographically explicit land cover maps detailing current and future habitats or vegetation maps are required. Spatial maps are developed using site assessments produced by the Bord na Móna ecology team. These were integrated into geospatial databases using ArcGIS 10.8.

To ensure that Bord na Móna carbon monitoring fits with national emission factor research, a literature review was conducted to ascertain the existence of emission factors that are available for use on Bord na Móna lands. The review results showed a wide range of emission factors from bare peat, revegetated sites and rewetted sites. These emission factors will be further investigated in collaboration with Bord na Móna ecology team and designated to the most representative habitats. Habitats that do not have a representative emission factor will be selected for inclusion of a closed chamber study.

Fluxes at these locations will be measured for Carbon Dioxide (CO_2) and Methane (CH_4). Emissions/Removals will be measured using the closed chamber method and measurements will be taken at least at monthly intervals and ideally more frequently. In addition to measuring CO_2 and Methane fluxes, other measured parameters will include:

- Photosynthetically Active Radiation (PAR)
- Soil Temperature
- Soil Moisture
- Conductivity
- pH
- Water Table
- Peat Depth
- Permanent Quadrats
- Peat Depth

Future Habitat maps will be used to estimate the projected change in habitats resulting from rehabilitation measures and area statistics from this analysis will be produced. Refer to Appendix D Area statistics from this analysis will inform on the likely habitats to emerge following rehabilitation and recolonization. Emission Factors will be estimated for these ecosystems using existing emission factors from previous studies and where data is lacking, using the CO_2 flux chamber to develop these emission factors.

In addition to the chamber measurements, a carbon monitoring project is planned for two bogs included in EDRRS and proposed for rehabilitation in 2023. At these locations, two flux towers and four flumes are being installed to measure the changes from bare peatland to rehabilitated peatlands in real time. The eddy covariance towers and flumes will estimate the major components of the GHG Balance (CO_2 CH_4, DOC and POC). N_2O and DIC will be estimated using nationally available emission factors.

The most significant components of the GHG balance in peatlands depends on the current condition of the bog and this varies from place to place and based on the land use activity at the site. To represent this variation a deep peat bog and a wetland site have been selected as the location for the eddy covariance towers. These sites represent opposite land use trajectories. As a deep peat site, (comparatively) limited extraction occurred while at the wetland site more intensive extraction occurred.

The towers will be located over bare peat and baseline data will be collected for a minimum of one year (CO_2 and CH_4 fluxes) in addition to a host of hydro-meteorological variables (e.g. Air Temperature, Soil Temperature and Moisture, PAR, Incoming Solar Radiation).

In conjunction with this, Dissolved Organic Carbon (DOC) and Particulate Organic Carbon (POC) will be measured. DOC will be measured continuously in addition to flow rates and POC will measuring via spot samples and laboratory analysis. It is important to measure these aquatic carbon losses as previous studies have indicated that up to 47% of carbon emissions may be allocated to aquatic losses of carbon (Evans et al. 2017).

Combing the results from our flux towers and flume and DOC/POC measurements will enable the calculation of the most significant components of the GHG balance as they relate to peatlands. The output from this monitoring process will help to identify the baseline conditions for a bare peat bog and the immediate impact following rewetting. Additionally, as the site begins to recolonise it is well placed to measure the carbon benefit of recolonization at the site.

The combination of the chamber measurement study and the carbon eddy covariance towers means that the scheme will be capable of estimating both the immediate impact of rehabilitation processes and estimate the future carbon benefit after the measures have had a greater opportunity to take effect. In addition, this input can be used to refine rehabilitation processes to maximise the carbon benefits of restoration. Data gathered from the monitoring of bare peat and rewetted peat can be used in conjunction with other metrics to study the optimum rehabilitation measures to reduce GHG emissions. This is unlikely to inform EDRRS rehabilitation design due to the scheme timescale.

In addition, an Enhanced Rehabilitation Monitoring Program is good governance and should also increase the scientific knowledge of the role that peatlands can play in managing climate stability.

Existing research on Bord na Móna lands (co-funded by the EPA & Bord na Móna) to determine the GHG balance of cutaway bogs in different environments and management scenarios include Carbal, CarbonRestore, Reedflux, and NEROS projects. The scale of research activities has ranged from plot-scale (2m x 2m) across rehabilitated acidic cutaway, rewetted alkaline cutaway and drained bare peat. This has generated some data for the establishment of GHG fluxes and emission factors across different types of raised ecotopes, cutover bog and degraded peatlands. There are also several ongoing projects (SMARTBOG, SWAMP, UCC Birch Woodland Study, UL Methane Study) that will also establish ecosystem scale measurements (>10 ha) and will refine GHG fluxes and carbon losses via water from degraded peatland habitats including some Bord na Móna sites. The SMARTBOG project has established an eddy-covariance flux tower (EC) at Cavemount Bog (characterised by alkaline wetland habitats). One EC tower has been established on an area of Birch woodland (Lullymore) as part of the SMARTBOG Project. This project is underway as a partnership between UCC, TCD, and UCD. Cavemount is a re-wetted bog that is characterised by its wetland development and is a typical example of how many future rehabilitated Bord na Móna cutaways will develop in the future, particularly sites with pumped drainage. GHG fluxes at an ecosystem level from this type of wetland cutaway with a mosaic of different vegetation types are not clearly understood.

This research will be compatible with and will compliment other GHG research being carried out by NPWS, EPA and DAFM.

The carbon research infrastructure will also allow monitoring of sites post-project completion, if funding is made available, and better understand their resilience to future climatic variability in the longer term, thereby permitting the collection of critical information on the effects of a changing climate on the carbon balance of restored peatlands. This is also necessary in order to assess the role of vegetation and hydrology on carbon sequestration and GHG dynamics, thereby permitting the quantification of potential emission savings associated with active management.

Water quality

Conditions 6.2. 6.4, 6.5 & Schedule 1 (ii) of the relevant IPC licences detail the water monitoring regime that must be carried out by Bord na Móna. As these are clearly mandated by the licence, the obligation and monitoring costs associated with complying with these conditions lies with Bord na Móna and will not be deemed eligible costs under the proposed funding.

However, where enhanced improvements are proposed, the frequency and suite of analyses are increased, including, *inter alia*, the monitoring of dissolved organic carbon (DOC) to assist in quantifying carbon fluxes.

A stratified approach has been taken with sites selected that reflect both the variation of environments (pumped drainage vs gravity drainage, deep peat vs shallow peat, etc.) and the variations in rehabilitation measures deployed.

In general, the frequency of surface water monitoring has been increased under the scheme so that circa 70% of each bog's drainage catchments are monitored on a monthly basis.

Hydrology

The main objective of the enhanced monitoring programme for hydrology is to understand water levels and water flows and to measure the expected benefits of enhanced rehabilitation in relation to optimising water levels for climate action. An understanding of the hydrology / hydrogeology and interaction with ecology and a hydrogeological characterisation of each peatland site is vital for the planning and implementation of successful enhanced rehabilitation measures. It is also anticipated that the monitoring programme will inform future design both on sites within EDRRS not yet rehabilitated and future schemes by analysing the efficacy of the different measures on site with varying characteristics.

The EDRRS programme will require significant site investigations prior to the implementation of enhanced measures. This will take an ecohydrology approach. This will involve developing a network of hydrology monitoring equipment as determined appropriate on a bog by bog basis. An allowance of 5 pairs of phreatic wells and piezometers per 100 ha of cutaway bog was included in the original design of the scheme, however the number and location of these nests is determined by a number of factors. These include peat depth, underlying condition, anticipated water levels post rehab as well as practical considerations such as the ability to access the nests and undertake routine monitoring into the future, in instances where shallower peat was encountered only shallow wells would be required. This network will measure the water table (phreatic water level) and Deeper groundwater in peat.

The key objective of this hydrological monitoring is to:

- Collect baseline data on the hydrological setting of each site to inform rehabilitation design (through characterisation of hydrological conditions).
- Collect data prior to, during and post-rehabilitation to assist in determining the impact of specific rehabilitation measures (to inform future rehabilitation measure design and determine the success or otherwise of the measures).
- Collect data prior to, during and post-rehabilitation which can be extrapolated across representative sections of the site to ensure that the site is on the correct anticipated trajectory.

It is proposed that the enhanced monitoring for site investigation would involve at least 1 year's baseline data, however due to the scheme timeframe this was not possible for the Year 1 rehabilitation sites. A combination of automated loggers and manual dipping are used. While it is preferable to continue the piezometer monitoring post rehab, it is proposed to recycle the hydrological monitoring equipment on a rolling basis with piezometers retained on site for a minimum of a full year, post rehab. The majority of the automated loggers will then be removed and relocated to other sites proposed sites for rehabilitation. Bord na Móna are supported by external professional services (professional hydrologists) in this part of the monitoring programme.

Baseline surveying of various water levels and invert levels across sites (key locations such as wetland levels, silt ponds, outfalls, adjacent low-lying drainage and low-lying land and downstream levels) are carried out where required to inform the site investigations, model hydrology across the cutaway bog and inform understanding of waterflows across these sites. Updated LiDAR data has been obtained to inform topography, drainage and flow paths. This baseline survey, in addition to existing baseline data (drainage plans, survey data, LiDAR) is important in establishing internal catchments and flow paths. This data will be used to minimise potential of unintended impacts on surrounding land and will also inform Drainage Management Plans prepared for each bog unit.

Ideally there will also be a permanent monitoring programme established to measure fluctuations in groundwater levels after rehabilitation has been implemented. Such permanent monitoring can only extend past the life of the scheme subject to funding availability. A stratified approach will be taken with selected sites that reflect the variation of environments (pumped drainage vs gravity drainage, deep peat vs shallow peat) and variation in rehabilitation measures. This will help inform and measure the expected benefits of enhanced rehabilitation in relation to optimising water levels for climate action.

As stated in Section 5.3, at the end of August 2022, a total of 1563 piezometers have been installed in 51 bogs and 430 of these piezometers have been equipped with automated loggers.

Biodiversity

It has already been demonstrated that re-wetting cutaway peatlands brings significant biodiversity benefits as new habitats develop and species colonise these new habitats. Some Bord na Móna sites that have been re-wetted/rehabilitated in the past now contain habitats of high ecological value such as Annex I habitats as defined under the EU Habitats Directive, or habitats which are scarce and declining at a local or regional level in Ireland. Some rehabilitated bogs host species of conservation value or conservation concern which are rare and under pressure in the wider landscape.

Annex I Habitats

Several bogs that were drained but not used for peat extraction have been re-wetted and restored, and are developing Annex I Active raised bog (7110) habitat of European conservation value (EU Habitats Directive – priority habitat) that is expected to contribute to Ireland's National Raised Bog SAC Management Plan, and commitments to the conservation of this protected habitat.

The following tables provide an overview of some of the EU Habitats Directive Annex I habitats expected to establish on rehabilitated peatlands and considers their likely development as part of the scheme. The conservation status of these habitats is outlined in "*The status of EU protected habitats and species in Ireland*" (NPWS 2019). The overall status of these mainly peatland habitats is in general "Bad" and deteriorating.

Table 7.2 – List of EU Habitats Directive Annex I habitats whose known distribution overlaps the EDRRS scheme footprint and potential scheme benefits on these habitats. Number codes refer to habitat codes in the EU Habitats Directive.

Annex I Habitats	Scheme benefits – Expected positive benefits on EU Habitats Directive Annex I habitats.
7110 Raised bog (Active)*	Where restoration activities are being undertaken on degraded raised bogs (7120) that support some active peat forming ecotopes (7110), there is potential for positive benefits on this habitat. Annex I active raised bog already occurs at several BnM sites included in the scheme including Glenlough. Restoration will improve the structure and function of existing habitat. New Annex I active raised bog is modelled to develop at several BnM sites included in the scheme, including Kellysgrove. Restoration is expected to increase the overall area of active raised bog in Ireland. The development of this Annex I habitat is expected to extend beyond timeframe of the scheme (new habitat developing after 5-10 years). The development of new areas of active raised bog may improve the current national geographic distribution and range at a 10km level.
7120 Degraded raised bogs still capable of natural regeneration	Annex I Degraded raised bog already occurs at several BnM sites included in the scheme including Kellysgrove and Glenlough. Annex I degraded raised bog is now identified by having several characteristics, including the ability to become active raised bog after restoration measures are carried out (NPWS 2019[5]). Annex I Degraded Raised bog is now identified using modelling. Applying these modelling techniques to several drained BnM raised bog sites within the scheme indicates that Annex I Degraded Raised bog is present and has the capacity to become active raised bog once restoration is carried out. The identification of new areas of degraded raised bog on BnM sites may improve the current national geographic distribution and range at a 10km level.
7140 Transition mires and quaking bogs	Currently this Annex I habitat has not been identified from sites in the scheme or from other cutaway sites. However, some indicators of this habitat are present on cutaway sites and environmental conditions for the development of transition mires are present, so it is expected that transition mire habitat will develop on the cutaway in the future. Rehabilitation activities undertaken on cutover bogs do have the potential to create appropriate conditions for the formation of this Annex I habitat in the future. The trajectory of this Annex I

[5] NPWS (2019). The status of EU protected habitats and species in Ireland. Volume 1: Summary Overview. Unpublished NPWS report.https://www.npws.ie/publications/article-17-reports

	habitat development (from bare peat cutover bog) is expected to be across a period of 30-50 years. Any resultant formation of new areas of Transition mires and quaking bogs may improve the current national geographic distribution at a 10km level.
7150 Depressions on peat substrates of the Rhynchosporion	Where raised bog restoration activities are being undertaken on degraded raised bogs (7120) and active raised bogs (7110) there is potential for positive benefits on this habitat (7150). Restoration activities undertaken on raised bog has the potential to both improve the quality of existing areas of the 7150 habitat where it occurs as well as having the potential to create appropriate conditions for the formation of this habitat in the future. Currently this habitat has not been identified at any sites in the scheme. However, it is likely to occur in some active raised bog areas that already occur at raised bog sites in the scheme, such as Glenlough. More detailed monitoring is likely to identify new sites with this Annex I habitat in the future. Any eventual formation of new areas of Depressions on peat substrates of the Rhynchosporion may improve the current national geographic distribution and range at a 10km level.
7210 Calcareous fens with *Cladium mariscus* and species of the Caricion davallianae*	Rehabilitation activities undertaken on cutover bogs has the potential to create appropriate conditions for the formation of this Annex I habitat in the future. Stands of *Cladium mariscus* have developed already on revegetating cutover bogs (Lullymore) where suitable conditions occur. However, this current vegetation was not considered to qualify as this Annex I habitat yet in the last Article 17 Review. Annex I Cladium fens refers to *Cladium mariscus* beds which are in contact with species-rich vegetation of small-sedge fens (Alkaline fen) (NPWS 2019) and so far this combination of vegetation types has not developed on the cutaway yet. The development of this Annex I habitat structure is expected to extend beyond timeframe of the scheme (new Annex I habitat expected to develop after 30-50 years). Any formation of new areas of calcareous fens with *Cladium mariscus* may improve the current national geographic distribution at a 10km level.
7230 Alkaline fens	Rehabilitation activities undertaken on cutover bogs has the potential to create appropriate conditions for the formation of this Annex I habitat in the future. Alkaline conditions with developing fen vegetation have been recorded in some cutover bogs where a groundwater influence exists. Ecological indicators of alkaline fen are present at several sites and are expected to expand. However, there are no stands of vegetation that are deemed developed to qualify as this Annex I habitat yet. Currently the structure and function of the pioneer habitat is poor and does not meet the criteria of this Annex I habitat. This vegetation type is still in a pioneer phase and the development of this Annex I habitat is expected to extend beyond timeframe of the scheme (new Annex I habitat expected to develop after 10-50 years). More detailed monitoring is likely to identify new sites with this Annex I habitat in the future. Any formation of new areas of Alkaline fens may improve the current national geographic distribution at a 10km level.
91D0 Bog woodland*	Rehabilitation activities undertaken on cutover bogs has the potential to create appropriate conditions for the formation of this Annex I habitat in the future. Birch-dominated woodland with extensive *Sphagnum* cover that already meets most of the criteria for this Annex I habitat has already been identified at several BnM cutover sites (e.g. Ballycon), although it covers a very small area at present. Although not conforming to the Annex I habitat type at present (due to poor diversity, structure and function), it is expected that the rehabilitation measures will increase the extent of suitable environmental conditions required for the development of this Annex I habitat in the future. More detailed monitoring is likely to identify new sites with this Annex I habitat in the future. This vegetation type is still in a pioneer phase and the development of this Annex I habitat is expected to extend beyond timeframe of the scheme (new Annex I habitat expected to develop after 10-50 years). Any formation of new areas of wet woodland conforming to the Annex I habitat may improve the current national geographic distribution at a 10km level.
6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)	Rehabilitation activities undertaken on cutover bogs has the potential to create appropriate conditions for the formation of this Annex I habitat in the future. This Annex I habitat has not been identified from BnM cutaway yet. However similar vegetation exists, and more detailed monitoring may identify new sites with this vegetation type in the future.

Terrestrial Fauna

The following tables provide an overview of some of the more typical terrestrial species of EU Habitats Directive Annex II and V faunal species (NPWS 2019) known to establish on rehabilitated peatlands and considers their likely development as part of the scheme.

Table 7.3 – List of EU Habitats Directive Annex II and V faunal species whose known distribution overlaps the EDRRS scheme footprint and potential scheme benefits[6]. Number codes refer to codes in NPWS 2019.

Annex II species	**Scheme benefits – Expected positive benefits on EU Habitats Directive species**
White-clawed crayfish (*Austropotamobius pallipes*) (1092)	This species has been recorded in several BnM cutaway sites associated with wetlands and lakes. Rehabilitation activities undertaken on cutaway bogs has the potential to create suitable wetland habitats that, where connected to adjacent natural watercourses or modified watercourses within the bog that already support this species, will allow for future colonisation. This is likely to be restricted to scheme sites that also support the required hydro chemical conditions. The stabilisation of large areas of bare peat as part of the EDRRS scheme will result in improved water quality benefits both within and downstream of each scheme site. This will therefore contribute to improving the quality of supporting habitat for the species in a local and regional context. This may contribute towards the establishment of future supporting habitat distribution for White-clawed Crayfish. The creation of extensive areas of suitable supporting habitat for the species under the EDRRS scheme is likely to contribute to improving the long-term conservation status and distribution of the species in a local and regional context.
Marsh fritillary (*Euphydryas aurinia*) (1065)	This species has been recorded in more than 25 BnM sites so far (restored raised bogs and cutaway sites with establishing pioneer habitats). Marsh fritillary butterfly is expected to continue to benefit from proposed rehabilitation, as rehabilitated cutaway bogs revegetate and significant areas of new supporting habitat develops. The creation of extensive areas of suitable supporting habitat for the species under the EDRRS scheme is likely to contribute to improving the long-term conservation status and distribution of the species in a local and regional context.
Otter (*Lutra lutra*) (1355)	This species has been regularly recorded at some EDRRS scheme sites (Noggusboy, Timahoe, Oughter etc) using both natural watercourses and newly developing wetlands on cutaway bog. Rehabilitation activities undertaken on cutaway bogs has the potential to create suitable wetland habitats that, where connected to adjacent natural watercourses or modified watercourses within the bog that already support this species, will allow for the future colonisation and use of some sites by this species. The stabilisation of large areas of bare peat as part of the EDRRS rehabilitation scheme will result in improved water quality benefits both within and downstream. This is therefore likely to contribute to improving the quality of supporting habitat for Otter in a local and regional context.
Annex V species	
Common frog (*Rana temporaria*) (1213)	This species has been regularly recorded at many EDRRS scheme sites (Noggusboy, Oughter, Boora etc) using newly developing wetlands on cutover bog. Rehabilitation activities undertaken on cutaway bogs has the potential to create new suitable wetland habitats that will allow for further colonisation and population expansion. The stabilisation of large areas of bare peat as part of the rehabilitation scheme will result in improved water quality benefits both within and downstream of each site. This is therefore likely to contribute to improving the quality of supporting habitat for Common frog in a local and regional context, The creation of extensive areas of suitable supporting habitat for the species under the EDRRS scheme is likely to contribute to improving the long-term conservation status and distribution of the species in a local and regional context.
Pine marten (*Martes martes*) (1334)	This species has been regularly recorded at many EDRRS scheme sites (Noggusboy, Oughter, Boora etc) using newly developing Birch-dominated woodlands on cutaway bog. Rehabilitation activities undertaken on cutaway bogs has the potential to create extensive areas of suitable supporting habitat for Pine marten in the future, by stabilising large areas of bare peat. The overall target of the scheme is the development of wetter peatland ecosystems. Birch woodland readily develops on BnM cutaway and is likely to continue to develop in those areas that can not be re-wetted sufficiently. Wet woodland types will also develop as part of the overall mosaic and these habitat types will also support this species.

[6] Note that there are likely to be many other species that will indirectly benefit from the restoration and rehabilitation of degraded and cutaway bogs. This table provides some of the more regularly occurring species noted to occur on formerly rehabilitated peatlands.

	The creation of extensive areas of suitable supporting habitat for the species under the EDRRS scheme is likely to contribute to improving the long-term conservation status and distribution of the species in a local and regional context.
Mountain hare (*Lepus timidus hibernicus*) (1357)	This species has been regularly recorded at many EDRRS scheme sites using pioneering vegetation as well as more established peatland and wetland habitats Rehabilitation works undertaken on cutaway bogs has the potential to create extensive areas of suitable supporting habitat for Mountain hare in the future. The creation of extensive areas of suitable supporting habitat for Mountain hare. The creation of extensive areas of suitable supporting habitat for the species under the EDRRS scheme is likely to contribute to improving the long-term conservation status and distribution of the species in a local and regional context.
Sphagnum spp. (1409)	*Sphagnum* spp. mosses have been regularly recorded at many EDRRS scheme sites on both re-wetted raised bogs and BnM cutaway sites. Rehabilitation works undertaken on cutaway bogs has the potential to create new habitats for these species and to improve condition of existing habitats. These species are expected to expand in their abundance and distribution across BnM cutaway sites in the future. The creation of extensive areas of suitable supporting habitat for the species under the EDRRS scheme is likely to contribute to improving the long-term conservation status and distribution of the species in a local and regional context.
Lycopodium group (1413)	*Lycopodium* spp.(Club-mosses) have been regularly recorded at many EDRRS scheme sites on both re-wetted raised bogs and BnM cutaway sites (e.g. *Huperzia selago*). Rehabilitation works undertaken on cutaway bogs has the potential to create new habitats for these species and to improve condition of existing habitats. The creation of extensive areas of suitable supporting habitat for the species under the EDRRS scheme is likely to contribute to improving the long-term conservation status and distribution of the species in a local and regional context.

Avian Fauna

Some cutaway bog sites in the winter become inundated with water and turn into large wetlands that provide feeding and roosting habitat for significant numbers of wintering waterbirds such as Whooper Swan (*Cygnus cygnus*) (BoCCI Amber listed in Ireland and listed in Annex I of the EU Birds Directive). Where located adjacent to European Sites designated for wintering wildfowl these refugium's become more important and may serve to support conservation objectives of adjacent European Sites.

Many rehabilitated bogs now or will in the future also provide important foraging and roosting opportunities for species such as Hen Harrier (*Circus cyaneus*) (listed on Annex I also and BoCCI Amber listed in Ireland). Most recently the re-colonisation of Ireland by Eurasian Crane (*Grus grus*) has occurred on a BNM owned naturally re-wetting cutaway bog[7]. It is expected that the current scheme may assist in the breeding expansion of this iconic species by both improving the quality of the existing habitat used by the current breeding pair and by creating more suitable habitat in the region.

Other examples of avian fauna likely to benefit from EDRRS include ground-nesting breeding birds such as Meadow Pipit (*Anthus pratensis*) and Skylark (*Alauda arvensis*) (BoCCI[8] Red-listed bird species in Ireland) that are now scarcer in the wider countryside due to land-use changes and agricultural intensification, but colonise pioneer cutaway bog Wetland specialists including Black headed Gull

[7] Copland, A.S., Cullen, C., Ryan, T., Murphy, J.N., Doyle, S., Cregg, P. &. Kelly, S.B.A. (2022). Confirmed breeding of Common Crane *Grus grus* in Ireland in 2019 – 2021. Irish Birds 44: 99-103

[8] Gilbert, G, Stanbury, A., Lewis, L., (2021) Birds of Conservation Concern in Ireland 4: 2020–2026 Irish Birds 43: 1–22 Kilcoole available here https://birdwatchireland.ie/birds-of-conservation-concern-in-ireland/

(*Larus ridibundus*) (Red listed) and wading species such as Redshank (*Tringa tetanus*) (also Red listed) are also known colonisers.

The following tables provide an overview of some of avian species of conservation concern (namely EU Birds Directive Annex species [9]), which are known to establish on previously rehabilitated peatlands and considers any positive quality benefits resulting from EDRRS.

Table 7.4 – List of EU Birds Directive Annex I bird species whose range is known to overlap with the scheme footprint and potential scheme benefits.

Annex I bird species	Scheme benefits – Expected positive benefits on listed Annex I bird species
Kingfisher *(Alcedo atthis)*	Kingfisher has been recorded using natural and modified watercourses that border or flow through many scheme sites (Oughter, Esker & Carranstown for example). Rehabilitation activities undertaken on BnM cutaway bogs has the potential to create suitable wetland habitats that will allow for future colonisation by Kingfisher. The stabilisation of large areas of bare peat as part of the rehabilitation scheme will result in improved water quality benefits both within and downstream of each rehabilitation scheme site. This is therefore likely to contribute to improving the quality of supporting habitat for Kingfisher in a local and regional context.
Greenland White-fronted Goose *(Anser albifrons flavirostris)*	Greenland white-fronted Goose has been recorded in the past using EDRRS cutaway bogs including Kilmacshane Bog. Co. Galway. Rehabilitation activities undertaken on cutaway bogs has the potential to create suitable foraging, roosting and staging habitat for this species. The stabilisation of large areas of bare peat as part of the rehabilitation scheme will result in improved water quality benefits both within and downstream of each rehabilitation scheme site. In addition, the increase in revegetated wetland habitats providing supporting feeding and roosting habitats is likely to contribute to improving the extent of supporting habitat for the species in a local and regional context. Such measures are likely to support the conservation status of Greenland White-fronted Goose locally, regionally and nationally.
Whooper Swan (*Cygnus Cygnus)*	Whooper swan has been recorded using rewetted cutover bogs including Kilmacshane, Noggusboy, and Garryduff Bogs. Rehabilitation activities undertaken on BnM cutaway bogs has the potential to create suitable foraging and roosting habitat for this species. The stabilisation of large areas of bare peat as part of the rehabilitation scheme will result in improved water quality benefits both within and downstream of each rehabilitation scheme site. In addition, the increase in revegetated wetland habitats providing supporting feeding and roosting habitats is likely to contribute to improving the extent of supporting habitat for the species in a local and regional context. Such measures are likely to support the conservation status of Whooper Swan locally, regionally, nationally and possibly even internationally through the provision of ex-situ wintering refugia for species when adjacent to designated SPA's elsewhere.
Little Egret (*Egretta garzetta)*	The species has been recorded using revegetating cutover bogs including Kilmacshane, Noggusboy, Derries etc. Rehabilitation activities undertaken on BnM cutaway bogs has the potential to create suitable foraging, roosting and potentially breeding habitat for this species. The stabilisation of large areas of bare peat as part of the rehabilitation scheme will result in improved water quality benefits both within and downstream of each rehabilitation scheme site. In addition, the increase in revegetated wetland habitats providing supporting feeding and roosting habitats is likely to contribute to improving the extent of supporting habitat for the species in a local and regional context. Such measures are likely to support the conservation status of Little Egret locally, regionally and nationally.
Marsh Harrier (*Circus aeruginosus)*	Marsh harrier has been recorded using revegetating cutaway bogs including Boora bog. Rehabilitation activities undertaken on cutover bogs has the potential to create suitable foraging and roosting habitat for this species. The stabilisation of large areas of bare peat as part of the rehabilitation scheme will result in creation of supporting foraging and roosting habitats. In time, there is potential for some scheme sites to support breeding Marsh harrier, depending on the success and extent of colonisation by this recently confirmed breeding bird in Ireland. Such measures are likely to support the conservation status of the species locally, regionally and nationally.

[9] The status and trends of Ireland's bird species – Article 12 Reporting | National Parks & Wildlife Service (npws.ie)

Hen Harrier (*Circus cyaneus)*	Hen harrier has been recorded foraging and roosting (previous research in the Irish context) on revegetating cutaway bogs including Boora, Ummeras, Derries etc. One notable research project has recorded Hen Harrier from an SPA in the Slieve Bloom Mountains utilising a BNM Bog during the early part of the breeding season. Rehabilitation activities undertaken on cutover bogs has the potential to create suitable foraging and roosting habitat for this species. Scheme measures are likely to support the conservation status of Hen Harrier locally, regionally, nationally and *internationally* as they may interact with ex-situ habitat availability for individuals comprising part of the breeding SPA network in Ireland.
Merlin *Falco columbarius*	Rehabilitation activities undertaken on cutover bogs has the potential to create suitable foraging habitat for this species. Merlin have been recorded using cutover bog, typically during the winter months. Rehabilitation measures are likely to support the conservation status of the species locally and regionally.
Peregrine *Falco peregrinus*	Rehabilitation activities undertaken on cutover bogs has the potential to create suitable foraging habitat for this species. Peregrine have been recorded hunting over many cutover bogs that support good numbers of wintering and breeding wildfowl and waders. Rehabilitation measures are likely to support the conservation status of the species locally and regionally.
Golden Plover *Pluvialis apricaria*	Rehabilitation activities undertaken on cutover bogs has the potential to create suitable foraging and roosting habitat for this species. The species has been recorded using revegetating cutover bogs including Kilmacshane, Cavemount, Ummeras etc. The creation of large areas of wetland habitats as part of the rehabilitation scheme will result in an increase in supporting habitat for the species. Such measures are likely to support the conservation status of the species locally and regionally.

Invertebrates

Marsh Fritillary butterfly (*Euphydryas aurinia*) (EU Habitats Directive Annex II species and Ireland's only protected butterfly species) continues to colonise the Bord na Móna cutaway bogs and over 25 different cutaway sites are already known for this species. As the rehabilitated cutaway bogs revegetate, significant areas of new supporting habitat developers. This is important given the metapopulation structure of the species in the wider landscape, in which they use a network of sites. The extent of suitable supporting habitat on the revegetating cutaway bogs is likely to become important given the pressures on the species from agricultural improvement, abandonment[10] and development. This species is expected to continue to benefit from proposed rehabilitation. Other cutaway habitats which have been managed or rehabilitated in the past such as at Lullymore in Co. Kildare are now some of Ireland's most diverse butterfly landscapes.

Vegetation Monitoring

Table 7.5 - Vegetation Monitoring Metric.

Metric	Frequency	Method	Objective
Vegetation Cover (Quadrats)	Years 1 &2 or 1-4 (see Table 7.2)	Standard Relevé	Measure longer-term changes in vegetation following rehabilitation under the scheme.

Changes in vegetation of the Bord na Móna cutaway due to re-wetting via EDRRS are monitored at two different scales. Broader scale changes are monitored using habitat mapping. Smaller scale changes are monitored using the establishment of permanent vegetation monitoring quadrats.

The main objectives of vegetation monitoring proposed as part of EDRRS were:

[10] NPWS (2019). The Status of EU Protected Habitats and Species in Ireland. Volume 3: Species Assessments. Unpublished NPWS report. Edited by: Deirdre Lynn and Fionnuala O'Neill

- to measure and demonstrate changes in vegetation cover, and to demonstrate a positive trajectory in the establishment of vegetation cover and eventually habitat development in response to re-wetting.
- To provide a map (based on habitats and condition – specifically wetness) on which different GHG emission factors for different key habitats could be applied to estimate avoided GHG emissions during the period of the scheme (it is expected that as the distribution and extent of pioneer baseline habitats change that the overall calculated GHG emissions will also change).
- To support the quantification of GHG emissions from the footprint of the scheme, and the estimation of the avoided GHG emissions due to re-wetting from the scheme.

These key objectives for vegetation monitoring fit with the overall objectives of the scheme to demonstrate that re-wetting or rehabilitation has occurred (that there are responses to the rehabilitation/restoration measures carried out as part of EDRRS).

The overall objectives aim to provide an estimate of total changes in GHGs and total avoided GHG emissions in response to re-wetting of BnM cutaway during the scheme.

A selected number of scheme sites have or will have permanent vegetation monitoring quadrats established (See Table 7.2). Eleven out of 19 bogs rehabilitated in 2021 had permanent quadrats installed. Several other bogs to be rehabilitated in 2022 have also been added to expand the range of sampled typical cutaway types and bog condition. Permanent monitoring quadrats (5 m X 5 m) were established or will be established to set a baseline to measure longer-term changes in vegetation. Criteria for locating the position of permanent quadrats included:

- Quadrats in the main cutaway types (wetland mosaic, bare peat, pioneering vegetation on peat (deep and shallow), raised bog restoration etc.)
- Quadrants located in a range of vegetation types and bog conditions across each cutaway type (bare peat, vegetated areas etc.)
- Locations aligned with piezometer positions
- Locations aligned with carbon monitoring locations.
- Locations aligned with differing rehabilitation techniques

The monitoring schedule took account of the general lag in response of vegetation colonisation to re-wetting and the overall period of the scheme. It is expected that some positive change will be recorded after four years. However, it was decided not to re-survey every quadrat every year to reduce survey effect and manage resources.

A network of permanent monitoring quadrats can be used to monitor long-term changes in different vegetation types and in different rehabilitation methodologies (across 10-20 years). This is obviously dependant on longer term funding support. This long-term monitoring and research programme could demonstrate in detail how pioneer cutaway vegetation establishes and develops over time on a trajectory towards the development of peat-forming habitats.

Regarding vegetation monitoring quadrats, plant nomenclature for vascular plants follows Stace (2019), Fourth Edition, while mosses and liverworts nomenclature follows identification keys published by the British Bryological Society, Atherton *et al.* (2010). Species cover abundance of the vascular and bryophyte indicator species is recorded using the Domin scale. Data is collected using a handheld GPS recorder (Honeywell, handheld tablets) in the field. Other physical and biological parameters are noted for each quadrat surveyed: ground firmness, % *Sphagnum* cover, surface water occurrence, overall vegetation cover and general comments. A photographic record of all quadrat locations and additional features of interest is taken in the field.

Table 7.6 - List of sites with permanent vegetation monitoring quadrats.

Site	Year	Number of Quadrats	Main Cutaway bog type	Survey timing			
Belmont	FY22	5	mosaic	2021	2024		
Castlegar	FY22	5	Deep peat	2021	2022	2023	2024
Cavemount	FY22	5	wetland/fen	2021	2024		
Clonad	FY22	5	mosaic	2021	2024		
Derrycolumb	FY22	5	wetland	2021	2024		
Edera	FY22	5	Deep peat	2021	2022	2023	2024
Garryduff	FY22	5	Wetland	2021	2024		
Kellysgrove	FY22	5	Raised bog restoration	2021	2024		
Oughter	FY22	5	Wetland/fen	2021	2024		
Pollagh	FY22	5	Mosaic	2021	2024		
Ummeras	FY22	5	Deep peat	2021	2022	2023	2024
Carranstown	FY23	5	Deep peat	2022	2024		
Begnagh	FY23	5	Mosaic	2022	2024		
Timahoe South	FY23	5	Deep peat - vegetated	2022	2024		
Glenlough	FY23	8	Raised bog restoration	2022	2024		
Derries	FY22	5	Mosaic	2022	2024		
Mouds	FY25	5	Deep peat	2022	2024		
Ballycon	FY23	5	Wetland/fen	2022	2024		

Habitat Mapping

The baseline ecological condition is being established by using habitat maps (already developed – updated if necessary) based on updated aerial photography, to establish the condition of the site before or during the implementation of enhanced rehabilitation. *Note to reader: further discussion is ongoing with NPWS regarding a revised habitat monitoring programme to assess changes in vegetation, changes in GHG emissions & the effectiveness of different rehabilitation techniques.*

All scheme sites will have vegetation mapped via baseline habitat maps. These will be mapped using an adapted BnM cutaway habitat classification based on the main vegetation categories or communities typically present on cutaway. The methodology is being updated and adapted following discussions with NPWS, and to align with new peatland classification systems (Smith and Crowley 2020[11]) and recent research in Irish vegetation classification (IVC) (Irish Vegetation Classification - National Biodiversity Data Centre (biodiversityireland.ie)).

[11] Smith, G.F. & Crowley, W. (2020) The habitats of cutover raised bog. Irish Wildlife Manuals, No. 128. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.

Habitat mapping follows best-practise guidance from Smith *et al.* (2011). Map outputs including all habitat maps and target notes are produced using GIS software application packages (ArcGIS). Habitats that form the margins/ boundary of any given bog, that have not been modified significantly by industrial peat extraction, are classified using Fossitt *et al*. (2000).

Habitat mapping carried out during EDRRS can form a baseline for comparison to potential future habitat monitoring beyond the scheme. Monitoring over a longer timescale (beyond the scheme) (5-10 years) is likely to give a much better indication of the trajectory of pioneer habitat development after re-wetting.

Where time and resources allow, the use of new innovative techniques using remote sensing data may also be considered during the period of the scheme to assess the development of biomass (scrub using infrared photography) and the condition of the peat (wetness).

The vegetation and habitat mapping dataset will also be important to inform other national reporting where appropriate (e.g. EU Habitats Directive Article 17 conservation assessments on the extent and condition of Annex I habitats) and newly developing national land-use maps informing the Land Use Land Use Change and Forestry (LULUCF) sector.

Pollinators

Table 7.7 - Pollinators Metric

Metric	Frequency	Method	Objective
Pollinators	Years 1-4, 2 & 4 or 2 & 5 (see Table 7.3).	National Biodiversity Bumblebee Monitoring Scheme	Show change in species abundance and diversity post-restoration following vegetation establishment/change.

The main objective of establishing pollinator transects proposed as part of EDRRS are:

- to establish a baseline for pollinators at the start of the EDRRS scheme and to monitor responses by pollinators during the scheme to the initial re-wetting and the initial changes in vegetation cover and habitat development.

To date transects have been established across 11 different bogs to monitor pollinators. Study locations were selected to cover different geographic areas and different types of cutaway bogs. Transects vary in length between 1-2 km. Pollinator recording follows guidelines set out by the National Biodiversity Bumblebee Monitoring Scheme[12]. Monthly visits or a minimum number of counts are carried out during the period March-October inclusive. Transects are being monitored annually at some bogs, and at other bogs monitored at the start and at the end of the scheme (See Table 7.7).

It is expected that for some pollinator species there will be a potentially quick response to re-wetting as bare dry peat transforms to wet peat with pools of standing water and drains are infilled with water, while for other species there will be a lag as that these species will respond directly to the vegetation establishment, which is expected to develop at a slower pace. The starting point for each site will be

[12] Details of the Pollinator Monitoring Scheme are published by the National Biodiversity Data Centre and available online at https://www.biodiversityireland.ie/projects/monitoring-scheme-initiatives/bumblebee-monitoring-scheme/get-involved/

different as some sites will be starting from mostly bare peat, while other sites will be starting with various degrees of vegetation establishment. As part of the survey approach, both extensive areas of bare peat and existing established vegetation (marginal habitats or linear strips of vegetation along railways) were chosen to represent the different environmental conditions occurring. The application of fertiliser as part of EDRRS may also influence colonisation rates.

Table 7.8 - List of sites with pollinator transects and monitoring schedule.

Bog name	**County**	**Timing**				
		2021	2022	2023	2024	2025
Castlegar	Galway	x	x	x	x	
Derrycolumb	Longford	x	x	x	x	
Clooniff	Galway		x		x	
Cavemount	Offaly	x	x	x	x	
Clonad	Offaly	x	x	x	x	
Ummeras	Kildare/Offaly	x	x	x	x	
Edera	Longford	x	x	x	x	
Oughter	Offaly	x	x	x	x	
Begnagh	Longford		x			x
Lodge	Kildare		x	x	x	x
Blackwater	Offaly		x	x	x	

Breeding Birds

Table 7.9 -Breeding Birds Metric.

Metric	**Frequency**	**Method**	**Objective**
Species Richness, Relative Abundance	April to June or April to July inclusive across 2 or 4 years (see Table 7.4)	Transect/Breeding Waders (CBS/ O'Brien and Smith 1992)	Establish quality of effects on relative abundance or proportion of species of conservation concern, following scheme implementation.

The main objectives of establishing breeding bird monitoring proposed as part of EDRRS are:

- to establish a baseline for breeding birds at the start of the EDRRS scheme and to monitor responses by breeding birds during the scheme to the initial re-wetting and the initial changes in vegetation cover and habitat development.

Cutaway peatlands are important for some breeding bird species where habitats have developed after peat harvesting. Re-wetting former areas used for industrial peat extraction creates new habitat for these species. Ground nesting waders such as Ringed Plover (*Charadrius hiaticula*) or Lapwing (*Vanellus vanellus*) quickly colonise re-wetting bare peat cutaway soon after peat extraction ceases. Eurasian Crane have recently re-colonised a naturally rewetted cutaway bog owned by Bord na Móna. As vegetation and habitats develop and mature the breeding bird assemblage can change. For example, areas of revegetating bare peat in newly establishing wetlands that may initially be favoured by species such as Lapwing and Ringed Plover may in time develop dense scrub or woodland. This area would be no longer favoured by these species but would benefit others e.g. small passerines. Therefore, some species populations may change over time as the rehabilitated bogs reach a climax vegetation. Some species that prefer more cover or are less constrained by the effect of boundary distance (e.g. Redshank or Curlew (*Numenius arquata*)) may colonise these new wetlands.

For general bird species, the sampling approach follows the latest guidelines for the Countryside Bird Survey (CBS) methodology used to monitor breeding bird populations across Ireland. This requires two visits (April to mid-May and mid-May to end-June) and recording breeding birds along pre-determined transects. Surveying lowland breeding waders requires three visits during the breeding season between April and mid-July[13]. Surveying lowland breeding waders is a somewhat more intensive survey effort in relation to site visits and overall site coverage.

The CBS approach allows calculation of bird-density estimates, rather than simple presence/absence data, thereby permitting the importance of the observed bird community to be determined. The CBS is supported by NPWS as the basis for national bird population monitoring. The application of this standardised approach allows for comparisons between sites over time, while also allowing for annual variation in bird occurrence from transects to be compared to the national CBS dataset. This may be important in identifying underlying, broad-scale patters of bird occurrence.

Combining these two approaches, some sites are visited four times during the breeding bird season (April, May, June & July). These visits specially target breeding birds already using the site (e.g. Ringed Plover and Meadow Pipit in the shallow cutaway peat prone to winter inundation), species starting to colonise the deep residual bare peat area and other species using more established habitats on the marginal areas (e.g. Sedge Warbler).

Breeding bird transects will be monitored annually at some bogs, and at other bogs monitored at the start and at the end of the scheme (See Table 7.9 for detail on YR 1 and YR2 scheme monitoring i.e. monitoring <u>to date</u> in this regard). Further transects will be added to this as time allows.

[13] O'Brien, M. & Smith, K.W. 1992. Changes in the status of waders breeding on wet lowlands grasslands in England and Wales between 1982 and 1989. Bird Study. 39: 165–176.

Table 7.10 - List of sites with breeding bird surveys and monitoring schedule.

Bog name	**County**	**CBS**	**CBS +Wader survey**	**Timing**				
				2021	**2022**	**2023**	**2024**	**2025**
Belmont	Offaly	x			x			x
Castlegar	Galway		x		x			x
Derrycolumb	Longford		x	x	x	x	x	
Kellysgrove	Galway		x	x	x	x	x	
Kilmacshane	Galway	x			x			x
Clooniff	Roscommon	x		x			x	
Garryduff	Galway	x			x			x
Cavemount	Offaly		x	x	x	x	x	
Clonad	Offaly	x			x			x
Ummeras	Kildare/Offaly		x	x	x	x	x	
Pollagh	Offaly			x			x	
Edera[a]	Longford		x		x			x
Oughter	Offaly		x	x	x	x	x	
Mount Lucas	Offaly	x			x			x
Boora	Offaly	x			x			x
Turraun	Offaly	x			x			x
Derrycashel	Roscommon	x			x			x
Bunahinly - Kilgarvan	Offaly/ Westmeath	x			x			x
Bloomhill	Offaly	x			x			x
Derryfadda	Roscommon	x			x			x
Derrybrat	Offaly	x			x	x	x	
Lodge	Kildare	x			x			x
Glenlough	Longford/ Westmeath	x			x			x
Noggusboy	Offaly	x			x	x	x	x
Blackwater	Offaly	x			x	x	x	x

<u>Wintering Birds</u>

The main objectives of establishing wintering bird monitoring proposed as part of EDRRS are:

- to establish a baseline for wintering birds at the start of the EDRRS scheme and to monitor responses by wintering birds to the initial re-wetting and the initial changes in vegetation cover and habitat development during the scheme.

Table 7.11 - Wintering Water bird Metric

Metric	Frequency	Method	Objective
Species Richness, Relative Abundance	Monthly over the winter period across 1-4 Years (see Table 7.5)	I-WeBS	Establish quality of effects on relative abundance or proportion of species of conservation concern, following scheme implementation.

Several cutaway bogs already attract significant numbers of migratory wintering waterbirds (waders and wildfowl) during the winter period as previously mentioned. Geese, swans, ducks and waders are regularly recorded using cutaway bogs during this period, sometimes in nationally and internationally important numbers. For example, the highest numbers of Whooper Swans counted during a National Swan Census in 2012 was at Garryduff and Kilmacshane Bogs. Some bogs are already counted as part of the national Irish Wetland Bird Survey (I-Webs) (Boora) or have been counted in the past (Blackwater) and large flocks of waders (Lapwing, Golden Plover) that can number up to 5000 birds have been recorded. Water birds have used cutaway bogs that have been re-wetted for some time as well as bogs that have been used for active production during the summer but become inundated during the winter.

Surveys are therefore required to provide coverage of potential foraging and roosting areas on the selected bogs (See Table 7.5). Fixed counts, following I-WeBS methods, are used to count water birds. I-WeBS requires monthly counts from September to March at wetland sites. Numbers of visits would typically be 1 per month and a minimum of six is proposed under EDRRS.

Table 7.12 - List of sites with wintering bird surveys and monitoring schedule.

Bog Name	County	Timing				
		2021	2022	2023	2024	2025
Belmont	Offaly	*		*		*
Boora	Offaly	*			*	
Castlegar	Galway	*	*	*	*	
Cavemount	Offaly	*	*	*	*	
Clooniff	Roscommon	*	*	*	*	
Derrycashel	Roscommon	*				*
Derrycolumb	Longford	*	*	*	*	
Edera Bog	Longford	*	*	*	*	
Garryduff	Galway	*			*	
Kellysgrove	Galway	*	*	*	*	
Kilmacshane	Galway	*		*		*
Oughter	Offaly	*	*	*	*	
Pollagh	Offaly	*			*	
Turraun	Offaly	*			*	
Ummeras	Kildare/Offaly	*	*	*	*	
Bunahinly Kilgarvan	Offaly/Westmeath		*		*	
Begnagh	Longford		*			*
Bloomhill	Offaly		*			*
Derryfadda	Roscommon		*	*	*	*

Noggusboy	Offaly		*	*	*	*
Knappoge	Longford		*			*
Derrybrat	Offaly		*	*	*	*
Blackwater	Offaly		*	*	*	*

Bog Condition Mapping

A high-level cutaway bog condition assessment based on several key indices, wetness (wet/dry), rehabilitation (yes/no) and habitats (bare peat to developing habitats) has been developed. The main objective of this bog condition assessment would allow a high-level comparison in condition between different scheme sites (with different environmental conditions) and also allow monitoring of changes in condition and map trajectories over time. This approach takes account of the relatively large area, delineating conditions of different areas, and attempts to simplify the complexity of the variable environments and ecology across heterogenous cutaway bogs at a suitable scale. It also attempts to take account of the relatively short EDRRS time-frame, the known lag in ecological response and the longer-timeframe for the potential restoration or development of new habitats.

This approach follows the approach developed and adapted over the years by the Society for Ecological Restoration "The UN Decade on Ecological Restoration: Ten Guiding Principles - Society for Ecological Restoration (ser.org) (Gann et al. 2019)". It takes account of the time required to fully restore some habitats and accepts that as environmental conditions changed so much that some habitats cannot be restored immediately but ecosystem function can be repaired so that other habitats can develop.

Condition maps developed for Edera Bog demonstrate how a scheme site like Edera (Figure 7.27) is expected to develop into the future. The baseline condition was generally dry bare peat (Condition 0). After rehabilitation and by the end of the scheme Edera Bog is expected to be re-wetted and have some pioneer vegetation development (Condition 2). However, it is accepted that this status in 2024 is only a starting point on a trajectory towards restoration or development of stable naturally functioning peatland ecosystems. Edera bog will not be completely vegetated in 2024 and cannot be considered restored. In a longer time frame, Edera will be dominated by developing peatland habitats (Condition 3, 20-50 years), and eventually stable peatland habitats (Condition 4, 30-100 years).

Bog condition maps will be developed for each site at the start and at the end of the scheme. The Bog Condition Map index is a draft index and is subject to further discussion and adaption.

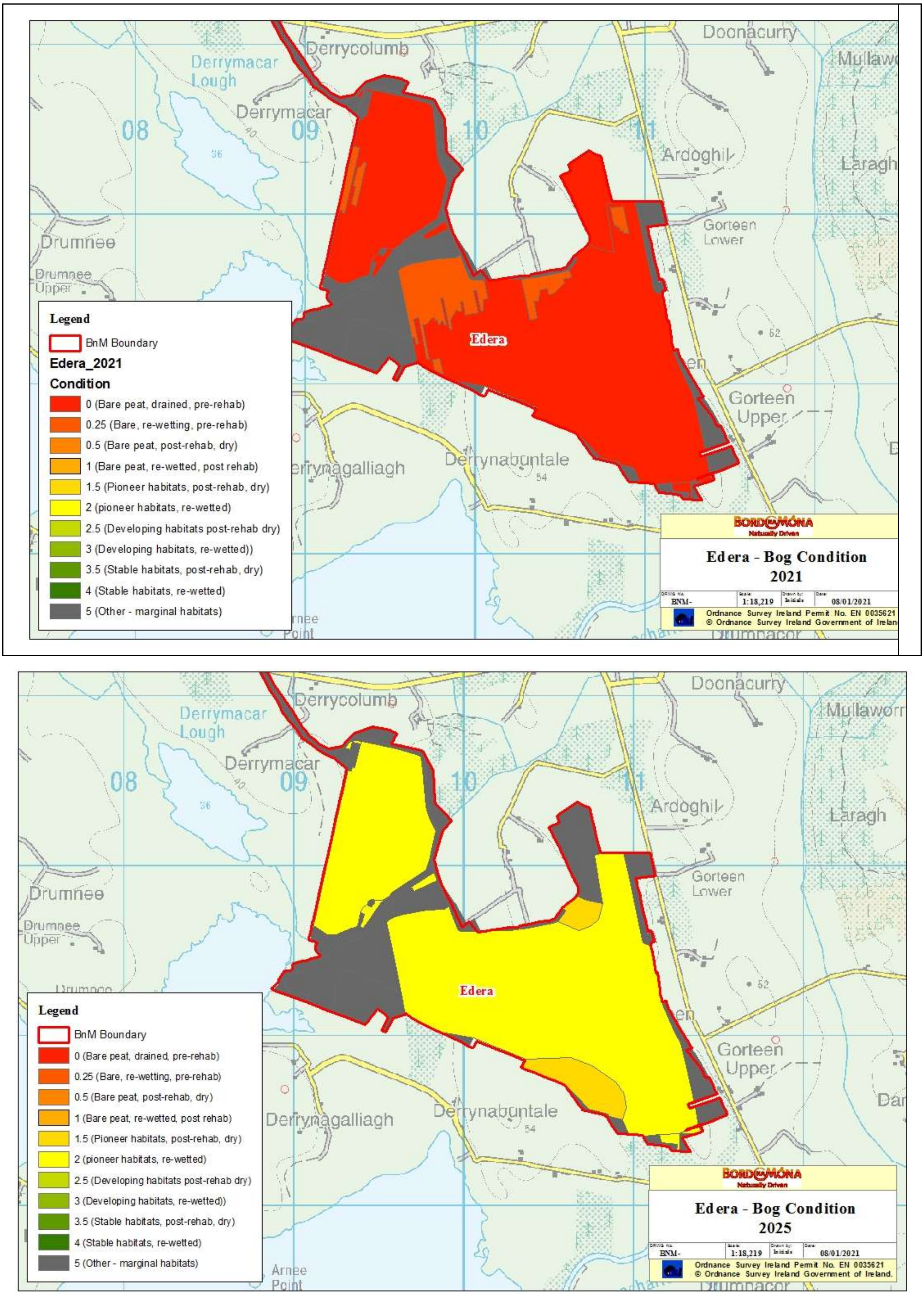

Figure 7.27. Edera bog condition map in 2021 and 2025.

8. Rehabilitation Packages/ Methodology

It is proposed to deliver the enhanced rehabilitation measures, described in section 7, through a series of costed **Rehabilitation Packages or Methodologies** (to be read in conjunction with Table 8.1 and Table 8.2). The basis for selection of a specific methodology is driven by the heterogeneity of the Bord na Móna cutaway and different cutaway types (e.g. Deep Peat, Dry Cutaway, Wetland, etc.), together with the need to deploy different measures and strategies in different environmental conditions. While several of the enhanced measures can be applied to cutaway of different types, others are more suitable for one particular cutaway type (e.g. cell formation is most suitable for deep peat cutaway).

The primary rationale for the different rehabilitation methodology is also to optimise the application of resources to derive maximum benefits. The over-riding principle is to 'do the right thing in the right place' (selecting the correct objectives, actions (rehabilitation measures) and targets for the most suitable sites) to optimise ecosystem service benefits, particularly climate action, while considering constraints. This requires a balance between application of scarce resources (external funding), the intensity of the enhanced rehabilitation approach and resulting benefits. Rehabilitation methodologies have different costs per hectare rehabilitated. The selection of various rehabilitation methodologies will require careful planning, see chapter 5, to optimise the ecosystem service benefits across the whole of the target area. Planning and management challenges for these cutaway habitats are described below.

In the following sections, the standard and enhanced rehabilitation measures are grouped into rehabilitation methodologies suitable for deployment in different 'high level' categories of land types. A brief description of the land types 'categories' are set out in section 8.1.

Table 8.1. Rehabilitation Actions and Measures.

(Section)	Rehabilitation measures	Rehabilitation Packages																			
		Deep Peat					Dry Cutaway			Wetland					Marginal Land			Added Work	
		1	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	1	2
6.2	Modifying main outfalls and managing water levels using outfall pipes to re-wet cutaway	X					X	X		X	X	X							
6.3	Turn off or reduce pumping and re-wet cutaway									X	X	X							
6.4	Regular field drain-blocking with a machine to re-wet cutaway (3 peat dams/100m)	X					X	X		X									
7.2	Drain-blocking with an excavator to re-wet cutaway (~7 peat dams/100 m)		X	X					X				X	X		X	X		
7.3	Field re-profiling to improve the overall topography and optimise re-wetting			X										X					
7.4	The use of berms and field re-profiling to optimise re-wetting				X														
7.5	Using cut and fill cell bunding to re-wet deep peat cutover bog					X													
7.6	Using controlled weir outfalls to manage water levels on cutaway		X	X	X	X			X				X	X					X
7.7	Creating new drainage channels (swales) to manage excess water				X	X													X
7.8	Targeted modifying of outfalls within a site to re-wet cutaway										X	X							X
7.9	Using larger berms to re-wet cutaway											X							X
7.9	Using a boundary berm to help re-wet cutaway																X		X
7.11	Trench drain blocking to re-wet cutaway																		X
7.12	Fertiliser application to accelerate natural colonisation of vegetation		X	X				X	X	X	X	X	X	X					X
7.13	Inoculation of Reeds and other vegetation from donor sites to accelerate vegetation establishment											X	X	X					
7.14	Sphagnum inoculation to accelerate vegetation establishment			X	X	X													X
7.15	Install Solar Powered Pumping System to elevate water within site				X	X													

X = this measure is an option

Table 8.2. Rehabilitation Methodologies (made up from the rehabilitation actions and measures).

Code	Description
Deep Peat Cutover Bog	
DPT1	Regular drain blocking – Speed Bump method (3/100 m) + modifying outfalls and managing water levels with overflow pipes
DPT2	More intensive drain blocking (max 7/100 m) + modifying outfalls and managing overflows with a controlled weir outfall + fertiliser application
DPT3	More intensive drain blocking (max 7/100 m), + field reprofiling + modifying outfalls and managing overflows with a controlled weir outfall + fertiliser application
DPT4	Berms and field re-profiling (circa 45m x 60m cell) + modifying outfalls and managing overflows with a controlled weir outfall + drainage channels for excess water + fertiliser application + Sphagnum inoculation
DPT5	Cut and Fill cell bunding (circa 30m x 30m cell) + modifying outfalls and managing overflows with a controlled weir outfall + drainage channels for excess water + fertiliser application +Sphagnum inoculation
DPT6	Trench drain blocking + modifying outfalls and managing overflows with a controlled weir outfall + fertiliser application
Dry Cutaway	
DCT1	Targeted fertiliser application
DCT2	Regular drain blocking – speed bump method (3/100 m) + modifying outfalls and managing water levels with overflow pipes + targeted fertiliser treatment
DCT3	More intensive drain blocking (max 7/100 m) + modifying outfalls and managing overflows with a controlled weir outfall + targeted fertiliser treatment
Wetland	
WLT1	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes+ targeted fertiliser application
WLT2	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes + Targeted modifying of outfalls within a site+ targeted fertiliser application
WLT3	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes + Targeted modifying of outfalls within a site + constructing larger berms to re-wet cutaway + transplanting Reeds and other rhizomes+ targeted fertiliser application
WLT4	More intensive drain blocking (4/100 m), + modifying outfalls and managing overflows with a controlled weir outfall + transplanting Reeds and other rhizomes+ targeted fertiliser application
WLT5	More intensive drain blocking (max 7/100 m), + field reprofiling + modifying outfalls and managing overflows with a controlled weir outfall + transplanting Reeds and other rhizomes+ targeted fertiliser application
Marginal Land	
MLT1	No work required
MLT2	More intensive drain blocking (max7/100 m)
Additional Work – no specific land category	
AW1	No work required
AW2	Targeted drain blocking with excavator (1 per 100m)

8.1. Land Type Categories – High level descriptions

8.1.1. Deep peat cutover bog

The definition of deep peat cutover bog used here relates to former raised bogs that have been in industrial peat production, where production has ceased but the remaining peat depth is typically in excess of 2m. In general, the average life of the Bord na Móna bog is about 50 years. A Bord na Móna site generally becomes cutaway when it is economically unviable to continue industrial peat extraction or when the bulk of the available peat has been removed. However, there are series of Bord na Móna bogs where the peat production timeframe has been much shorter and there are significant depths of peat remaining (2-6m). In some cases, peat extraction ceased before the peat resource was fully exploited for various operation reasons or due to other constraints. Bord na Móna held many of these sites in reserve for future peat extraction and would have planned in the past to convert them to milled peat extraction but have now made the decision to rehabilitate these sites following the decision to permanently cease peat production.

Sphagnum mosses are key species of raised bogs and the greater part of the peat mass is formed from these mosses. *Sphagnum* species and other raised bog species are a key part of raised bog habitat function and prefer more acidic, nutrient poor, water-logged conditions. Typical raised bog *Sphagnum* mosses and other bog species do not thrive with the more typical alkaline water chemistry of cutaway bog but do grow well in these more acidic conditions where peat has been re-wetted.

There is potential to re-develop *Sphagnum*-rich plant communities in these conditions if the peat can be re-wetted. This brings the opportunity of re-developing *Sphagnum*-rich vegetation communities that are considered Carbon sinks and restoring the carbon sequestration function of these sites. Deep peat cutover bog sites are likely to have the best potential for the application of intensive enhanced cutaway rehabilitation measures by accelerating and optimising the area of *Sphagnum*-rich vegetation communities across the Bord na Móna cutaway.

Deep Peat habitat identification

The key environmental factor that distinguishes these deep peat cutover bog sites is the depth of the residual peat (see Figure 8.1). Generally, Bord na Móna has removed the more acidic surface peat layers of the former raised bogs through milled peat extraction, and continued to exploit the fen peat layers until the peat resource is exploited and the sub-soils are exposed, or it is economically unviable to continue industrial peat extraction. Sites with a shorter peat extraction history tend to have more acidic exposed peat type compared to typical cutaway bog where the majority of peat has been removed (see Figure 8.2).

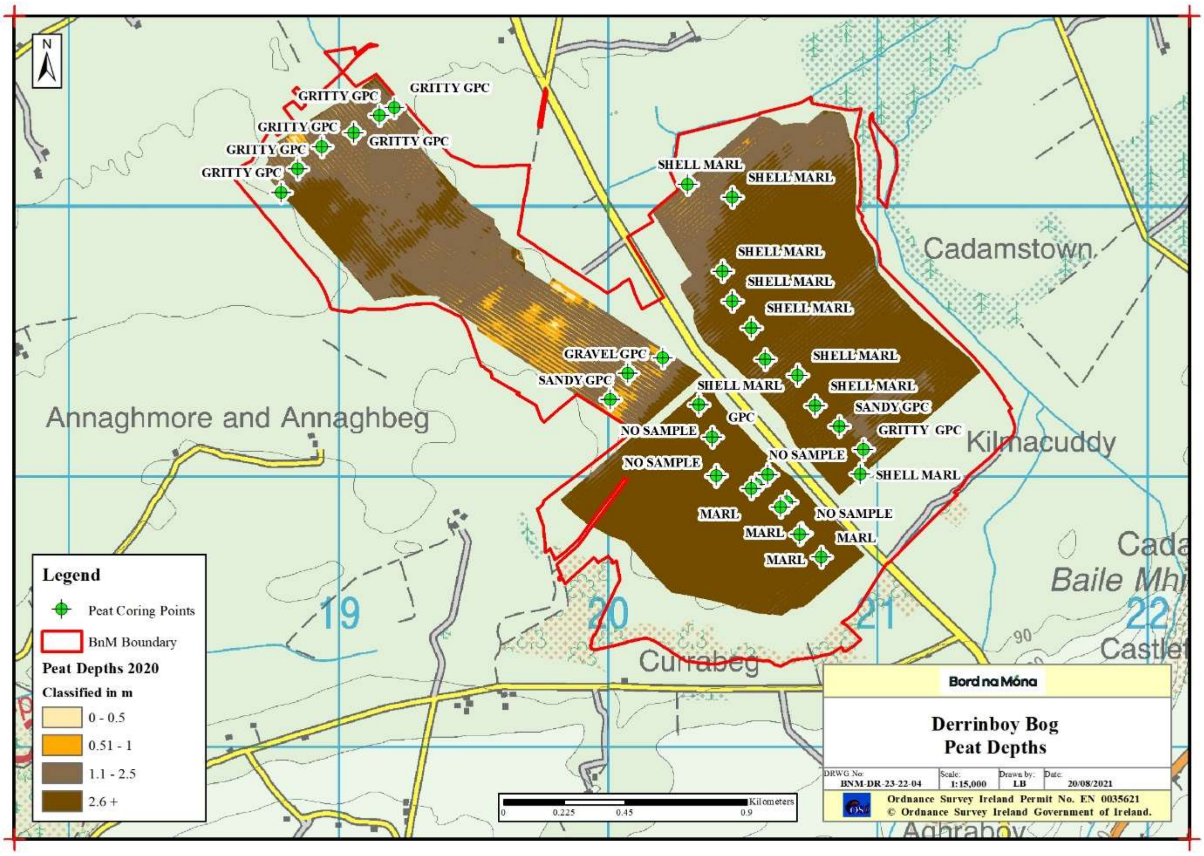

Figure 8.1. Map showing range of peat depths at Derrinboy Bog in Co. Offaly. This GIS data is essential for identifying areas of deep peat with potential for re-wetting.

The key objective of deep peat cutover bog rehabilitation is to re-wet peat and to accelerate the trajectory of the site towards the development of *Sphagnum*-rich peat-forming habitats (embryonic raised bog communities). This requires the application of innovative and more intensive re-wetting techniques to manage water levels and maximise the area of suitable environmental and hydrological conditions that would encourage the natural development of *Sphagnum* mosses and set the targeted site towards a trajectory of a naturally functioning peatland ecosystem.

Figure 8.2. Typical deep peat cutover bog. Deep peat sites are characterised by lighter colours indicating acidic peat (white peat or red peat when they are dry. The second picture shows a mat of Sphagnum-dominated vegetation that developed naturally on deep peat at Timahoe North bog. This vegetation community is analogous to a peat-forming community and is likely to be a GHG sink. It is likely to have been developing since sod turf extraction ceased in this area in the 1980s. This is

an indication that if suitable hydrological conditions are established (in this case naturally) then Sphagnum-rich vegetation can re-establish.

Deep peat cutover bog rehabilitation methodologies

The key improvements to be applied to deep peat cutover bog restoration/rehabilitation is re-wetting peat to encourage natural colonisation of typical vegetation and the development of *Sphagnum*-rich peat-forming vegetation communities. This requires managing water-levels close to the surface of the peat for most of the year (± 100mm). Several different approaches can be taken to this type of restoration/rehabilitation, and five rehabilitation methodologies with different rehabilitation/restoration intensities to managing suitable hydrological conditions are proposed (see Table 8.3):

Table 8.3. Rehabilitation option packages for deep peat cutover.

Deep Peat Cutover Bog	
DPT1	Drain blocking – Speed bump method (3/100 m) + re-configuration of water levels with overflow pipes + fertiliser application
DPT2	More intensive drain blocking (7/100 m) + modifying outfalls and managing overflows with a controlled weir outfall + fertiliser application
DPT3	More intensive drain blocking (max 7/100 m), + field reprofiling + modifying outfalls and managing overflows with a controlled weir outfall + fertiliser application
DPT4	Berms and field re-profiling (circa 45m x 60m cell) + modifying outfalls and managing overflows with a controlled weir outfall + drainage channels for excess water + Sphagnum inoculation + fertiliser application
DPT5	Cut and Fill cell bunding (circa 30m x 30m cell) + modifying outfalls and managing overflows with a controlled weir outfall + drainage channels for excess water + Sphagnum inoculation + fertiliser application
DPT6	Trench drain blocking + modifying outfalls and managing overflows with a controlled weir outfall + fertiliser application

8.1.2. Wetland cutaway bog

The high level descriptor for wetland cutaway bog used here relates to former raised bogs that have been in industrial peat production, where production has ceased and the majority of peat has been cutaway, and where this cutaway has the potential to be re-wetted. A significant number of Bord na Móna sites have pumped drainage and these sites are likely to develop a mosaic of wetland habitats when pumping is reduced or stopped. The water chemistry of wetland cutaway frequently is strongly influenced by the more alkaline sub-soils that have been exposed during peat production. This means that pioneer vegetation is more typical of fen, rather than raised bog.

Wetland cutaway has a broad range of hydrological conditions depending on the local topography. In some cases, these wetlands may form deep water (> 0.5m deep) whilst other areas may have the water table at or just below the surface of the ground. Optimal peatland rehabilitation seeks to maintain a water table just above the ground level (100mm ± 50mm) throughout the year. However, establishing such a consistent level across large sites with undulating topography is challenging, and in some sites impossible, particularly in areas where there are deep basins that have been historically pumped to manage water levels. Further complications arise if an area is subject to winter flooding, such as sites that are close to the River Shannon and associated tributaries. In general, it can be relatively straight-forward to re-wet large areas of wetland cutaway by blocking drains, or turning off pumps, but more challenging to optimise the coverage of suitable water levels for climate action and other ecosystem service benefits. The key objectives within wetland cutaway will be to initially establish wetland habitats (reed beds, fen and wet woodland) that optimise climate action and other ecosystem service benefits. The establishment of these initial habitats will set these areas on a trajectory towards naturally functioning wetland and peatland ecosystems and is analogous to the original development of these peatlands.

Wetland habitat identification

Areas that are likely to develop into wetlands can largely be determined from a combination of LiDAR data, supplemented by flood mapping and surveys of levels (with the latter referencing existing water levels such as silt ponds or other outfalls from the site). Depending upon the hydrological management regime in place on any site, information may also be available in relation to existing water levels where wetlands have become established or have appeared due to other management actions (such as the failure of a pump or blockage of an outfall).

Wetland rehabilitation methodologies

Some wetland cutaway sites are relatively straight-forward to re-wet. This is because they have been continually harvested into a natural basin. Blocking the outfalls can hold back water and can create a large wetland. The key objective in these sites is to re-wet peat but to manage water-levels at an appropriate level for maximum climate mitigation benefit. Again, the key objective is to manage water-levels at 0-10cm above the peat surface for as much of the year as possible and create soggy conditions. The water chemistry of these sites tends to have a higher pH (basic or fen conditions) due to the exposed residual fen peat and greater influence of the underlying geology on the water chemistry.

This allows emergent wetland vegetation to develop (fen, reedbeds and wet scrub/woodland). In the medium-term this will develop a pioneer mat of compatible moss species (fen species, not raised bog *Sphagnums*) that will start the trajectory of the site back towards peat-forming conditions. A key constraint is to set the discharge pipe or drain at a level that minimises extensive deeper open water (that would be slow to recolonize with vegetation) but to maximise re-wetting with shallow water depths.

Targeted re-wetting is suitable for sites that have already had a period of natural colonisation, minimising disturbance to pioneer habitats. In some peatlands it is beneficial to provide berms in conjunction with drain blocks which is a combination of WLT3 and WLT4 methodologies. The frequency and layout of the wetland berms will be dependent on the peatlands topography and will be designed on a bog by bog basis.

Table 8.4. Rehabilitation option packages for wetlands.

Wetland	
WLT1	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes + fertiliser application
WLT2	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes + Targeted blocking of outfalls within a site + fertiliser application
WLT3	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes + Targeted blocking of outfalls within a site + constructing larger berms to re-wet cutaway + transplanting Reeds and other rhizomes + fertiliser application
WLT4	More intensive drain blocking (4/100 m), + modifying outfalls and managing overflows with a controlled weir outfall + transplanting Reeds and other rhizomes+ application of fertiliser

WLT5	More intensive drain blocking (4/100 m), + field reprofiling + modifying outfalls and managing overflows with a controlled weir outfall + transplanting Reeds and other rhizomes + fertiliser application

8.1.3. Dry Cutaway

A portion of the Bord na Móna cutaway can be categorised as relatively dry cutaway. These areas can be categorised as dry cutaway where it is not deemed practical or feasible to re-wet these areas completely. While Bord na Mona rehabilitation strategy is to re-wet peat where possible and the key objective of the Enhanced Rehabilitation Programme will to optimise suitable hydrological conditions for climate action *via* enhanced measures such as bunding, etc. and actually reduce the area of relatively dry cutaway, it is inevitable that many areas of cutaway will still remain relatively dry. This is due to the heterogeneous topography of the cutaway, as well as requirements for continued drainage on site for identified after-uses, or off site in relation to neighbouring lands or other infrastructure. A portion of this dry cutaway will also have no or very little residual peat as it has been completely cutaway.

The topography of cutaway tends to be quite heterogeneous and the former raised bogs were frequently underlain with ridges and mounds of gravels and mixed tills that were laid down during the last glaciation. These ridges and mounds can become exposed during peat extraction and form a heterogeneous topographical mosaic separated by basins. Dry cutaway may have very thin or no residual peat where ridges and mounds have been exposed. The exposed sub-soils are a mix of glacial gravels, muds and tills that can be quite free-draining. Dry cutaway may also have deeper residual peat but in a location (i.e. at the margin) where the peat cannot be re-wetted due to boundary constraints. Dry cutaway may also develop in situations where there a relatively steep slope that inhibits re-wetting. Generally, it is not practical to re-wet these more steeply sloped areas. The extent of dry cutaway was originally forecast during the development of Bord na Móna Future Habitat Map layer and is being further investigated and modelled during the planning phase of the Enhanced Rehabilitation Programme. The Bord na Móna Future Habitat Map layer was developed based on the expectation of the implementation of standard rehabilitation and measures and is being revised as part of the Enhanced Rehabilitation Programme.

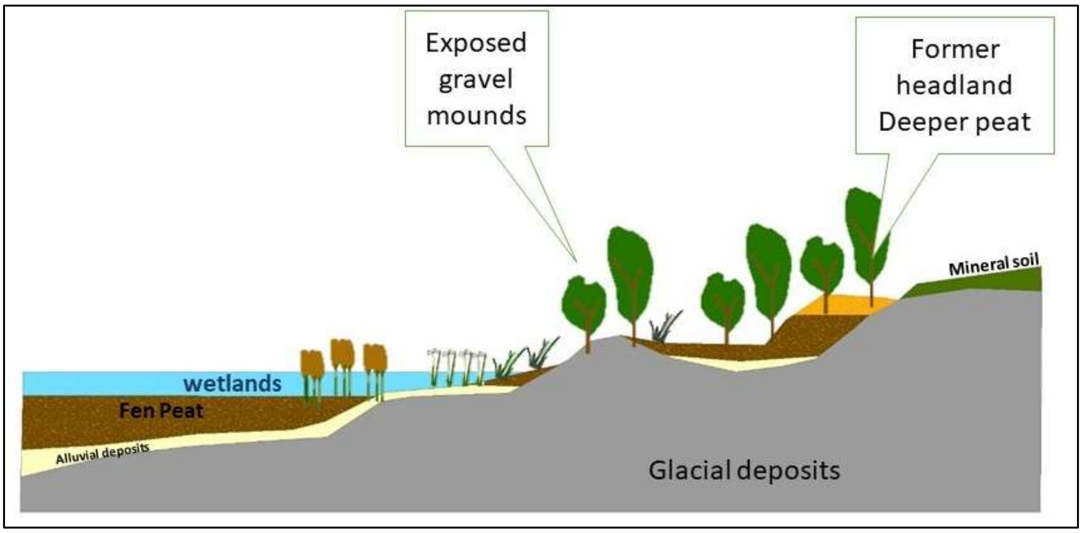

Figure 8.3. Typical profile demonstrating a wet to dry gradient. The influence of the variability of the underlying glacial deposits can be seen here with exposed gravel mounds and lower lying basins. The deeper peat found along the headlands is also evident here.

The main objective of rehabilitating drier cutaway is to develop pioneer vegetation through natural colonisation that will help stabilise these areas. In time this pioneer vegetation will develop eventually into naturally functioning scrub and woodland habitats that will blend into the surrounding landscape. While re-wetting these areas completely is not feasible, it is still Bord na Móna strategy to block drains to make these areas wetter for longer, or as wet as possible in order to reduce GHG emissions. Surface water will still eventually flow off these areas but the variable topography means that small pools and wet areas can establish. Bord na Móna will encourage the development of these small wetter features within this habitat by blocking drains and looking to modify the topography, where it is deemed to have benefits.

These drier ridges, mounds and more steeply sloped areas have tended to develop pioneer habitats such as grassland, heath, scrub and Birch woodland. The substrates of these drier areas can vary. Peat has been completely removed from some of the ridges and mounds, exposing the glacial sub-soils. This can lead to the development of species-rich grassland (GS1) in some locations and eventually the development of Oak-Ash-Hazel woodland (WN2). This climax habitat is already present at some cutaway sites where glacial mounds had developed this type of woodland along with the development of the surrounding raised bog (e.g. Derries woodlands in Clongawney Bog). As the raised bog developed, it paludified and covered some lower ridges and mounds but did not reach these woodland islands, which were left intact. In some cutaway sites, calcicole species that are indicators of WN2 woodland, like Hawthorn, Blackthorn, Hazel and Ash are already appearing in these drier environments where sub-soils are exposed. Calcicole species are species that prefer lime-rich environments that have now developed as a result of the exposure of these glacial limestone-based sub-soils.

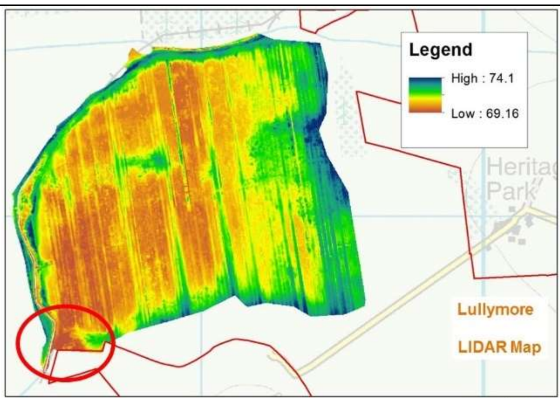

Figure 8.4. LIDAR heat map of Lullymore highlighting the higher cutaway around the margins of the site and along a ridge through the middle (green and blue colours). The top-right picture shows Birch woodland developing along the southern headland. The bottom-left photo shows Birch woodland that has been developed in the centre east part of the site. The bottom-right photo shows a typical high field at Lodge Bog colonised with Birch, Gorse and Heather.

In other areas like marginal headlands and high fields deep peat may be present in drier conditions. These areas will tend to develop in different ways with Birch and Heather being a frequent coloniser and they can develop a similar pioneer habitat to some raised bog face-banks. In intermediate situations, some drier areas with thinner layers of residual peat have colonised with frequent Heather cover.

Area of cutaway can also be underlain with freer draining sub-soils. In general, there are correlations between the topography and the underlying substrates. Basins tend to be underlain with lacustrine marls that were laid down after glaciation in shallow lake environments and were the first step towards the formation of raised bogs. These types of marls tend to be more impermeable and therefore favour the development of re-wetted peat. Some of the glacial mounds and ridges are made up of free-draining gravels with no marl buffer, meaning that when the peat that overlays these areas is drained and largely removed, it is very difficult to replace this sponge that kept water levels high.

In some situations, the old peat fields erode and break down naturally at a relatively quick rate. The drainage function is already breaking down. At some sites, old peat fields can still also remain intact in drier conditions. In these situations, it is still proposed to block these drains to remove the impact of the drainage infrastructure. This is likely to have some benefit and may keep these drier peats wetter for longer. However due to the environmental conditions (steeper slopes, elevated ridges and mounds with freer-draining substrates, underlying freer draining sub-soils), blocking these drains will not completely re-wet these areas and they will remain naturally drier.

Dry Cutaway habitat identification

Areas of peatlands that are likely to remain dry can be initially assessed from the existing habitats on site, coupled with information on drainage systems, subsoils, remaining peat depths and other hydrological characteristics of the site. LiDAR data are also likely to be useful but note that these are unlikely to give a true indication of habitat wetness as relatively high sites (e.g. raised bog remnants) have the potential to be as wet as lower areas.

Areas that are dry and have been cutaway for several years will often have developed characteristic dry habitats, including species-rich calcareous grassland communities, dry, heather-dominated heath-type habitats and, if cutaway for longer periods of time, oak-ash woodlands. Note that some of these sites may still benefit from re-wetting if rehabilitation work had not been undertaken on the areas previously but the efficacy of such re-wetting needs to be considered carefully against the current value of the habitats present coupled with resources required for such rehabilitation and measured against the likely expectation for end results.

Dry cutaway rehabilitation methodologies

The typical approach to the rehabilitation of dry cutaway is to encourage the development of natural habitats and to re-wet residual peat, where possible. Areas where it is more appropriate to re-wet will be re-wetted. The application of enhanced rehabilitation methods can both accelerate and enhance the development of various habitats and ecosystem service benefits. Due to the limited nutrient availability, fertilisation has been shown to speed this process up and forms one technique to accelerate the development of vegetation in areas that cannot be re-wetted. However, with re-wetting seen as the key objective for cutaway peatlands, opportunities to re-wet dry areas of cutaway are investigated using drain blocking techniques. Three different rehabilitation packages are proposed (see Table 8.5).

Table 8.5. Rehabilitation option packages for dry cutaway.

Dry Cutaway	
DCT1	Targeted fertiliser treatment
DCT2	Drain blocking – speed bump method (3/100 m) + modifying outfalls and managing water levels with overflow pipes + targeted fertiliser treatment
DCT3	More intensive drain blocking (max 7/100 m) + modifying outfalls and managing overflows with a controlled weir outfall + targeted fertiliser treatment

8.1.4. Marginal Lands

Marginal lands are considered here to include those areas surrounding Bord na Móna production bogs and which have not been used for industrial peat production. These will typically include raised bog remnants, cutover bog, scrub, Birch woodland and a range of other habitats. Some of the marginal Birch woodland has been in development some time and is quite mature. Marginal lands will also act as seed sources for the adjacent cutaway bog.

Many of the marginal raised bog remnants are small in scale, are relatively dry and have been heavily affected by adjacent hydrological management actions (both Bord na Móna and private turf-cutting). These bog remnants are relatively narrow and have poor bog restoration or conservation prospects as they will continue to dry out. Some of the bog remnants would have been drained in anticipation of industrial peat extraction, but never fully developed. There are also some intact undrained raised bog remnants that still have significant ecological and conservation value. Some high bog remnants have been subject to turf cutting within the Bord na Móna boundary and some of this turf cutting is private turbary (where private turf cutting overlaps with Bord na Móna property). Any such areas are constrained out of EDRRS and not included in the 33,000 ha to be rehabilitated under the scheme. Bord na Móna may also own only a portion of the overall bog remnant and many bog remnants extending beyond the Bord na Móna boundary are being actively cut for turf by private operators (on the other side). Marginal cutover bog can be divided into two main categories,

- cutover bog that is still being used for turf cutting and is largely bare peat and pioneer vegetation, and
- cutover bog that is developing into secondary peatland habitats.

Marginal land habitat identification

Marginal lands are defined as those areas (generally around the margins but can also be located on islands within sites) where industrial peat production has not taken place. These can be identified from habitat maps coupled with aerial images of the sites.

The habitat present on these sites can vary substantially, from near-intact raised bogs to cutover bog associated with domestic turf-cutting and the varied habitats such activities create (potentially including grasslands, wetlands and woodlands, as well as dry heath or peatland habitats).

Marginal land rehabilitation methodologies

In general, any proposed rehabilitation actions within marginal land can be considered enhanced rehabilitation. Although within the licenced area for energy peat production, marginal lands that are vegetated are not considered part of the scope of the standard rehabilitation to comply with the EPA Licences (these areas are already considered environmentally stabilised or the activities are not under the control of Bord na Móna – private turbary).

The objective for the enhanced rehabilitation of marginal lands will be dependent upon the habitats and management objectives for the site as a whole and, in particular, adjacent areas of peatland where rehabilitation is being undertaken. Opportunities to enhance the hydrological condition of marginal habitats will be assessed in detail. This will include targeted drain blocking. In some cases, there may be significant potential to improve the conservation status and hydrological condition of various habitats. These include some drained bog remnants (drained by Bord na Móna and also historical drains) as part of the process for energy peat extraction. Cutover bog that is already developing secondary vegetation is likely to have opportunities for re-wetting via drain-blocking and cell-bunding. In other areas, opportunities for re-wetting will be limited due to ongoing turf cutting or adjacent land-use.

Care also needs to be taken that actions do not lead to unintended consequences for adjacent (non-target) land and such unintended consequences are assessed in the Drainage Management Plans for each bog unit. In general, all boundary drains are retained, and no blocking of these drains is proposed to avoid impacts on adjoining lands.

Opportunities to integrate the management approaches and outcomes for marginal lands with the remainder of the site, supporting and complementing other wider actions, will be explored and optimised. Options for marginal land are listed in Table 8.6.

Table 8.6 - Rehabilitation option packages for marginal land.

Marginal Land	
MLT1	No work required
MLT2	More intensive drain blocking (max 7/100 m)

8.1.5. Additional Rehab Measures

In order to deliver the rehabilitation measures some additional measures over and above the methodologies set out Sections 8.1.1 to 8.1.5 are required.

New berms may be required as part of the rehabilitation measures and where these are not included in the methodology, they are included as an additional measure. In order to ensure third party adjoining lands are not impacted by the raising of the water levels on the bog some upgrade of existing drains and provision of new piped or open drains may be required. In addition, piped high level taps through the high fields have been included to regulate water levels. Details of these measures are set out in the Engineering report and detailed drainage drawings for each bog. They are included in the cost estimates that are submitted to NPWS for approval in advance of the commencement of the rehab measures.

8.1.6. Additional Rehab Measures

High fields are a feature of almost all of the Bord na Móna Bogs and are used to store harvested peat prior to onward distribution. Historically they were located at every eleventh field to facilitate peat production in the five fields of either side. Peat production was not carried out on the stockpile field and was therefore not lowered at the same rate as the adjoining fields. In some bogs the fields used for stockpiles were alternated so that there is little variance in their height, while in other bogs they are significantly higher than the adjacent production fields. For former milled peat production bogs, the high fields are 15m in width similar to the width of the adjacent production fields throughout the bog. It is currently proposed to retain these high fields to support the enhanced rehabilitation measures which account for circa 10% of the area to be rehabilitated.

Castlegar trial

At the request of NPWS, Castlegar bog was selected to carry out a trial where a section of a high field was lowered to the level of the adjacent production fields. The trial was carried out on a representative area, 200m in length, in regard to the resources, plant and time required.

The costs per metre length of high field lowered was developed from this trial. It should be noted that these costs are based on the height of the high field included in the trial and these heights vary across the bogs with some fields higher and some lower.

Findings

The trial has demonstrated the activity to level a section of high field can be carried out in ideal conditions, however there will be additional significant costs incurred per metre length of high field lowered. It should be noted that all bogs are different and it is envisaged that in some instances the local bog conditions would not allow for lowering of the high fields. The following findings should be considered in detail before a decision is made to level high fields:

- The high fields currently provide access into the centre of the bog for operatives, it is important that plant and safe access should be assured if field is lowered.
- Features, such as berms in deep peat areas with adjacent ponds, need to be created to counteract their removal where the high fields serve as berms to adjacent cells.
- The lowering of high fields will impact on the sequencing of works on adjacent production fields and the surplus peat will need to be managed (used to fill drains). This could wet the adjacent production fields, this was seen in an earlier trial on when peat was deposited into a drain using a screw-leveller, preventing access and the installation of drain blocks.
- If the planned rehab methodologies on production fields adjacent to a high field are carried out before the lowering of a high field (for example ponds either side of high field) then there may be no outlet for the excess fill from the high field (i.e. drains are already filled).
- In some bogs the high fields are/will be utilised to regulate water levels and if lowered could make it more difficult to regulate water levels across a site.

- Given the existing elevation of the high fields above the adjacent production fields, levelling of these may impact on unknown undisturbed archaeology within the depth of the high field. This would be significantly more intrusive than any other methodologies and would need to be agreed with National Museum of Ireland.
- Some high fields are vegetated and lowering of high fields will result in the removal of this vegetation. There will be a small trade-off here due to the removal of the vegetation, although it is expected this area will re-vegetate in time.
- Lowering of high fields will result in the disturbance and mobilisation of larger quantities of compact peat. This would need to be considered as a separate methodology in the AA process and would add some additional risk of potential sediment mobilisation, which would likely need additional mitigation.
- Lowering of high fields on a large scale will add significantly to the overall cost of rehabilitation of a bog and no allowance has been made for this in the original financial model. There may also be additional costs as high fields located adjacent to Deep Peat pond methodologies and levelled can no longer be utilised as berms.

While it is considered that the lowering of the high field will increase the area of the bog that is rewetted reducing the GHG emissions from these areas, any such benefits should be considered in conjunction with the issues listed above.

Where two or three high fields exist adjacent to each other such as in Bloomhill Bog, it is proposed to create cells on these high fields. This bog will be rehabilitated in 2022 and the success or otherwise of this measure will be considered on completion of the rehabilitation. No decision has yet been made in relation to the lowering of high fields on a large scale as part of the EDRRS Scheme. As the high fields are required for access to deliver the rehabilitation as well as in some cases for access for monitoring, methods of rewetting some high fields can be considered on a bog by bog basis following the completion of rehabilitation in each bog.

8.2. Additional Enhanced Rehabilitation

Additional enhanced rehabilitation is defined as the application of enhanced rehabilitation improvements on areas that have already been partially rehabilitated by Bord na Móna with an EPA licenced area. For example, some rehabilitated sites may benefit from additional re-wetting. While the overall site is deemed environmentally stable to comply with the conditions of the EPA Licence, some of the enhanced rehabilitation actions could be applied to specific areas within these sites to further improve and optimise overall hydrological conditions for climate action and other ecosystem service benefits.

Bunding may be an option to help re-wet specific areas within sites. Alternatively, some wetland sites could be assessed to consider if water levels could be managed more appropriately to optimise conditions for emergent wetland vegetation (lowering water levels to reduce open water and increase wetland vegetation).

Some sites may benefit from targeted improvements to further slow water movement through the site and lengthen the pathway for water flow. This will improve the capacity of wetlands to reduce fluvial carbon losses (carbon losses from water) and will improve water quality of water leaving to targeted sites.

Some older Bord na Móna cutaway has already developed a mosaic of peatland habitats including woodland and stabilised naturally but have not benefited from any re-wetting or drain-blocking. These enhanced actions would benefit climate action ecosystem services by re-wetting residual peat (Carbon storage) in areas that have not been re-wetted, particularly in some deep peat cutover sites, and improving and optimising the development of carbon sequestration ecosystem services (Carbon sink) through the development of *Sphagnum*-rich embryonic raised bog vegetation. The development of woodland and scrub is an additional constraint to additional enhanced rehabilitation where trees would have to be cleared first prior to any direct intervention (e.g. bunding).

A re-assessment of rehabilitated areas and hydrological modelling will be required to identify areas that could benefit from additional re-wetting or other enhancement measures.

Table 8.7. Options for additional enhanced rehabilitation measures.

Code	Description
	Using controlled weir outfalls to manage water levels on cutaway
	Creating new drainage channels (swales) to manage excess water
	Targeted blocking of outfalls within a site to re-wet cutaway
	Using larger berms to re-wet cutaway
	Using a boundary berm to help re-wet cutaway
	Trench drain blocking to re-wet cutaway
	Fertiliser application to accelerate natural colonisation of vegetation
	Sphagnum inoculation to accelerate vegetation establishment

9. Indicative Benefits of Standard and Enhanced Rehabilitation Improvements

Table 9.1. Table outlining indicative benefits of standard and enhanced rehabilitation improvements.

			Ecosystem Services													
			Carbon sequestration		Carbon storage		Water flow regulation		Water purification		Habitats		High biodiversity value species		Amenity, Recreation, Cultural, Education	
	Rehabilitation Methodology		S	En	S	EN	S	EN	S	EN	S	EN	S	EN	S	EN
Deep Peat Cutover Bog	DPT1	Drain blocking Speed Bump Method (3/100 m) + modifying outfalls and managing water levels with overflow pipes +fertiliser application	*		*		*		*		**		**		**	
	DPT2	More intensive drain blocking (max 7/100 m) + modifying outfalls and managing overflows with a controlled weir outfall + +fertiliser application		**		**		**		**		**		***		**
	DPT3	More intensive drain blocking (max 7/100 m), + field reprofiling + modifying outfalls and managing overflows with a controlled weir outfall + + +fertiliser application		**		***		**		**		**		***		**
	DPT4	Berms and field re-profiling (circa 45m x 60m cell) + modifying outfalls and managing overflows with a controlled weir outfall + drainage channels for excess water + + Sphagnum inoculation+fertiliser application		***		***		**		***		**		***		**
	DPT5	Cut and Fill cell bunding (30m x 30m cell) + modifying outfalls and managing overflows with a controlled weir outfall + drainage channels for excess water + Sphagnum inoculation+fertiliser application		***		***		***		***		***		***		**
Dry Cutaway	DCT1	Targeted fertiliser treatment			*		*		*		*		*		*	**
	DCT2	Drain blocking – speed bump method (3/100 m) + modifying outfalls and managing water levels with overflow pipes + targeted fertiliser treatment				*		*		**		**		**		**
	DCT3	More intensive drain blocking (max 7/100 m) + modifying outfalls and managing overflows with a controlled weir outfall + targeted fertiliser treatment				**		**		**		***		**		**
Wetland cutaway	WLT 1	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes + fertiliser application			**		*		**		*		**		**	**
	WLT 2	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes + Targeted blocking of outfalls within a site+ fertiliser application				***		**		**		**		***		**

	WLT 3	Turn off or reduce pumping to re-wet cutaway + modifying outfalls and managing water levels with overflow pipes + Targeted blocking of outfalls within a site + constructing larger berms to re-wet cutaway + transplanting Reeds and other rhizomes+ fertiliser application				***		***		**		***		***		**
	WLT 4	More intensive drain blocking (4/100 m), + modifying outfalls and managing overflows with a controlled weir outfall + transplanting Reeds and other rhizomes+ fertiliser application				***		***		***		***		***		**
	WLT 5	More intensive drain blocking (max 7/100 m), + field reprofiling + modifying outfalls and managing overflows with a controlled weir outfall + transplanting Reeds and other rhizomes+ fertiliser application				***		***		***		***		***		**
Marginal land	MLT 1	No work required	*		*		*		*		*		*		*	
	MLT 2	More intensive drain blocking (max 7/100 m)		**		**		**		**		**		**		**
	AW2	Targeted drain blocking		***		***		***		***		***		***		**

S = Standard Improvements

En = Enhanced Improvements

Indicative Ecosystem Benefit: - * Fair ** Moderate *** High

The above table compares the relative indicative ecosystem service benefits that are expected to be derived from the various rehabilitation measures.

Assumptions made with carbon sequestration and carbon storage are that more enhanced measures will re-wet a greater peatland footprint compared to standard measures and that there will be a greater footprint with optimal water levels and hydrology for greater climate benefits. More enhanced measures will also speed up the trajectory towards the development of naturally functioning peatland ecosystems.

Assumptions made with water flow and water purification are that more enhanced measures (e.g. more drain-blocks and bunding) will slow water movements and provide more potential for silt retention compared to standard measures (fewer measures). More enhanced measures will also speed up the trajectory towards the development of naturally functioning peatland ecosystems that in turn will provide greater water flow and water purification benefits.

Assumptions made with Habitats are that both standard and enhanced measures will both support the development of various habitats. However, more enhanced measures will support the development of wetter peatland habitats rather than drier peatland habitats. More enhanced measures will also speed up the trajectory towards the development of naturally functioning peatland ecosystems.

Assumptions made with High biodiversity value species are that more enhanced measures can be targeted to a greater degree to support some high biodiversity value species, compared to standard rehabilitation measures.

Assumptions made with amenity, recreation culture and education are that both standard and more enhanced measures can provide these benefits.

10. Rehabilitation Action and case studies

Table 10.1. Rehabilitation Action and case studies

Rehabilitation Actions	Case Studies
Drain Blocking (Speed Bump Method) with dozer (3 bumps per 100m)	Carrickhill; Derryvilla; Templetuohy
Drain Blocking with excavator (1 block per 10 cm fall)	Ballysorrell
Field profiling using dozer	Carrickhill
Surface profiling (45m x 60m ponds) using dozer + create surrounding berms (5m wide) using excavator and dozer + install drainage pipes in berms	Killeens
Cut and fill profiling (30m x 30m ponds "Sluggan") using excavator + create surrounding berms (5m wide) using excavator + install drainage pipes in berms	Sluggan Moss; Lodge Bog
Install outfall pipes at boundary outlet	Lodge Bog; Cavemount Bog; Corlea Bog
Install controlled weir at boundary outlet	Finnamores, Sluggan Moss; Srahmore; Boltonfell Moss
Install drainage channels with excavator to rout excess water to boundary outlets	Baunmore
Apply Fertiliser	Drumman; Cavemount, Ballycon, Lullymore
Turn off pumps	Corlea, Carrickhill
Block outfall channels through the site	Derrycashel;
Construct water control berms in the site and construct the appropriate number of taps	Ballycon
Construct Boundary Berm with excavator + install a controlled weir outfall	Lullymore Bog; Ardagullion Bog;
Targeted Drain Blocking with excavator	Cavemount (west); Clonsast
Targeted trench drain blocking	Derryhogan Bog
Reed inoculation	Cloniff Bog; Blackwater Bog
Sphagnum inoculation	Kilberry Bog; Bunahinly Bog; Lodge Bog, Srahmore; Sluggan Moss;

Sluggan Moss (Co. Antrim,) Ardagullion Bog (Co Westmeath) and BoltonFell Moss (Cumbria., UK) are non-Bord na Móna sites.

11. Peatlands originally identified for inclusion in the Programme

Table 11.1. Bog areas initially identified for EDRRS

Bog Group - (Associated Bord na Móna Works)	Bog / Location	Total Peatland Area (ha)	Initial apportionment[14] of Peatlands for EDRRS Area (ha)
Ballivor	Ballivor	654	469
Ballivor	Bracklin	745	412
Ballivor	Carranstown	305	52
Ballydermot	Ballydermot	4,742	2,464
Ballydermot	Lodge	417	263
Ballydermot	Ticknevin	458	273
Ballydermot	Timahoe North	807	428
Ballydermot	Timahoe South	1,704	1,130
Blackwater	Ballaghhurt_Glebe	735	110
Blackwater	Belmount	320	269
Blackwater	Blackwater	2,333	1,030
Blackwater	Bloomhill	889	756
Blackwater	Bunahinly-Kilgarvan	393	333
Blackwater	Clooniff	531	460
Blackwater	Cornafulla	467	389
Blackwater	Cornaveagh	499	346
Blackwater	Culliaghmore	446	312
Blackwater	Garryduff	972	892
Blackwater	Kellysgrove	203	150
Blackwater	Kilmacshane	1,298	1,248
Blackwater	Lismanny	451	302
Boora	Bellair South	229	154
Boora	Boora Bog	1,851	850
Boora	Clongawney	1,021	570
Boora	Derries	371	282
Boora	Derrybrat	177	168

[14] As detailed Enhanced Decommissioning and Rehabilitation plans are developed and approved, and in accordance with the Scheme's Regulatory Controls, the exact areas in the individual bogs may change – this however, will not negatively impact the final aggregate area (32,779 ha) within the above bog groups that will benefit from enhanced interventions. In addition other Bord na Móna licenced peatlands have been, and will be, identified (subject to approval within the Scheme governance) as candidate sites for enhanced improvements, including restoration, in keeping with the objectives of the EU Green Deal communication on its Biodiversity Strategy for 2030.

Boora	Drinagh	1,383	694
Boora	Galros	194	58
Boora	Killaranny	244	17
Boora	Lemanaghan	1,260	243
Boora	Noggusboy	923	527
Boora	Oughter	358	306
Boora	Pollagh	304	274
Boora	Turraun	541	307
Coolnagun	Coolcraff	413	23
Coolnagun	Coolnagun	668	239
Coolnagun	Milkernagh	628	541
Coolnamona	Cashel	248	97
Coolnamona	Coolnacarten	582	161
Coolnamona	Coolnamona	653	402
Derryfadda	Boughill	426	275
Derryfadda	Castlegar	519	326
Derryfadda	Derryfadda	1,111	682
Derryfadda	Gowla	665	440
Derryfadda	Killeglan	584	91
Derrygreenagh	Ballybeg	836	570
Derrygreenagh	Ballycon	281	109
Derrygreenagh	Ballykeane	452	431
Derrygreenagh	Cavemount	513	405
Derrygreenagh	Clonad	446	349
Derrygreenagh	Cloncreen	1,011	866
Derrygreenagh	Clonsast	2,111	802
Derrygreenagh	Daingean_Townparks	90	12
Derrygreenagh	Derryarkin	713	350
Derrygreenagh	Derrycricket	190	26
Derrygreenagh	Derryhinch	336	320
Derrygreenagh	Derrylea	664	565
Derrygreenagh	Derryounce	664	0
Derrygreenagh	Drumman	1,120	392
Derrygreenagh	Esker	566	510
Derrygreenagh	Garryhinch	817	460
Derrygreenagh	Mount Lucas	1,229	450
Derrygreenagh	Toor	444	329
Hort Bog Group	Ummeras	302	216
Mountdillon	Begnagh	264	242
Mountdillon	Clooneeny	389	279
Mountdillon	Cloonshannagh	486	384

Mountdillon	Cloonshannagh Rail Link	486	0
Mountdillon	Corlea	170	38
Mountdillon	Derraghan	504	378
Mountdillon	Derryadd	985	664
Mountdillon	Derryarogue	901	589
Mountdillon	Derrycashel	384	360
Mountdillon	Derrycolumb	461	387
Mountdillon	Derrymoylin	383	340
Mountdillon	Derryshannoge	453	356
Mountdillon	Edera	282	249
Mountdillon	Erenagh	92	53
Mountdillon	Granaghan	213	157
Mountdillon	Killashee	110	107
Mountdillon	Knappoge	314	284
Mountdillon	Lough Bannow	542	329
Mountdillon	Moher	487	408
Mountdillon	Mountdillon	601	199
	Total	**56,019**	**32,779**

A number of additional peatland sites have been added to the Scheme to date and these are set out in Table 11.2 below. These bogs were added following Bord na Mona's decision to permanently cease peat production. The inclusion of these bogs will not result in any material difference in the expected climate action benefits, biodiversity or ecosystem services enhancements which the overall Scheme will ultimately deliver rather, as these bogs have significant depths of peat, it is expected that their inclusion will increase the overall benefits of the scheme. In addition, each of the areas listed above are in the vicinity of bogs already contained in the initial list and do not require any modifications to the geographical distribution of operatives who will be engaged on the proposed EDRRS activities.

Table 11.2. Additional Bog areas added to the EDRRS.

Bog Group - (Associated Bord na Móna Works)	Bog / Location	Total Peatland Area (ha)	Initial apportionment[15] of Peatlands for EDRRS Area (ha)
Ballivor	Lisclogher West	237	190
Boora	Derrinboy	308	267
Derryfadda	Tirrur- Derrymore	445	248
Derrygreenagh	Daingean Derries	277	235
Derrygreenagh	Daingean Rathdrum	368	234
Derrygreenagh	Gilltown	344	320
Derrygreenagh	Prosperous	217	205
Derrygreenagh	Mouds (Allen)	433	410
Mountdillon	Glenlough	335	331
Mountdillon	Clynan	403	283

One bog has been removed from the scheme to date and that is Daingean Townspark. This bog is a proposed NHA and is planned for rehabilitation under a separate NPWS scheme. Further bogs or areas of bogs will be removed from the scheme to accommodate the inclusion of the bogs in Table 11.2.

12. EDRRS Rehabilitation Year 1

EDRRS Rehabilitation – Year 1

Table 12.1. Rehabilitation completed under EDRRS at end of March 2022 (hectares by bog and methodology).

Bog	Completed Area (Ha)																	Bog Area Complete
	DPT1	DPT2	DPT3	DPT4	DPT5	DCT1	DCT2	DCT3	WLT1	WLT2	WLT3	WLT4	WLT5	MLT2	AWT2	MLT1	AWT1	
Belmount	0.0	4.7	0.0	40.1	3.6	6.6	37.0	0.0	0.0	12.8	8.1	103.6	0.0	3.1	1.1	25.6	0.0	246
Clooniff																	0.0	0
Garryduff	0.0	13.3	0.0	4.8	26.6	0.0	69.4	0.0	0.0	344.1	45.8	286.1	0.0	14.3	0.0	63.6	0.0	868
Kellysgrove	0.0	105.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.3	0.0	132
Kilmacshane	0.0	36.6	0.0	57.2	0.0	15.6	116.9	0.0	0.0	400.6	157.5	271.0	0.0	10.6	0.0	106.9	0.0	1173
Boora	0.0	14.6	0.0	50.5	0.0	120.1	14.0	0.0	0.0	0.0	50.1	113.1	0.0	0.0	37.8	26.9	110.7	538
Derries	0.0	4.3	0.0	3.4	3.4	112.2	48.1	0.0	0.0	147.5	4.6	0.0	0.0	0.0	5.2	30.0	0.0	359
Oughter	0.0	0.0	0.0	0.0	0.0	14.8	36.4	0.0	0.0	14.0	21.1	123.6	0.0	5.6	0.0	26.5	0.0	242
Pollagh	0.0	0.2	6.9	72.3	4.7	0.0	41.9	0.0	0.0	1.7	14.9	87.1	0.0	0.0	0.0	16.6	0.0	246
Turraun	0.0	0.0	0.0	0.0	0.0	0.0	88.9	0.0	0.0	38.3	5.7	184.7	1.4	0.0	0.0	65.9	0.0	385
Castlegar	23.0	58.7	100.1	92.5	22.7	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.7	0.0	361
Cavemount	0.0	0.0	0.0	17.2	0.0	4.8	38.7	0.0	0.0	7.4	242.6	42.6	0.0	0.0	28.2	38.8	0.0	420
Clonad	0.0	0.0	0.0	34.0	0.3	0.0	64.4	0.0	0.0	0.0	2.4	163.4	0.0	0.0	0.0	25.7	0.0	290
Esker	0.0	0.0	156.9	114.3	44.7	10.9	53.6	0.0	0.0	0.0	34.6	53.6	0.0	3.3	0.0	37.6	0.0	509
Mountlucas	0.0	0.0	30.6	25.3	37.8	0.0	64.3	0.0	0.0	4.1	21.4	75.2	0.0	0.0	115.8	77.3	444.7	897
Ummeras	0.0	11.4	0.0	112.5	22.5	5.9	28.7	0.0	0.3	5.9	1.1	17.1	0.0	0.0	0.0	33.1	0.0	238
Derrycashel	0.0	0.0	0.0	0.0	0.0	0.0	70.9	0.0	4.6	189.2	0.0	47.9	0.0	41.5	0.0	0.0	0.0	354
Derrycolumb	0.0	9.6	70.9	38.8	4.6	0.0	83.3	0.0	0.0	43.3	19.8	97.0	0.0	0.0	0.0	40.7	0.0	408
Edera	0.0	0.7	51.1	59.1	18.1	0.0	10.3	9.9	0.0	0.0	0.0	42.4	6.8	0.0	0.0	51.4	0.0	250
FY22 Completed (Ha)	*23*	*259*	*416*	*722*	*189*	*291*	*878*	*10*	*5*	*1209*	*630*	*1708*	*8*	*78*	*188*	*747*	*555*	*7917*

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Appendix A

Cutaway peatland rehabilitation – standard approaches to meet EPA licence obligations

Examples/ Case Studies

APP A1: Blocking main Outfalls and Managing Water Levels – Case Studies

The eastern side of Cavemount Bog is a particularly good example of this rehabilitation measure. Several main outfalls were blocked by lifting pipes and filling infilling the holes. Cavemount Bog has a very typical cutaway bog topography and eastern side is shaped as a shallow basin due to long-term industrial peat extraction. The majority of peat has been removed from the site and residual peat depths were generally 0- 1m. This bog is underlain with shell marl. Once the main outfalls were blocked the eastern side re-wetted and has been developing as a wetland. The images below show the contrast in environmental conditions after re-wetting with the darker colours shallow surface water. Pioneer wetland vegetation is continuing to colonise these re-wetted areas. The development of vegetation has been influenced by the more alkaline sub-soils that were exposed, leading to the development of fen type pioneer vegetation.

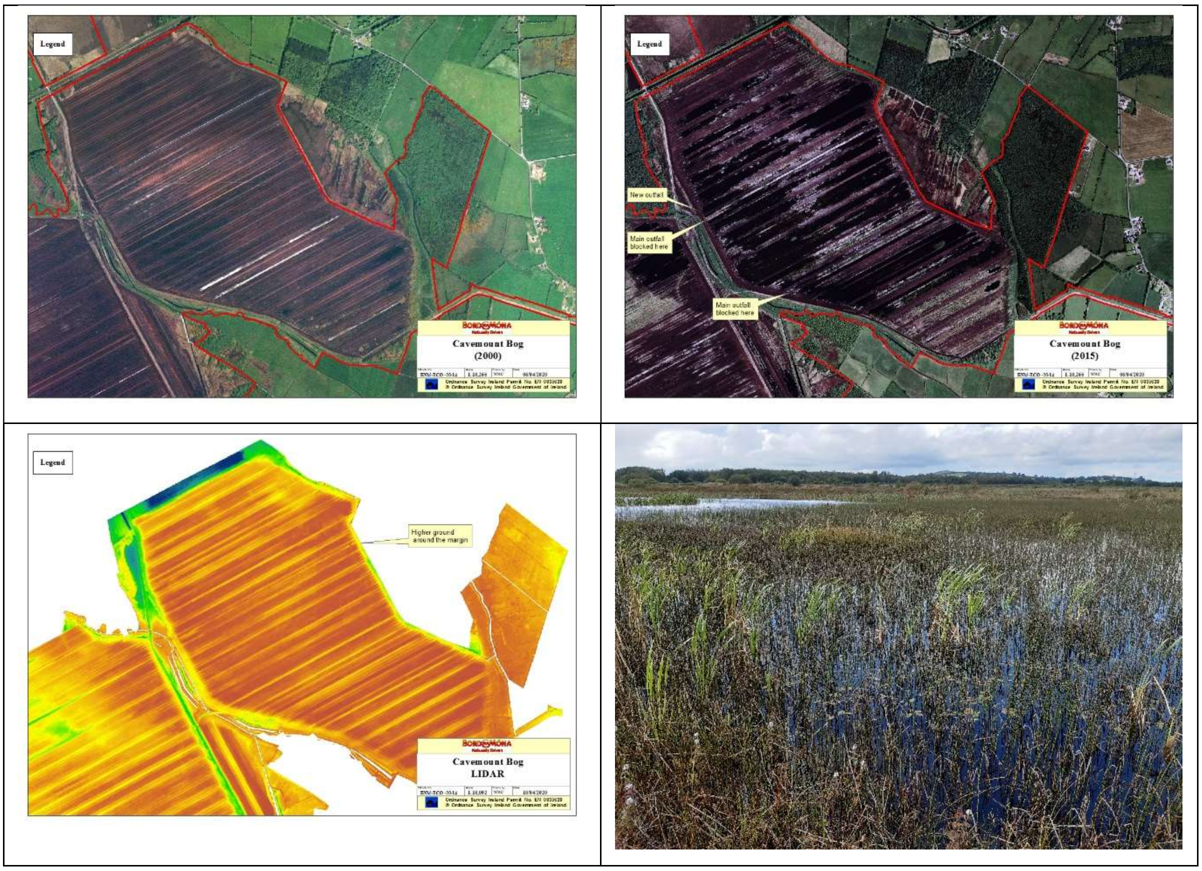


Figure A2.1. Cavemount in 2000 and 2015. The above approach was applied at Cavemount and 2 main outfalls from Cavemount West were blocked in 2012. The impact across the bog is obvious with significant wetland development. An overflow was subsequently constructed in 2016 to regulate water levels. The LIDAR map shows how the topography of Cavemount Bog is suited for re-wetting, being a typical basin surrounded by a lip of higher ground.

Excess water (overflow) can be managed by creating a new outflow at the most suitable level. This measure is particularly effective for cutaway bogs with relatively flat basins where the outfall level will control the overall level across a relatively large area. One way is to block the original pipes (set at a level to drain the cutaway bog). Then place a new overflow pipe set at the appropriate level to allow excess water to flow towards the silt ponds and out of the site.

At Lodge wetland, a new bund was created around the original outfall pipe and a new pipe inserted into the bund. This overflow pipe was built in this way as the original outfall pipe could not be blocked at the time. Some grass seed and fertiliser was sown onto the new bund to help stabilise the bare peat. This has been successful and this pipe is now the main water level control at Lodge wetland.

At Cavemount Bog a different approach was taken. The old outfall pipe had already been lifted and blocked, allowing the creation of wetland across the cutaway. A new outfall pipe was constructed across the main headland to take water from the wetland into the existing drainage channels. This is now the main water level control at Cavemount Bog. It was positioned at a height to control winter flood levels, while retaining water across the wetland in the summer. Water levels in the wetland in summer 2018 dropped meaning that the pipe stopped flowing for a period, but there was continued flow during 2019.

Figure A2.2. The 2 top pictures show the Overflow pipe constructed at Lodge wetland. The bottom left and middle photo is the main water outlet at Cavemount. The bottom right photo is the main water outlet at Corlea. The pipe at Corlea was located at the old pump site.

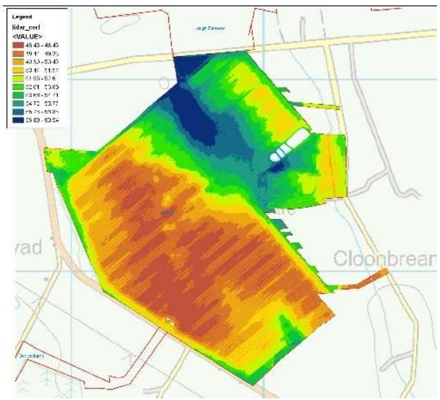
In general water levels are managed to keep sites wet during the summer but avoided significant water build up in the winter. Target water levels are generally 10-20 cm in height during the summer, to allow the development of emergent wetland vegetation while preventing the site from drying out. The new pools and re-wetted areas now act as natural ‘silt control’ in a similar way to constructed wetlands. Some Bord na Móna sites do require overflow management as otherwise they would fill to high levels and there is the risk of unintended consequences and flooding non-target adjacent land.

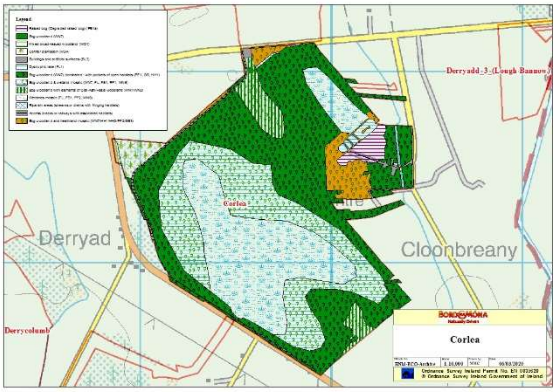
This approach has been an effective measure that can lead to the development of a diverse mosaic of wetland habitats. The larger wetland units are also very attractive to wintering and breeding birds and Cavemount, Bog for example, has become nationally important due the numbers of wintering Whooper Swans, and due to the numbers of breeding waders in the spring/summer.

APP A2: Turn off or reduce pumping and re-wet cutaway – Case Studies

The rehabilitation of Corlea Bog (a former pumped bog) was carried out in several phases. The first section associated with the amenity trail in the NE corner of the site (smaller basin) was re-wetted in 2016 while the second part (main section) was re-wetted in 2018.

Analysis of topography across the bog indicated that it would be relatively straight-forward to re-wet this bog and create wetland habitats as it was a large basin. Stopping pumping would allow water-levels to rise across the main basin. Hydrological analysis allowed Bord na Móna to identify that setting the level of the outfall pipe at 48m OD would maximise the extent of shallow water conditions to benefit the future development of emergent wetland vegetation (Reedbeds, fen and wet woodland) (0-10cm - green areas) in the main basin. An outfall pipe (30cm diameter) was inserted at this level to take overflow water across the headland direct this water into existing the drainage infrastructure towards silt pond.





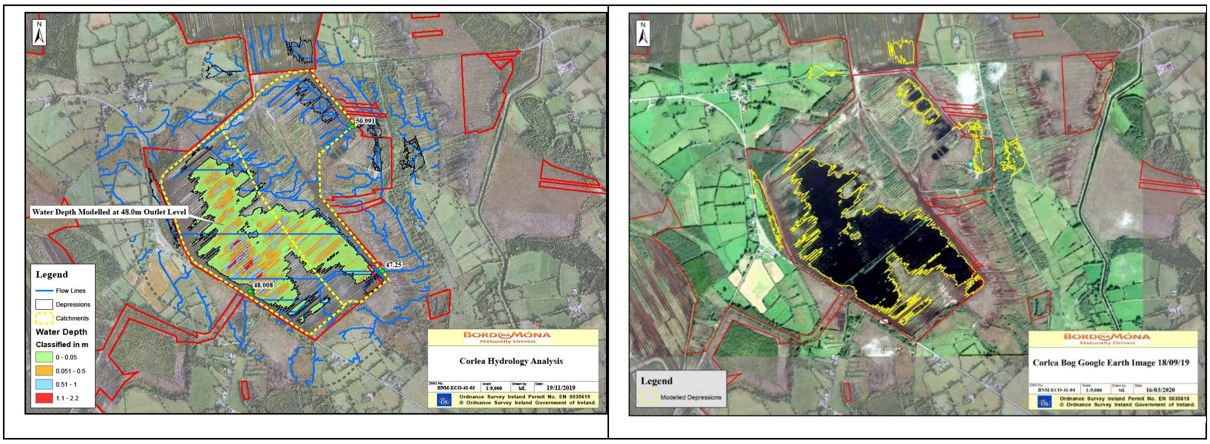


Figure A2.3 Corlea Bog. The top left picture is from the NE wetland and is a picture of the basin looking south. The top right photo is of the main basin at the former pump site. The LIDAR map outlines the extent of the main basin in Corlea Bog (Orange areas) surrounded by a lip of higher ground (yellows and greens). This was a pumped bog with a deep basin so it was expected to re-wet and develop wetland habitats – as outlined in the Future Habitat Map. The bottom pictures demonstrate the value of hydrological modelling. The left picture is a hydrological model of the predicted water depths and the right pictures is an aerial image from 2019 demonstrating that the wetland footprint in the main basin is very similar to be modelled footprint.

Water-levels at Corlea will continue to be monitored in the near future to monitor the natural development of emergent vegetation. If it is concluded that water levels are inhibiting the development of extensive wetland vegetation, then the level of the outfall pipe can be lowered by a small amount (~30cm). Water-levels are not uniform across the basin due to the natural heterogeneous topography. Some deeper water (< 0.5m) will always be present at this site. However, the current water levels will lead to the development of a natural mosaic of wetland habitats that will reflect natural hydrological zonation at this site.

APP A3: Regular Field Drain Blocking with a machine (dozer) - Case Studies

Application of the deep peat cutover bog field drain blocking methodology was carried out in Carrickhill Bog using a bulldozer. Note the 'speed bump' peat dams and the irregular cover of surface water that reflects the heterogenous topography. Carrickhill is still relatively bare of vegetation as it came immediately out of peat production before undergoing rehabilitation. It is expected that re-wetting will encourage natural colonisation over the next few years.

Figure A3.1. Carrickhill Bog.

Water still flows across this re-wetted landscape according to the prevailing slopes, but now flows across the peat surface and generally avoids the new peat dams. Hollows and drains across this new re-wetted landscape remain wet. A key issue on these milled peat bogs is the uneven topography of the peat fields. This means that when drains are blocked, hollows become wet while other higher areas remain dry. The variation in topography between adjacent peat fields can be significant (0.5-1m). Typical peat fields are also cambered and are higher in the centre and lower towards the drains, helping drainage of the fields but limiting the re-wetting of the central area.

This approach has been applied in a **targeted way** using the undulating topography to maximise re-wetting by creating peat dams across peak of the undulations in Derryvilla and Templetuohy Bogs thereby re-wetting the troughs or basins through the cutaway. Overall, the re-wetted footprint can be significant when applied appropriately.

Figure A3-2. Derryvilla Bog (left) and Templetuohy Bog (right): Application of the deep peat cutover bog field drain blocking methodology using a bulldozer.

Figure A3.3. Derryvilla Bog. Aerial photos date from 2000 and from June 2019.

Rehabilitation was carried out in Derryvilla Bog in 2018. The main objective was to block the field drains using the field drain blocking – bulldozer methodology. The dozer targeted 'peaks' across the undulating landscape to trap water in the 'basins' or cells between where drains are blocked. This method has been very successful at re-wetting this site. Some fertiliser was also applied at this site.

Natural colonisation has been exceptionally fast at this bog as seen in the photograph below with plenty of bog cotton and some Sphagnum colonisation in the drains. This bog was bare peat in 2018

Figure A3.4. Derryvilla Bog. June 2022

APP A4: Case Study - Environmental Stabilisation of Derries Cutaway Bog

The development of Derries cutaway bog is an example of the targeted rehabilitation and natural colonisation acting together to develop pioneer habitats and stabilise former industrial peat production bog.

Industrial peat extraction began to cease in sections of Derries Bog during the early 1990s. Peat extraction generally stops in phases as continued industrial extraction of peat becomes unviable and particular sections of bog become cutaway. The majority of the site was still bare peat in 2000 but pioneer vegetation was starting to develop in places. Part of the site (south-east section) was re-wetted prior to 2000 as part of the Lough Boora Discovery Park development. In 2000, the greater part of the site was still in industrial peat production.

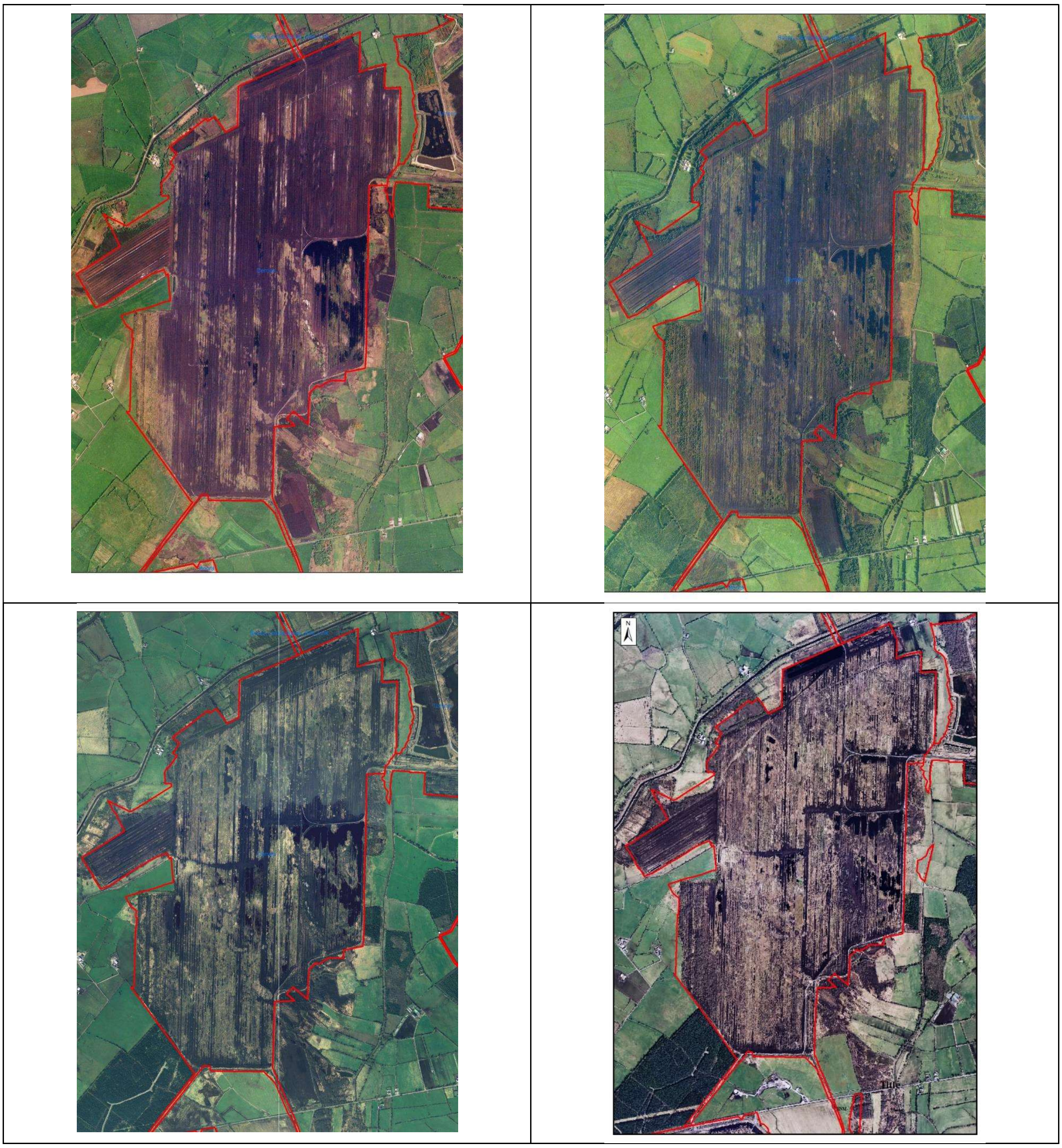


Figure A4.1. Derries Bog. Aerial photo series from 2000, 2004, 2009 and 2015.

By 2005 peat extraction had ceased across the bulk of the site and through the central part of the site. Typical pioneer vegetation continued to establish during the 2000s and by 2009 the majority of the site was vegetated via natural colonisation, which was encouraged by the cessation of disturbance from peat extraction activity. During this period, the field drainage system naturally began to break down as well, accelerating natural colonisation. The development of pioneer habitats reflects the underlying environmental conditions with the key factor being topography and hydrology. The Bord na Móna bog railway was in continued use during this period. Peat extraction was ongoing in several smaller areas around the periphery of the site. The Bord na Móna railway was partially re-aligned between 2009 and 2015. By 2015 the progress of natural colonisation and environmental stabilisation is clearly evident. Birch woodland is clearly developing in the SW part of the site and the extent of bare peat has been significantly reduced. Vegetation cover is greater than 90%. The central part of the site is a mosaic of wetland and Birch woodland that reflects the underlying topography of the site. Peat extraction has now ceased at this site and the remaining bare peat areas are continuing to naturally colonise. The most obvious bare peat areas are the old headlands and travel paths that are still in use and still being disturbed.

An extension to the Lough Boora Discovery Park cycle network was built along the eastern side of Derries bog on part of the old railway network in 2016. Some targeted re-wetting (drain-blocking) was carried out in the western spur in 2018. Future options for peatland rehabilitation at this site includes the potential adjustment of water levels when the bog railway is decommissioned.

Derries Bog is a typical Bord na Móna cutaway bog. In general, the first 5 years after peat extraction ceases sees the development of pioneer vegetation through natural colonisation with bare peat still dominant. But the following 5 years sees the establishment of pioneer habitats and the overall environmental stabilisation the cutaway. While these changes on a cutaway bog can be hard to see from year to year, over periods of 5-10 years, progress is obvious. The site has now established a mosaic of developing habitats including wetlands, scrub and Birch woodland. Bare peat cover has been significantly reduced compared to its extent in 2000.

Derries Bog now meets the criteria for environmental stabilisation as per the EPA Licence. Peat erosion via wind and water has been minimised and water movement across the site has been slowed significantly via natural colonisation and the development of pioneer habitats. The site is now on a trajectory towards having 100% vegetation cover and natural cutaway habitats will continue to develop and diversify in the future.

Appendix B

Cutaway peatland rehabilitation – Enhanced Approaches to Rehabilitation

Examples/ Case Studies

APP B1: Drain blocking with an excavator to re-wet cutaway - Case Study

An example of the application of enhanced drain blocking rehabilitation measure is at Ballysorrell Bog. Ballysorrell Bog is a Bord na Móna site that was drained and developed, had its vegetation stripped off the surface and milled for peat extraction for 2 years in the 1980s. However, peat extraction ceased and the site was held in reserve for future peat extraction, until the decision was made to restore this site in 2017. The site had been naturally vegetating since the 1980s but was still relatively dry with active functioning drains. Rehabilitation has been completed at this site and the re-wetting has already had a positive impact with the development of new *Sphagnum*-rich communities in a short space of time. Ballysorrell Bog is an excellent example of how a deep peat bog can be restored to a trajectory towards the development of natural raised bog communities and the development of peat-forming *Sphagnum*-rich vegetation. It also demonstrates that time is important for peatland restoration as the recovering vegetation (prior to re-wetting) has been in development for over 30 years.

Figure B1.1. Ballysorell Bog. This site naturally recolonized from bare peat since the 1980s until drains were blocked in 2017. Note the peat dams and the high-water levels in the drains. Also note the degraded and embryonic raised bog vegetation with a proportion of bare peat. Re-wetting at this site will accelerate natural colonisation of vegetation and the re-establishment of fully functioning raised bog plant communities.

Ballysorrell bog now forms part of the Bord na Móna Raised Bog Restoration Programme. The Raised Bog Restoration Programme includes a sub-set of Bord na Móna sites and bog remnants that were drained initially but never developed for energy production. Consequently, they have significant raised bog restoration potential as the original raised bog vegetation is still intact (but degraded from drying out). Bord na Móna make a clear distinction between these types of sites that can be restored relatively quickly back to raised bog and sites where much more peat was extracted, altering the environmental conditions. The Bord na Mona Raised Bog Restoration Programme has now restored over 3000 ha of raised bog habitat across 26 sites with another 1300 ha targeted for restoration in the near future.

APP B2: Use of Berms and Field Re-profiling to optimise re-wetting - Case Study (pre-EDRRS)

Bord na Móna constructed bunds/berms at Lodge Bog as part of a re-wetting trial (bunding only, not re-profiling). Bunds were built with peat using the **trench bunding** approach. A foundation channel was cut by a large excavator to about 0.5 m and 2 m wide. This was then packed with peat and built up using peat from borrow areas on either side of the bund. The bund was built up to a height of 0.5 m. The bund was built between several high fields and was 3-4 peat fields wide. The excavator was used to track across and compact the peat in places and the bucket was used to compact the peat. One key constraint was the consistency of the peat, which had to be firm enough to be shaped and to be compacted. Trench bunding has not been used in the formation of the berms for the cells in the EDRRS rehabilitation as it was not considered suitable for the 0.5m high berms,

Figure B2.1. Lodge Bog cutaway. Trench bunds were created at Lodge Bog cutaway to create cells to re-wet the cutaway.

The trial at Lodge Bog demonstrated that this methodology could create cells to re-wet cutaway and to hold back water at slightly higher elevations.

Bord na Móna have also carried out a recent re-profiling trial at Killeens Bog. Here a bull-dozer was used to smooth out, flatten and level several fields, with the field drains in-filled. Peat was moved from higher elevations within the smoothed area to create a series of terraces. This trial is somewhat similar to the method being proposed as part of this enhanced measure (although there are some differences as cells not formed in the same way as proposed for EDRRS).

Figure B2.2. Killeens Trial Area Fields levelled with a dozer creating a series of terraces.

APP B3: Formation of Small cells to re-wet Deep Peat Cutover Bog - Case Study (pre-EDRRS)

Bulrush harvest horticultural peat from former small raised bogs in north Antrim and Derry, including at Sluggan Bog (50 ha). The original cutaway landscape would have regular peat fields and drains in a similar configuration to Bord na Móna bogs. Peat was harvested using the milled peat production. Bulrush generally cease peat extraction with at least 0.5m residual peat left in the bog. The cutaway tends to be well-drained and underlain with clay in an area with basalt geology (generates more acidic water chemistry).

Figure B3.1. Sluggan Bog. The top-right photo shows the Sphagnum mat that is typical of this site. The bottom right photo shows a typical berm that is used to hold water in the cells. The bottom-left cell shows a berm and a drainage pipe that is used to control water levels in the cell.

In terms of a case study for this technique, the general approach of Bulrush has been to create the most suitable hydrological conditions for the development of *Sphagnum* bog mosses. They have applied a much more intensive engineered approach to re-profile the overall bog to create cells that maximise suitable conditions for the development of bog mosses. The bogs were surveyed to accurately identify the surface contours before rehabilitation and 3D cut and fill software was used to design the targeted surface levels for individual areas within the bog.

The original cutaway did have uneven topography and there was an overall fall or slope from the eastern to the western end of the site. Water generally flows to the western side along the slopes to the main outfall. The approach taken was to remove the general influence of the slope by creating suitable flat or saucer type cells where water could be held at suitable levels to encourage the development of *Sphagnum* mosses. The bog drainage was designed to transfer excess water from cell to cell at different elevations cascading down peatland gradients. Bulrush installed a water control weir (with water level adjustment) to allow some control the water level at lower levels within the site.

Bulrush started cell construction at the highest part of the site and continued cell construction down the peatland gradient (cascading). Bulrush used a cut and fill approach to create flat 'saucers' or bunded areas (flat areas) on peat with berms to hold shallow water. Cells were sized approximately 25 x 25m to prevent erosion. Bog restoration at other sites has found that larger cells and deeper water can inhibit the spread of *Sphagnum* due to wave and wind action. The target water level was about 5-10cm of water. Laser levels were used on excavators to aid the construction of flat cells surrounded by flat berms.

As cells were being constructed production field drains were infilled with peat. The peat field drains were generally running from high ground to low ground, thus aligned with the direction the ponds were being cascaded. As a bund was being constructed (cut and fill), the operator was gathering peat to be used to create the berm which would surround the cell. The peat which was being cut was from the top of the fields and thus was not saturated. This was necessary to have drier peat to facilitate bund construction. Bunds were constructed using this drier peat which was placed by the excavator and then compacted by the excavator's tracks. Bunds were constructed at a level approximately 30cm higher than the cell floor. Bunds were sized to be about 4m in width. Sufficient compaction of the bunds was required to ensure that they would hold back the water level in the cell. The top surface level of the bunds was constructed with a high level of accuracy (level along the extent of length bounding the cell). This is essential as the bunds eventually become overflow weirs from cells at later stages when drainage pipes become ineffective.

Initially Bulrush spent some time laying out the design of the cells and laying out predetermined levels prior to construction and ground-works. However, this become unnecessary when the approach became familiar to the machine drivers, who were able to replicate the procedure and continue creating cells.

The work was completed with excavators. Bulrush used 14 tonne machines with widened chassis and wide tracks and some smaller 8 tonne excavators were used. The work carried out in summer and autumn. Some work was carried out in winter but only in good ground conditions.

There was little adjustment of drainage pipes required after 5 years. The bund heights are generally controlling water at suitable levels. Water levels are ankle deep or slightly higher with a mat of *Sphagnum* in this depth of water. Generally, the bunds were effective straight away. However, 1 out of 4 required follow-ups work to adjust bunds particularly in a circumstance where ponds did not hold water. Thus, it is essential that an excavator can access the bund network to reach a problem area and carryout the work required to seal the pond. Bunds were used for access during and after rehabilitation improvements. Bulrush mow some of the bunds annually to facilitate access across the site.

The engineered approach applied at Sluggan Bog has proven very effective in stabilising the former cutaway bog and encouraging the development of *Sphagnum*-rich vegetation, sometimes in less than 5 years. The vegetation, dominated by Rushes and Bog Cotton developed mainly through natural colonisation, although there was some inoculation of *Sphagnum* taken from another close by donor site. Re-wetting the site in this way also seems to have inhibited the development of significant stands of Birch. This approach has re-engineered at landscape that has encouraged the natural re-development of bog mosses. These sites are still in early stages of development but would be expected to develop embryonic raised bog or *Sphagnum*-rich poor fen communities in a relatively short time period (30-50 years) and moving the site from being a carbon source to a carbon sink.

The growth of *Sphagnum* at this site in a short time at Sluggan Bog has been exceptional and mirrors the experience of Bord na Móna in Bellacorrick and the experience of NPWS at Killyconny Bog. In general *Sphagnum* requires suitable water levels (couple of cm +/- the peat surface) and suitable water chemistry (ph < 5) to thrive and form *Sphagnum*-rich mats.

APP B4: Using Controlled Weirs to manage water levels on cutaway - Case Study (pre-EDRRS)

Controlled weirs can be used to help manage water levels at a site.

Although not regularly employed by Bord na Móna, this type of enhanced measure, using Drop-board sluices as weir option were used in the rehabilitation of cutaway peatlands at Bellacorick in Co. Mayo by Bord na Móna. These were built into weirs one the outflow of silt ponds to manage water levels, during the initial period when silt ponds were still required, to keep water levels in the silt ponds high and the silt ponds functioning correctly. In time as the bare peat of the cutaway re-colonised and less silt was accumulated in the silt ponds, the level of the silt ponds was lowered and eventually allowed to develop natural levels, with the silt ponds developing into small wetland features. Similar drop-board sluices were used at Shramore, Co. Mayo, to help manage water levels in the peat depository.

A drop board sluice was used in Sluggan Moss in Co. Antrim to control the outfall from the site. Bog rehabilitation work at Sluggan started at the highest end of the site, with the lowest area forming a large open water lake. As the rehabilitation work progressed, the water level was lowered to reduce the area of the lake and allow cell bunding to be undertaken to enhance Sphagnum cover on the site as a whole.

Figure B4.1. Types of controlled weir outfalls: Sluggan Moss (Bulrush) (left) and Srahmore (Bord na Móna) (right) with two different designs of drop board sluices.

This enhanced rehabilitation measure will allow greater control of water levels across various cutaway sites and also gives more flexibility to manage sites in different ways.

APP B5: Creating new drainage routes to manage excess water (High field Taps) - Case Study (pre-EDRRS)

An example of this approach was implemented at Baunmore Bog. Pioneer wetland vegetation was already developing at Baunmore, which was cutaway site positioned at a naturally low level in the landscape and adjacent to a river that was prone to flooding in the winter. Generally, this site would flood naturally in the winter and then dry out towards the end of the summer. Baunmore Bog also received water flow from an adjacent stream, which had originally flowed through the bog. Water flowed through the high fields through pipe connections, meaning that the high fields could be used as natural berms to divide the wetland into sections. Much of this wetland area was also relatively flat, meaning that a larger area could be controlled from one point. This meant that re-wetting at Baunmore was relatively straight-forward. The key issue was trying to manage summer water-levels in a more appropriate manner to keep the cutaway wet to promote the establishment of pioneer wetland and fen vegetation while avoiding the development of deeper water levels. This was achieved by blocking the original pipe and then cutting new channels through the high field at the target water level height.

Figure B5.1. Controlling water levels at Baunmore using overflow taps cut through the high field. The left photo shows the new overflow tap. Water levels were targeted reduce water depths in the bay on the central photo. The right photo shows typical target summer water levels at Baunmore to promote the establishment of emergent wetland and fen vegetation.

APP B6: Re- configuration of outfalls within a site to re-wet cutaway - Case Study (pre-EDRRS)

The north-east basin of Corlea is an example of where this approach was applied. This basin was sloped from the northern to the southern end and a pipe had been constructed through the middle of the basin to drain it (Pipes were generally positioned through the lowest point of the basin or along the headland). Field drains directed water to the pipe. The orientation of the fields meant that the high fields could be used as natural berms or bunds. The pipe at each high field was lifted. This meant that water levels had to rise in the series of low fields and then overflow the high field to reach the next series of low fields. The LiDAR map outlines this topographical arrangement and how this basin is divided into a series of sub-basins by the high fields. This targeted re-wetting has been extremely effective in creating a new wetland that now attracts water birds. It has slowed water flow through the re-wetted area. The water flow was piped at the last high field (southern end) to accommodate a walking trail and loop at this site.

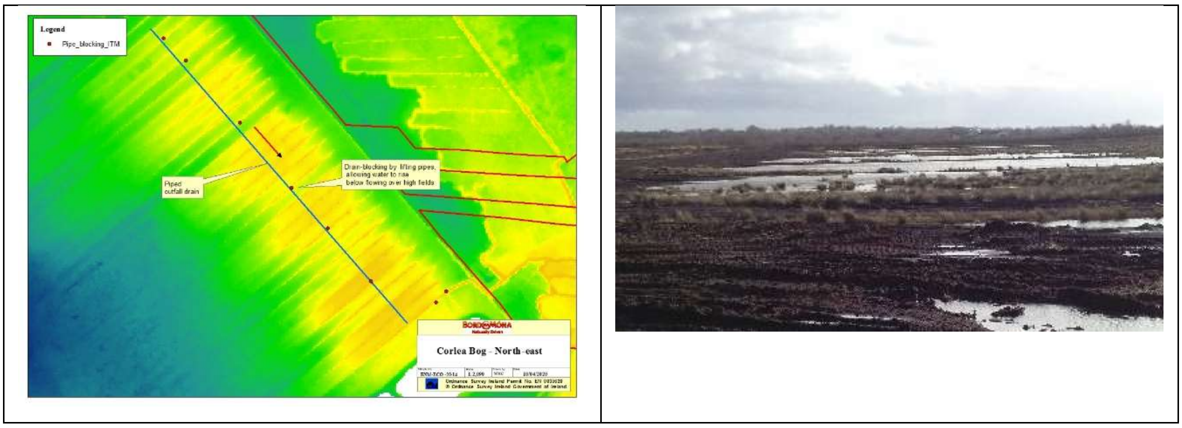


Figure B6.1. Corlea Bog – North-east. The LiDAR map displays the overall topography of the north-east basin. The pipe running through the middle of the basin was blocked at each high field, allowing water to rise, then overflow to the next 'compartment.' This has created a compartmented wetland with each compartment acting as a mini slit pond, slowing water movement through the site. Water now 'cascades' from the higher NW compartment to the lower SE compartment. This area is now colonising with wetland vegetation.

APP B7: Using larger berms to re-wet cutaway - Case Study (pre-EDRRS)

An example of this proposed approach can be seen at Ballycon Bog. Ballycon is a typical pumped drainage bog that came out of peat extraction around 2000. The LiDAR map demonstrates that the site is predominately a basin. The pump was switched off and decommissioned and the bog switched to gravity drainage encouraging the development of wetlands in the lowest section at the SE margin. The overall bog drained towards the old pump site. The overall levels at the old pump site could not be raised to a significant height to re-wet the overall bog as the Bord na Móna railway and travel path along the southern margin was still in use. The gravity drainage outfall was positioned at intermediate position to re-wet a portion of the bog while protecting the travel path and railway. The north-eastern part of the bog was planted with conifer forestry by Coillte in the 1990s and this was an additional constraint to raising water levels to a high level.

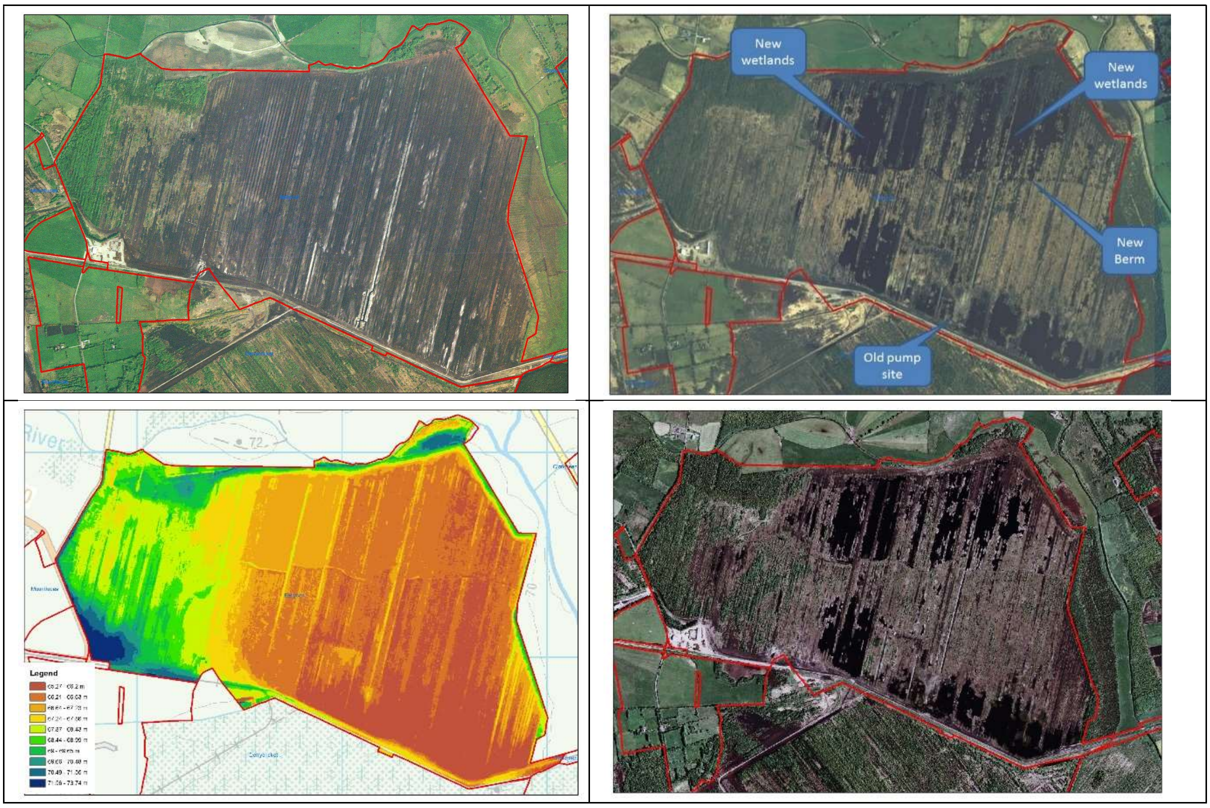


Figure B7.1. Ballycon bog. Top-left picture is from 2000. The top-right is from 2009; a berm was constructed in an east-west orientation across the middle of the bog. The berm is also visible in the LiDAR Map (bottom-left). The bottom-right picture is from 2015; the site has now naturally colonised quite well with a mosaic of wetland and Birch woodland habitats.

In 2003 a berm was built across the middle of the site to increase cutaway re-wetting in the northern half. This berm is visible on the LIDAR map and the 2009 aerial photo. The berm was built with a large excavator during the summer when the site was drier and there were better conditions for ground improvements. The berm was constructed to a height of 1.5 m and was 2-3m wide at the top and 4-5m wide at the base. It is now vegetated and has blended very well into the cutaway landscape. Overflows were managed with pipes to allow flow to reach the main outfall.

The development of this berm in association with the high peat fields that were already present was extremely effective at re-wetting a large area of cutaway at Ballycon.

Figure B7.2. Ballycon bog. The left photo is a berm, which is has now blended into the landscape. This has increased the area of suitable hydrological conditions for the development of emergent wetland vegetation.

APP B8: Using a boundary berm to help re-wet cutaway. - Case Study (pre-EDRRS)

A partial boundary berm was constructed at Lullymore as part of the ongoing rehabilitation of this site, which was a former pumped milled peat production bog. Milled peat extraction ceased across much of the site prior to 2000 but it was still partially in peat extraction. Lullymore Bog is a typical example of the topography of many cutaway sites. It has been cut down into a general basin and (mainly) surrounded by a lip of higher ground. During peat production it was drained by several main outfalls and via a pump at the northern end. The LiDAR map displays the general topography of the site with the higher ground being blue and green and the lower ground being orange and yellow. A ridge of glacial material that would have underlain the bog is now exposed and runs in an east-west orientation through the site.

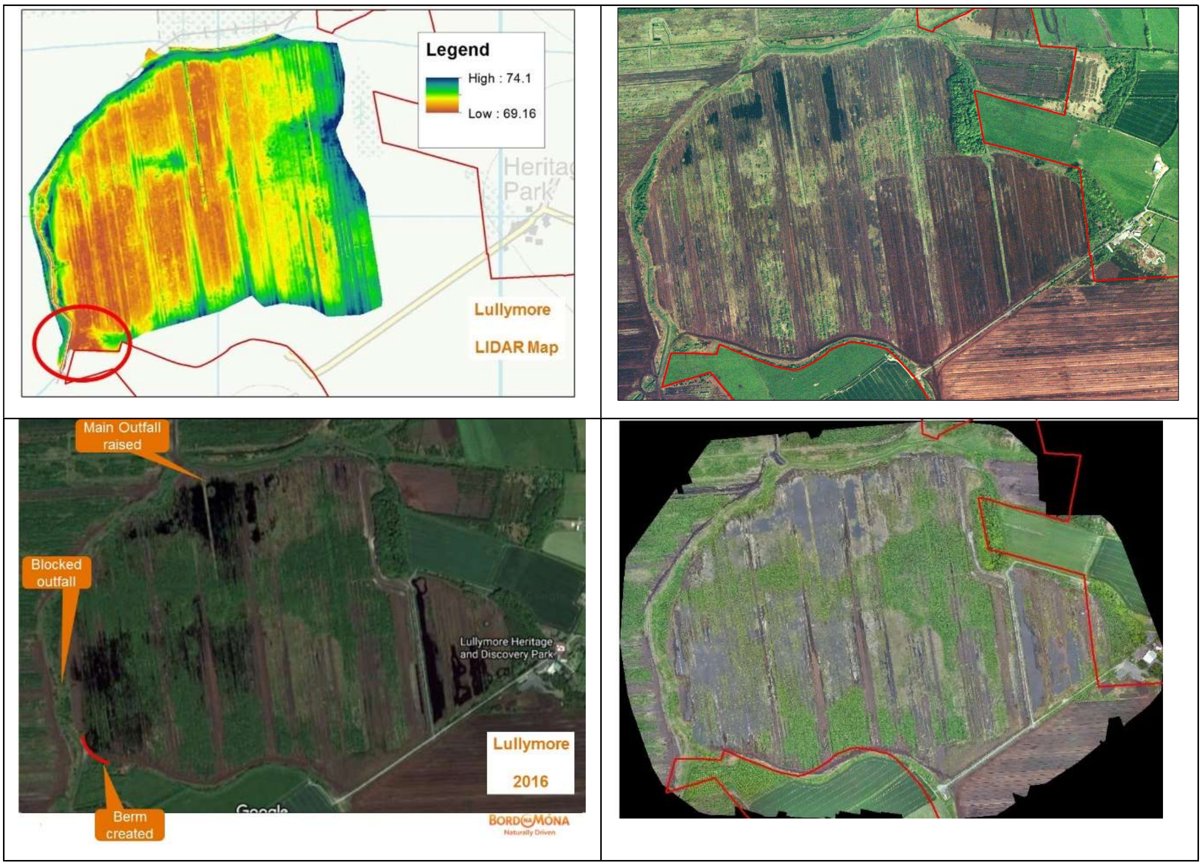


Figure B8.1. Lullymore wetland. The LiDAR image shows low ground (yellow and orange) surrounded by a lip of high ground (blue and green). The top-right photo is from 2000. The site was vegetating naturally and there was some wetland development close to the main outfall and former pump site at the northern end. There has been phased re-wetting at this site that focused on raising the outfall and finding other outfalls and pipes and blocking them. The final piece was the creation of a short bund at the SW corner to block off a low-lying 'crack in the saucer'. Building this bund had a significant impact on raising water levels and re-wetting peat across the site. The bottom-tight picture is a drone photo taken in 2016. Much more extensive surface water is evident in this photo (Darker grey). The light green colours are Birch woodland that has developed on higher ground.

Targeted rehabilitation was carried out on a phased basis at Lullymore. Initially the main outfall was raised, and some drains and the northern end of the site were blocked using an excavator. The site was continually monitored, and this demonstrated that water levels did not rise across the site to expected levels. Further monitoring of the site found several other outfall pipes that were then blocked. The key constraint to raising water levels was then identified as the SW corner where there was a low-lying section, as indicated by the LIDAR map. Water also flowed out of the site at this location in winter.

It was then planned to build a boundary berm at this SW location to 'plug' the gap in 2016. A bulldozer and excavator were used to build this berm. Initially the ground was cleared of vegetation and loose peat, which was stockpiled. Then sub-soil dug out and stock-piled from a nearby outfall was used to contrast the berm. This sub-soil was a mixture of gravel and blue silt marl, making it a suitable relatively impermeable material. The bulldozer and excavator worked together to move the material into position and then to build it up and to shape the berm. The berm was 10 m wide and about 1 m higher than the original cutaway level. It was bevelled from the wetland side down to the drier side.

The berm quickly re-vegetated naturally (after 1 year). There has also been some repair and enhancement work to extend the length of the bound and to repair some leaks. These generally occurred where peat was used in association with bog timber. These patches were dug out and blocked again with the more impermeable sub-soil mix.

Figure B8.2. Lullymore wetland. The left picture displays the constructed bund holding water while the right picture displays the impact and the targeted water-levels (emergent wetland vegetation over a wide area).

A boundary berm was also constructed around the northern and western sides of Ardagullion Bog in Co. Longford as part of the Living Bog LIFE Project. The berm was designed to hold water on an area of cutover bog that had been used for domestic turf cutting. Although the retained water was substantially below the level of the adjacent high bog, the area re-wetted had shallow water levels to allow the development of *Sphagnum* and other target embryonic raised bog species.

Figure B8.3. Ardagullion boundary berm.

APP B9: Trench drain Blocking to re-wet cutaway. - Case Study (pre-EDRRS)

Derryhogan is part of Littleton Bog and is a relatively old industrial peat production bog. Large-scale industrial peat production began in the 1940's where sod peat was produced for fuel. Sod peat production was mechanised during the 1950's. The method of harvesting sod peat has divided Derryhogan into long wide bays that were also drained by deep trench drains with some high travel fields separating the bays.

Derryhogan is a known nesting site for the Red-listed Curlew, and enhancement and extension of suitable Curlew breeding habitat at Derryhogan was also a management consideration alongside the peatland rehabilitation work. The main objective of rehabilitation at Derryhogan was therefore to re-wet the wide bays which were drained by deep trench drains.

Rehabilitation involved both a bulldozer and excavator infilling these trench drains using material circa 0.40m deep along the line of the trench drain. As with peat dams, the edges of the trench drain were excavated to provide a "key" with the resulting cavity and the trench itself then in-filled. Note that some of the infilling material included subsoil previously excavated from the trench drain, mixed with local peat from the vicinity of the location of the block.


Figure B9.1. Installation of two trench drain blocks at Derryhogan using bulldozer and excavator; note the block on the left photo used mostly peat from surrounding bog; the block on the right used excavated subsoil mixed with peat from the trench drain.


Figure B9.2. Line of trench drain at Derryhogan showing recent block in foreground (picture on left; Nov-19) and the same area c.10 weeks later (photo on right; Feb-20); note re-wetting on peatlands to either side of trench drain following installation of block.

Figure B9.3. View from high peat field over low sod peat harvesting bay in Derryhogan pre-trench drain blocking in Nov-18 (left photo) and the same area following trench drain blocking in Feb-20 (right photo).

APP B10: Innoculation of Reeds and other vegetation from Donor Sites to accelerate vegetation establishment. - Case Studies (pre-EDRRS)

A constructed wetland was created at Cloniff Bog as a trial in Spring 2016. This area was prone to winter flooding from the adjacent Shannon and difficult to dry out for peat extraction during the summer. It was decided to re-wet this area and create a wetland. An excavator was used to build a flood protection bund around 2 ha of cutaway using the existing headland and high fields. This was needed to protect the adjacent industrial peat extraction area. The bund was then spread with grass seed and with some fertiliser to help stabilise it.

Reed rhizomes were then collected from a donor site using an excavator (the adjacent silt ponds). They were transported to the new wetland area using a tractor and trailer. The Reed rhizomes were then distributed through the wetland area and then re-planted using the excavator. It was expected that planted Reeds would grow and establish new clumps that would then spread and naturally colonise across the wetland.

Figure B10.1. Clooniff Bog – Reedbed creation.

Water levels were managed with an outflow pipe through the newly constructed berm. The pipe level was selected to manage the summer water levels, keeping the wetland wet enough to encourage the establishment of Reedbeds. It was expected that water levels would rise during the winter as part of the natural winter flood levels. Reeds and Reedmace have established at this site and are naturally spreading.

Figure 10.2. Clooniff Bog – Reedbed creation. Top-left is spring 2016. Top-right is winter 2017. Bottom-left is summer 2018 and bottom-right is winter 2019.

Bord na Móna also carried out a Reedbed creation trial at Blackwater Bog in 2010. Machinery were used to transport Reed rhizomes from a nearby donor site (cutaway on site with established Reeds) to two trial area. Two excavators and a Maruka (tracked trailer) were used. The trial areas were bare peat fields, some of which was recently out of industrial peat extraction. Reed rhizome was taken to the trial areas, spread out and was buried with an excavator. Field drains in the trial area were blocked with the excavator.

Figure 10.3. Blackwater bog. Reedbed creation trial spring 2010. The top pictures demonstrate the machinery used. The bottom pictures show the growth of the Reeds during the following summer.

Monitoring over the years has shown that the Reeds did grow and establish from these transplanted rhizomes. The established Reeds have since consolidated and with other vegetation has formed complete vegetation cover, eventually stabilizing the cutaway area. A comparison of the area in 2010 and in 2018/2019 shows a significant contrast. While the area in 2010 was almost entirely bare peat, the area is now completely vegetated with significant Reed cover.

The Reedbed trial at Blackwater demonstrates that new Reedbeds can be established by transplanting Reeds from donor sites. The trial also demonstrates the value of natural colonisation and establishment as well and that, while it might take somewhat longer, similar results will occur with natural colonisation with the development of Reedbeds. The trial control area at Blackwater did have an advantage of having nearby cutaway Reedbeds to act as a natural seed source to aid natural colonisation.

Figure 10.4. Blackwater bog. Top-left picture is the trial area in 2010. The top right is the same area in 2018. Bottom-left is the same area in Feb 2019, while the bottom –right is the adjacent control area in Feb 2019. The control area was completely devoid of vegetation in 2010 but has now established substantial Reedbed cover naturally.

APP B11: Sphagnum inoculation to accelerate vegetation establishment - Case Studies (pre-EDRRS)

Bord na Móna has established several *Sphagnum* inoculation trials. A trial was established at Kilberry bog in 2012 using *Sphagnum* fragments (Canadian Moss Transfer Method). While *Sphagnum* has established at Kilberry, Co. Kildare, growth have been slow. It was concluded that the Kilberry site did not have optimum conditions for the growth of *Sphagnum* (water level fluctuations, drying out in summer, higher pH and conductivity (fen peat) compared to optimal environmental conditions). Interestingly *Sphagnum* has colonised other sections of the trail site at Kilberry, meaning that while conditions may not have been perfect in the trail plots, other nearby areas did suit *Sphagnum* colonisation.

A second trial using BeadaMoss was developed at Bunahinly Bog Co. Westmeath and Lodge Bog in 2017. *Sphagnum* establishment using BeadaMoss has been slow and not effective so far, but it is too early to make any conclusions from these trails. Beadaplugs have established quite well at Lodge Bog, Co. Kildare and are flourishing.

In contrast, a *Sphagnum* inoculation trial at Shramore Co. Mayo demonstrated that transferring a small amount (handful) of *Sphagnum* into a wet depression was extremely effective. These depressions were filled with *Sphagnum* moss after 2 years. This demonstrates that *Sphagnum* will colonise and grow quite quickly in suitable conditions. The conditions in Co. Mayo particularly suited the growth of *Sphagnum* due to the wetter climate (meaning there are water-logged conditions nearly all of the year), the more acidic peat (blanket bog peat) and the more acidic sub-soil geology.

Bulrush have had similar experiences at Sluggan Bog in Co. Antrim. They have trialled BeadaMoss and concluded that it was slow and not effective at this site. They also collected *Sphagnum* from a donor site and distributed a discrete quantity into each cell. They found this was much more effective in distributing and establishing *Sphagnum* bog mosses, which then spread naturally and has formed extensive mats and occasional hummocks over the cells.


*Figure B11.1. Bord na Móna Sphagnum trials. The top row are pictures of the Bunahinly site and the BeadaMoss used at the site. The bottom row are Sphagnum plugs that were planted as part of a trial at Lodge Bog. These plugs are doing well. /**

These inoculation techniques are expensive, vulnerable to poor establishment rates when environmental conditions are not suitable and not a panacea for large areas. It is not proposed to completely inoculate tens of thousands of hectares of deep peat cutover bog. However, there is potential to use *Sphagnum* inoculation to establish and diversify selected small areas on target sites with *Sphagnum* species, which in turn, and in combination with natural colonisation, can then naturally colonise the remaining deep peat cutover bog area. *Sphagnum* inoculation should only be used in appropriate environmental conditions (water-logged, deep peat with stable water levels and with more acidic water chemistry).

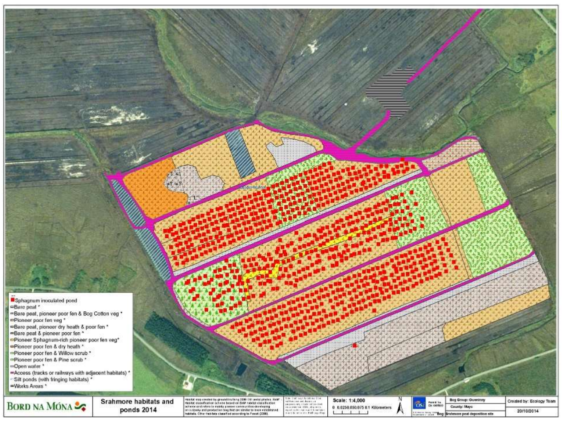



Figure B11.2. The first picture shows a shallow pond that were excavated in 2014. Sphagnum was collected from a local donor site and then a 'handful' distributed into each pond. In 2018, some of the ponds were filled with Sphagnum. The map shows the extent of ponds created at Shramore and now colonised with Sphagnum.

Appendix C

Summary Report on Use of Sheet piles to regulate flow between cells.

Belmont Bog – Cell Weir Trial Summary version

Enhanced Rehabilitation and Restoration

on Bord na Móna peatlands

May 2022

Contents

C1 Purpose of Plastic Sheet Weir Trial

This report describes a trial to use plastic sheet piles as an alternative to plastic pipes to control the overflow between cells in deep peat rehabilitation methodologies DPT4 and DPT5.

The trial has been designed and implemented due to feedback received from Bord Na Móna Operations after the commencement of 225mm diameter overflow pipe installation to deep peat cells. Some concerns and inefficiencies became apparent regarding health & safety, pipe cover (depending on berm height), functionality, stability, and accuracy of using 225mm Twinwall corrugated (unperforated) pipes with a 90° bend upstream to control water levels in deep peat cells. Concerns over long term functionality due to sediment build-up and future maintenance are among the main concerns highlighted. Belmont Bog was the chosen bog for this trial as no overflow pipes were installed yet within deep peat cells.

C2 Site Description

C2.1 Location of Belmont Bog

Belmont Bog is located in Co. Offaly, 1km north-west of Belmont Village. It is part of the Blackwater Bog group and is located on the east side of the Blackwater River, adjacent to Blackwater Bog. Belmont Bog has developed in two connecting basins, with the northern basin being much larger. These basins, or bog units are separated by a ridge of high ground.

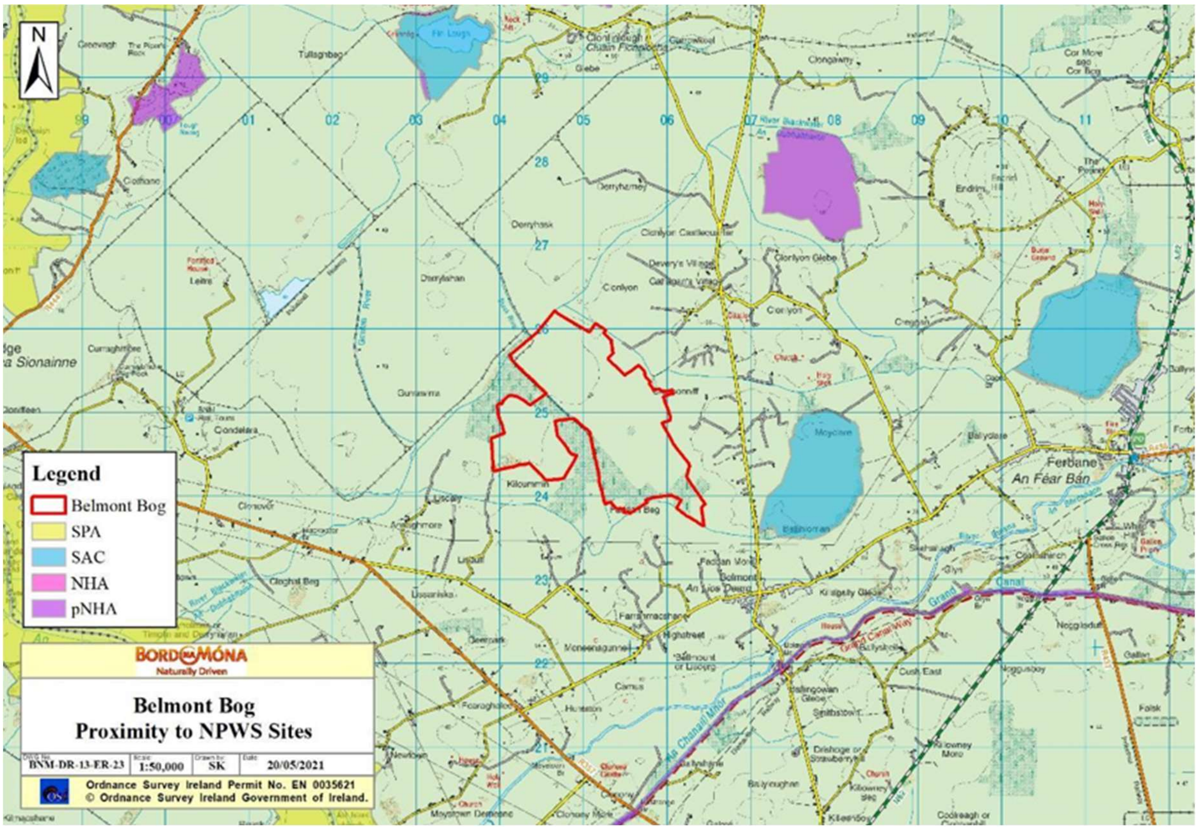


Figure C2.1 Belmont Bog location.

C3 Implementation of the Trial

C3.1 Site Organisation

The execution of the trial was coordinated by the Bog group manager and Area leader who developed the most effective methodology and arranged the relevant resources required. Various plant & resources at the disposal of BnM were utilised to action the trial.

C3.2 Surveyor Input

Survey input for the trial involved confirming the proposed flow paths as per drainage layout drawings i.e. position where the weir should be located and determination of weir crest level i.e. the optimal water level of +/-100mm above ground level. The method by which the cell over-flow level is calculated is described in the *PCAS Rehabilitation Methodologies - Survey Guidance Document Rev V5 [1]*. The weir crest level is set out by means of a single stake driven into the base of the cell floor.

C4 Summary of the Methodology

C4.1 Plastic Sheet Weir to control ideal water level in deep peat ponds

In the original methodology for DPT4 and DPT5 cells, the mechanism of promoting the optimal water level of +/-100mm above ground level was achieved by two 225mm overflow pipes per DPT4 cell and one 225mm overflow pipe per DPT5 cell. The optimal water level was to be achieved by controlling the overflow level with a 90° bend. The controllability was provided by means of rotating the 90degree bend to the ideal water level as set out by the surveyor. Some issues as described in section 1 have emerged with this element of the methodology so an alternative method of controlling water levels which has been used effectively on NPWS raised bogs was trialled. This method of controlling water levels is achieved by creating a weir crest using plastic sheets with dimensions of 4mm x 300mm x 2500mm as per figure C4.1 below. The Weir arrangement as installed is shown in Figure C4.2 & C4.3.

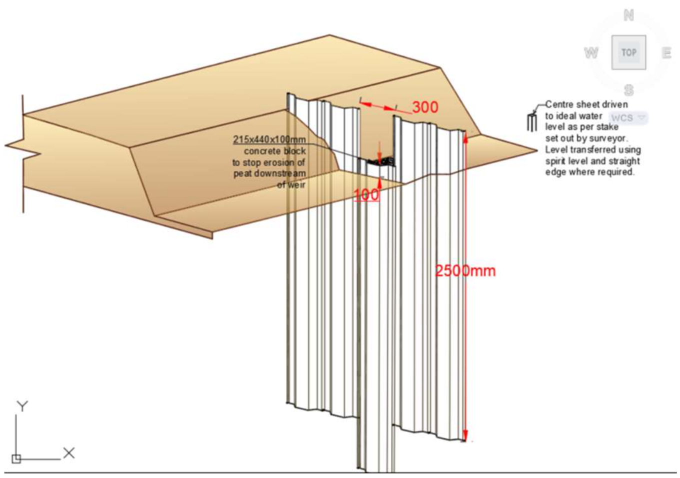


Figure C4.1. Weir to be constructed (snip from drawing PCAS-0100-021).

Figure C4.2 & C4.3. Weir arrangement on the bog.

C5 Discussion

From the outset operatives were having issues with driving the sheets the required depth as they were encountering wood both within the depth for the formed berm and what appeared to be at the bottom of the peat layer. This will not be an issue on every bog but bog wood may be encountered in some bogs. This was causing the sheets to buckle and fracture. Initially operatives dug the obstacles out of the ground and then resumed driving of the sheets. When obstacles were encountered but driven to a stable depth, the option developed was to cut the sheet to the correct level.

When comparing this methodology to the previous methodology of controlling cell over-flow level (225mm pipe with 90degree bend), access along the cell berms is greatly reduced in terms of being able to travel with tractor around the cells. Additional care is also needed when travelling by foot. The weir channel is continuous across the berm whereas with the pipes it is culverted. It is recommended that BnM Operations determine a preferred route through the cell area and crossing points be culverted to maintain machine access for inspection and maintenance. Once the access route is determined, the weir unit can be inspected and maintained easier when compared to the pipe water control method.

One main advantage of the weir method is that it appears the works can progress regardless if the cells are holding shallow water. There is no backfilling element to this methodology as the dug spoil will be spread over the existing berm. When overflow pipes were being installed in winter or during wet conditions and cells were holding water, the material became very wet and ''sludgy'' and became problematic for providing a stable bed and backfill material.

C6 Conclusion

The weir assembly appears to be more effective in terms of accurately controlling the ideal water level (overflow level) of deep peat cells when compared to using pipes. The weir unit is more stable and less susceptible peat subsidence, movement from buoyancy, and potential wave action.

The target output for the pipe method is 18 pipes per day whilst the output for the weir assembly is 16 per day. The proposal is to use one weir assembly per DPT4 cells while two pipes are currently being installed per DPT4 cell. The same area could be completed in approximately 40% less time using the weir methodology.

Subject to tender, the materials costs are expected to be lower or the same for the weir assembly when compared to the pipes.

The open nature of the weir assembly and channel means that the system is much less much less susceptible to blockage, easier to maintain and easier to inspect.

The 2.5m long sheet piles adopted within the trial are effective however given the length of the pile they do encounter obstructions such as timber etc before reaching the desired depth. Also, it is noted when the pile is driven approximately halfway (1.25m) significant resistance is already achieved. Therefore, it is likely that sheet piles 1.8m – 2.0m in length will be as if not more effective than 2.5m long piles which will reduce work effort, reduce cost, and improve workability. On foot of the trial, we therefore propose to utilise a 1.8 - 2m long sheet pile rather than the 2.5m piles used in the trial.

Appendix D

Method for Development of Future Habitats Maps

Development of Potential Future Cutaway Habitats

- Bord na Móna have developed a process to predict the development of potential natural habitats across cutaway bog.
- This process makes assumptions about current land-use and known after-use plans for the cutaway (development etc).
- These predictions are based on research and methods used to predict the natural vegetation of Ireland (Cross 2005) along with phytosociological research of cutaway habitats at Turraun (Rowlands and Feehan 2000) and Oweninny (Farrell 2001) and other studies that looked at future habitat development (Feehan and O'Donovan 1996, Feehan 2004).
- Cross (2005) predicted that cutaway bog is likely to develop a mosaic of Birch forest, alder and ash-alder carr, fen and heath in the future. Feehan and O'Donovon (1996) suggested that much of the drier cutaway would develop into bog woodland (WN7) eventually dominated by Scot's Pine. The NPWS Native Woodland Survey predicted that drier cutover bog had the potential to develop into Oak-dominated woodland eventually. Feehan (2004) looked at Derrycashel bog and predicted the development of aa significant extent of alkaline wetland habitat with deeper water. Feehan (2014) looked at Blackwater Bog and again predicted the development of wetland habitats with Reedswamp predominating. Egan (2006) considered the impact of the alkaline marl on development of specific areas on the development of specific wetland types and on potential conifer development.
- There is no timeline given for the development of these habitats, although it could be expected that the development of natural climax habitats could take hundreds of years.
- The above studies and research obviously made assumptions about the end of peat extraction and the potential future cutaway landscape (that most of the peat would be extracted). The cessation of peat extraction in 2020 has meant that bogs that came into peat extraction at a later date (1980-2000) still have deeper residual peat that now has a potentially different trajectory.
- The process was also based on the baseline Ecological Survey (2009-2012) and subsequent refinements to this survey. A significant amount of cutaway had come out of peat production from the 1980's and was developing cutaway habitats. This gave an insight of what cutaway habitats were already developing in areas with different environmental characteristics and what habitats that might expect to develop in areas with similar environmental characteristics in the future. The key characteristics were hydrology, peat depths, existing habitat development and expected land-use.
- A predicted future habitat map was then developed for each bog during 2012-2013. This was an iterative map and has been revised over the years as more information became available in relation to environmental information, peat extraction decisions and land-use.
- The resulting complexity is the result of small scale variations in the substrate and other environmental factors such as drainage and ground-water influence.
- Ultimately, there will be some uncertainty about predicting specific future habitats and the timelines to develop these habitats, particularly where there is a mosaic of environmental conditions. For example, Birch woodland (WN7) can develop within a 20 year period. However other habitats such as rich fen (PF1) and raised bog (PB1) that is analogous to semi-natural sites will have a longer trajectory.