



Littleton Bog Group Rehabilitation Plan

A document to detail the rehabilitation and aspects of decommissioning of the Bord na Móna Littleton Bog Group in compliance with Condition 10 of IPC Licence Ref. No. *P0-409-01*

July 2018

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Summary

- This document comprises an overview of peatland rehabilitation within the Littleton Bog Group. The key objective of rehabilitation is environmental stabilisation of these industrial peat production bogs when industrial peat production ceases. This rehabilitation plan is developed under Condition 10 of IPC Licence Ref. P0-409-01.
- The Littleton Bog Group comprises 12 bog areas.
- Originally sod fuel peat was cut at Littleton, Templetohy and Longfordpass for local use and for distribution. Sod turf extraction is still ongoing on several small sites and this activity is under review.
- A Briquette factory was built at Lanespark in 1981. Littleton bogs supplied milled peat to this factory near Littleton village Co. Tipperary. Industrial sod fuel peat production switched to milled peat production prior to the development of the new factory and was expanded to include other sites. Some new bogs were brought into development for milled peat production at this time. The majority of sites have been in industrial peat production for a number of decades.
- In 2017, Bord na Móna announced the closure of the Littleton Briquette Factory (closed March 2018) and the cessation of industrial peat production in the majority of bogs within the Littleton Bog Group. The only bog site where it is planned to continue milled peat production (for supply of horticulture) is Killeens. Industrial peat production has ceased in the remaining sites and it is expected that the next phase of decommissioning and rehabilitation will start shortly.
- Baseline surveys have been carried out for each bog unit and there are current habitat maps, future habitat maps and land use maps for each of the 12 bog areas. These have been updated in 2017/2018.
- A 14 turbine wind farm (42 MW overall) has been constructed (Bruckana Wind Farm) on Templetohy bog.
- A small area of cutaway at Lanespark has already been rehabilitated and developed into an amenity/biodiversity area that is leased to the Slieve Ardagh Rural Development community group (Lough Doire Bhile).
- Some cutaway and marginal bog areas were developed as conifer forestry (110 ha) in the 1980's/1990's by Coillte. This land is leased to Coillte by Bord na Móna.
- Some of the older industrial bog areas already have large areas of cutaway already developing with cutaway habitats. The baseline survey indicates that when bog becomes cutaway, the processes of natural colonisation begin straight away and that bog that was formerly bare peat soon becomes vegetated, aiding environmental stabilisation.
- The Littleton Bog Group comprises former raised bogs where most of the peat has been excavated to the deeper fen peat layers. Several bogs or portions of bogs have had a shorter industrial production history and remain in the deeper acidic peat layers.
- In general, there is no potential for extensive raised bog restoration in the short-term in areas where there has been extensive peat extraction or removal. This is because the majority of the peat mass has been removed, significantly changing key environmental factors such as hydrology and water chemistry acidity. Even if suitable, wet hydrological conditions can be re-established, milled peat cutaway tends to have a more alkaline water chemistry, due to the remnant fen peat layers being exposed and the influence of the underlying glacial geology (dominated by Limestone). Typical raised bog *Sphagnum* mosses and other bog species do not thrive with this alkaline water chemistry.
- Rehabilitation of the former industrial peat production sites will lead to the development of a mosaic of cutaway habitats (if they are not developed for other land-uses), largely comprising mosaics of wet peatland habitats, heath, scrub and Birch woodland. In some cases there may be potential to develop embryonic peat-forming communities where acidic peat is present.
- There is also potential for bog restoration at several sites (Knockahaw, Ballysorrell and the Derryhogan section of Littleton), where there is deeper remnant peat and there has not been extensive peat extraction.
- Re-wetting of the cutaway, where possible, is a general rehabilitation strategy. Targeted rehabilitation management, such as drain blocking, will be coupled with natural colonisation. Blocking of former peat production field drains will be carried out across the site to rewet the dry peat surface and facilitate vegetation establishment. This will mitigate against drying out of the peat soil surface and facilitate stabilisation of the peat with naturally colonising plants. These wetter areas will aid the trapping of silt within the site, by slowing down water

movement and acting as natural silt control areas, adding to the existing silt control infrastructure in providing additional retention time for solids. This has the capacity to enhance the biodiversity value and other ecosystem services value of these sites.

- It will not be possible to apply any one particular rehabilitation approach to the entire area, as there is such a broad range of conditions on site.
- Drain-blocking will not be carried out around the margins of the sites without detailed assessment and consultation with stakeholders. Rehabilitation will be carried out in a manner that does not impact on neighbouring land. Hydrological management will be key in relation to managing optimum water levels across the site and avoiding negative impacts, for example to neighbouring land. This is likely to require assessment of potential impacts of ceasing or reducing pumping and adjustment of outfall levels on a phased basis.
- Consultation with statutory and non-statutory consultees has been ongoing for a number of decades and will continue to the end of the rehabilitation process.
- Bord na Móna announced in 2015 that industrial peat production for the generation of electricity was to cease by 2030 (http://www.bordnamona.ie/wp-content/uploads/2016/01/Sustainability_Statement_2015.pdf). Industrial peat production (with regard to all appropriate regulations) by Bord na Móna to supply other customers or sectors (e.g. Killeens Bog and supply of horticulture peat) may continue after this date.
- New regulations for the extraction of peat are currently being drafted by government. Peat extraction on sites greater than 30 ha will be regulated through IPC licencing administered by the EPA. It is expected that implementation of these new regulations may trigger a review of the current IPC licence. This draft rehabilitation plan has been prepared under the conditions of the current IPC licence.
- Site-specific draft plans for each site have also been prepared. It is not possible to finalise a detailed rehabilitation plan for Killeens Bog until the final drainage pattern is developed as it is in active industrial peat production and this is expected to occur within two years of cessation of industrial peat production within individual areas.
- Where other after-uses are being developed for bog areas (as outlined under the Bord na Móna Land Use Framework document 2011), these will be subject to the relevant regulatory and planning controls and will be considered within the framework of the rehabilitation plan.
- Bord na Móna is currently assessing after-use options for renewable energy and other commercial development across these lands.

1 INTRODUCTION

Research into the after-use of cutaway industrial peatlands has been ongoing by Bord na Móna since the 1960s. There has also been significant international engagement during this period with other counties in relation to best-practise regarding peatland rehabilitation and after-use. Initially the main focus was on finding a commercial after-use for these areas and a number of experimental trials were established across the range of Bord na Móna peatlands to determine the success of vegetable growing, forestry, grassland and biomass crops. In latter years the focus has shifted towards allowing the post-industrial peatland areas to naturalise and revert to wet peatland habitats and dry wilderness areas, as well as developing alternative commercial uses such as using cutaway for renewable energy.

A number of rehabilitation measures comprising naturalisation and development of alternative after-uses have been already explored within some of the oldest production bogs owned by Bord na Móna in the Boora Bog Group (Co. Offaly), including coniferous forestry, biomass, agricultural grassland, amenity use, rare species conservation management (specifically Grey Partridge) and wetland creation. The key objective of rehabilitation is environmental stabilisation of these industrial peat production bogs when industrial peat production ceases. While agricultural fields and coniferous forestry have been developed successfully on the cutaway bogs at Boora, and at Lullymore and Clonsast, these require financial investment that at this time exceeds any potential commercial output value. The Lough Boora Discovery Park encompasses all areas relating to amenity and biodiversity www.loughbooraparklands.ie. Smaller scale development for amenity similar to Lough Boora Discovery Park has also been carried out in Littleton with the development of the Loch Doire Bhile fishing lake, amenity area and wetlands on Lanespark Bog.

Conifer plantations were also planted by Coillte in the Littleton Bog Group and in other areas in the 1980s across several sites (110 ha). Some sections have established and grown well but overall, the plantations have proven to be commercially unviable due to various different factors.

Some peatland rehabilitation was also carried out at Mountlucas as part of the construction of a wind farm on the site in 2014. Some cutaway was re-wetted in association with the construction of the wind farm tracks and management of site drainage. Mountlucas Wind Farm is an example of a multi after-use strategy with the cutaway being primarily used for a commercial renewable energy project. The majority of the cutaway bog is still developing a mosaic of typical cutaway peatland habitats including Birch scrub/woodland and small wetter areas. The wind farm infrastructure takes up less than 3% of the overall cutaway. In addition, the wind farm has developed an amenity walkway and cycleway through the cutaway bog using the existing tracks. This amenity is now attracting over 30,000 visitors per year.

Bord na Móna announced in 2015 that industrial peat production for the generation of electricity was to cease by 2030 (http://www.bordnamona.ie/wp-content/uploads/2016/01/Sustainability_Statement_2015.pdf). Industrial peat production (with regard to all appropriate regulations) by Bord na Móna to supply other customers or sectors (e.g. Killeens Bog supplying horticulture) may continue after this date.

In 2017, Bord na Móna announced the closure of the Littleton Briquette Factory (closed March 2018) and the cessation of industrial peat production in the majority of bogs within the Littleton Bog Group. The only bog site where it is planned to continue milled peat production (for supply of horticulture) is Killeens. Industrial peat production has ceased in the remaining sites and it is expected that the next phase of decommissioning and rehabilitation will start shortly. New regulations for the extraction of peat are currently being drafted by Government. Peat extraction on sites greater than 30 ha is expected to be regulated through IPC licencing administered by the EPA. This draft rehabilitation plan has been prepared under the conditions of the original (IPC Licence Ref. P0-409-01).

Bord na Móna submitted a general overview rehabilitation plan as part of the IPC Licences for the all the Bord na Móna boglands to the EPA in 2002 (Appendix II). This rehabilitation plan was essentially a generic plan that outlined the criteria defining successful rehabilitation of bog areas post peat production and described a number of test programmes that incorporated the principles and methods of rehabilitation. The condition that refers to cutaway bog rehabilitation within the IPC Licence is Condition 10 (Appendix 1). Both decommissioning of the site and rehabilitation of the cutaway boglands are addressed under Condition 10.

The original plan was generic and is replaced by this specific plan for the Littleton Bog Group licensed area, following the establishment of a significant database covering land use management, baseline ecology survey and potential future habitats and management developed by the Bord na Móna Ecology Team 2009-2013. A draft Littleton Bog Group Rehabilitation plan was submitted to the EPA in 2013, and an update submitted in 2015. The plan should be read in conjunction with the main background document Bord na Móna *Biodiversity Action Plan 2016-2021* (<https://www.bordnamona.ie/company/bord-na-mona-story/biodiversity/biodiversity-action-plan/>).

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2 AIMS OF THE REHABILITATION PLAN

The main objective of rehabilitation within the Littleton Bog Group is to ensure the environmental stabilisation of the industrial peat production area, by encouraging habitats suited to the various site environmental conditions to develop and encouraging the area to blend with the surrounding landscape.

Re-wetting of the cutaway, where possible, is a general rehabilitation strategy of Bord na Móna. The approach will require some targeted initial active rehabilitation work (blocking drains, etc.), followed by monitoring of effectiveness of this work. These wetter areas will aid the trapping of silt within the site, by slowing down water movement and acting as natural silt control areas, adding to the existing silt control infrastructure in providing additional retention time for solids.

It has also been shown by the work completed to date and in particular by the Bord na Móna baseline ecology survey that natural processes of vegetation colonisation, and vegetation succession will lead to the Littleton Bog Group becoming self-sustaining and stabilised landscape units, comprising a mosaic predominantly of regenerating Birch woodland, scrub, heathland and wetland habitats with some areas of regenerating peat-forming habitats that will contribute to the existing natural biodiversity of the area.

The aims of this plan are outlined as follows:

- To outline a detailed rehabilitation plan for the Littleton Bog Group (IPC License Ref. P0409-01), to include an overview of the component bog areas, status of industrial peat production, industrial peat production outlook, breakdown of habitats on each of the component areas, the range of environmental conditions, other issues, and an outline of the rehabilitation work necessary to provide for the environmental stabilisation of the site.
- The plan will include estimated timeframes for rehabilitation (and some decommissioning) measures to be completed, where possible. Planning scheduling and implementation will be kept under review during the rehabilitation plan review phases.

3 DEVELOPMENT OF A SCOPE STATEMENT FOR THE REHABILITATION PLAN

The formal development of an overall rehabilitation plan for the Littleton Bog Group has been ongoing since 2009 and formal consultation with other interested parties identified additional issues of concern, thereby broadening the scope of the rehabilitation plan. It should be noted that actual rehabilitation works have been tested and trialled at various Bord na Móna sites since the 1980s and consultation has been ongoing since that time. Consultation is an ongoing process in the development and implementation of rehabilitation plans and continues throughout all phases.

3.1 Consultation

Bord na Móna consults with a range of relevant agencies, authorities and affected parties as identified by Bord na Móna and the EPA in relation to the Littleton Bog Group Rehabilitation plan. These include:

- Environmental Protection Agency
- National Parks and Wildlife Service (Local, Regional and National levels)
- Inland Fisheries Ireland
- Tipperary County Council
- Kilkenny County Council
- Laois County Council
- Heritage Council
- Coillte
- An Taisce
- Irish Peatland Conservation Council
- Irish Wildlife Trust
- BirdWatch Ireland
- Countryside Alliance
- NARGC; local gun clubs
- Woodlands of Ireland

- Golden Eagle Trust
- Butterfly Conservation Ireland
- Fáilte Ireland
- Midlands Regional Planning Authority
- Waterways Ireland
- Local Authority Water and Communities Office (LAWCO)
- Irish Forum on Natural Capital.
- Ongoing consultation related to the National Peatland Strategy and the Irish Peatlands Council. Bord na Móna is a member of the National Peatlands Council and the National Peatland Strategy Implementation Group.
- National River Basin Management Plan 2016-2021 – Consultation
- Local communities and community groups
- Neighbouring landowners
- Open consultation is carried out with a range of stakeholders at annual Biodiversity Action Plan review days between 2010-2018.

This draft rehabilitation plan will be circulated to interested parties as part of the consultation process before it is finalised and submitted to the EPA.

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3.2 Scope of the Littleton Bog Group rehabilitation plan

The scope of the rehabilitation plan seeks to address issues of concern as identified by Bord na Móna and the consultees. The key issues identified so far are:

- Categorisation of the habitats on site and proposed rehabilitation measures for each habitat type,
- Environmental stabilisation of the former industrial peat production areas,
- Maintenance of silt control measures (*decommissioning*),
- Remediation of water-courses (*decommissioning*),
- Management of the nature conservation designated areas and rare species within the Bord na Móna Littleton Bog Group,
- The timeframe for cutaway bog rehabilitation.

This plan does not cover the facilities at Lanespark (factory) and Templetouhy (workshop). Why?

Rehabilitation focuses on site stabilization after industrial peat production. **After-use** involves the development of cutaway peatland into other land-uses. Rehabilitation can be incorporated into after-use development (e.g. Bruckana Wind Farm). Bord na Móna has focused after-use development of cutaway bogs into forestry, agriculture, grassland, amenity and biodiversity, (Lough Boora Discovery Park) and commercial industrial development (Drehid Resource Recovery, renewable energy – Mountlucas Windfarm). This rehabilitation plan **does not** outline future after-use development for the Littleton Bog Group. The general after-use strategy of Bord na Móna is outlined in the Bord na Móna *Strategic Framework for Future-Use of Cutaway Bogs 2011* (currently being updated by Bord na Móna). Any consideration of future after-uses for the Littleton Bog Group such as amenity, developments or mixed uses will be conducted following the relevant planning guidelines and consultation with relevant authorities. Bord na Móna is currently assessing options for renewable energy and other commercial development across these lands.

Rehabilitation of industrial peatlands is a key objective of the Bord na Móna Biodiversity Action Plan 2016-2021. This action plan outlines the main objectives and actions around biodiversity on Bord na Móna lands.

4 REHABILITATION OF THE LITTLETON BOG GROUP FOLLOWING CESSATION OF PEAT PRODUCTION

4.1 Background information

The Littleton Bog Group has been in peat production for a number of decades. There are 12 bog areas, 11 of which have been developed for milled peat. Knockahaw was developed for milled peat production in the past but no industrial peat production was carried out. One small site (Clonbaugh) has not been developed for industrial peat production, but parts not owned by Bord na Móna are being cut for turf by private individuals. Milled peat was formerly supplied to Lanespark Briquette Factory for the production of peat briquettes. In 2017, Bord na Móna announced the closure of the Littleton Briquette Factory (closed March 2018) and the cessation of industrial peat production in the majority of bogs within the Littleton Bog Group. The only bog site where it is planned to continue milled peat production (for supply of horticulture) is Killeens. Industrial peat production has ceased in the remaining sites and it is expected that the next phase of decommissioning and rehabilitation will start immediately.

The main aim of the baseline ecological survey was to identify key features in environmental stabilisation of the Littleton Bog Group following cessation of industrial peat production. The work has provided an ecological understanding of these sites, and an insight into the future landscape development of the Littleton Bog Group.

The main criteria¹ defining successful rehabilitation of the Littleton Bog Group are:

- (i) Environmental stabilisation of the former industrial peat production areas²
- (ii) Mitigation of potential silt run-off and,
- (iii) Re-establishment of appropriate semi-natural habitats, largely through natural colonisation with some targeted management based on existing trials and Bord na Móna rehabilitation projects.

There are a number of issues that must be addressed to allow for environmental stabilisation of the site in its entirety. However, the main areas of concern relate to the impacts of industrial peat production. The work has therefore concentrated on rehabilitation methods to (a) encourage vegetation of the former industrial peat production fields and related access areas (travel paths, rail-lines, stock-pile areas), (b) re-wetting peat and (c) trapping of silt within these wetter areas, by slowing down water movement across the cutaway and creating natural silt control areas, adding to the existing silt control infrastructure in providing additional retention time for solids. Addressing these issues will enhance the future natural capital value of these post-industrial areas, including the provision of various ecosystem services such as biodiversity, improving water quality, regulating water flows and creating future carbon sinks. This will involve the development of cutaway habitats that will merge with surrounding areas.

The rehabilitation work to date has focused primarily on some cutaway bog areas. This has involved (a) the establishment of a baseline vegetation study of the cutaway, (b) experimental work that focussed on determining suitable methods of encouraging vegetation establishment and target management for specific habitats and species (c) large-scale application of the rehabilitation methods (Loch Doire Bhile, Littleton & Lough Boora Discovery Park, Offaly).

An outline of the results attained from each of these steps is described here with more detail in referenced documents such as the *Bord na Móna Biodiversity Action Plan 2010-2015*, *Bord na Móna Biodiversity Action Plan 2016-2021*, and the *Bord na Móna Strategic Framework for Future-Use of Cutaway Bogs 2011*. An estimate of work required to rehabilitate the site completely will also be presented, with an associated timeframe for completion of the work. Decommissioning of the Littleton Bog Group is associated with rehabilitation and reference will be made as to how these two processes are inter-linked. Reference will also be made to the issues of concern relating to long term management and monitoring of the sites.

¹ These are the basic criteria as identified in the consultation process.

² Stabilisation of these areas infers revegetation. Once stabilised there will be no potential peat run-off from the site, which will cover the second criterion for successful rehabilitation.

4.2 Categorisation of Littleton Bog Group areas

The Littleton Bog Group comprises 12 discrete and defined bog units within the north-east Tipperary landscape covering an area of 5050 ha in total. Several bogs overlap and extend into Co. Kilkenny. Templetuohy also crosses the southern part of Laois's county border. These bogs are scattered across an area extending 30 km and are orientated in an N-S direction.

Each bog area further comprises a range of habitats from bare peat areas to re-colonising cutaway to workshop areas and transport infrastructure. Condition 10 of the IPC Licence refers to cutaway bog only. Cutaway bog is the term used to describe industrial peat production areas after the peat of commercial value has been extracted. The rehabilitation plan for the Littleton Bog Group encompasses all areas formerly and currently involved in industrial peat production including former peat production areas and associated facilities.

A breakdown of the component bog areas for the Littleton Bog Group IPC License Ref. IPC Licence Ref. P0-409-01 is outlined in Table 1. These areas are also outlined on Figure 1 (Map of the Littleton Bog Group).

Table 1. Bog units in the Littleton Bog Group IPC licensed area.

Bog name	Area (ha)	Industrial peat production outlook (year)	Current status
Ballybeg_Lanespark_Derryvilla	484	2017	25% cutaway already – pioneer habitats developing Amenity area developed – Loch Doire Bhile Milled peat production by Bord na Móna now ceased
Ballysorrell	196	/	Drained bog - former peat reserve Bog restoration measures planned
Bawnmore	531	2017	50% cutaway already - pioneer habitats developing Milled peat production by Bord na Móna now ceased
Carrickhill	170	2017	Milled peat production by Bord na Móna now ceased
Clonbaugh	37	/	No industrial peat production development. No drainage
Derryville	232	2017	50% cutaway already - pioneer habitats developing Milled peat production by Bord na Móna now ceased
Inch	120	2017	Milled peat production by Bord na Móna now ceased
Killeens	627	2030	40% cutaway already - pioneer habitats developing Continued milled peat production on remaining area
Knockahaw	397	2017	Drained bog - former peat reserve Bog restoration measures planned
Littleton	1020	2017	80% cutaway already Milled peat production by Bord na Móna now ceased
Longford Pass (Popes Bog)	273	2017	Milled peat production by Bord na Móna now ceased
Templetuohy	737	2017	50% cutaway already Bruckana Wind Farm in operation
Total	4824		

With reference to Table 1, there are 12 defined bog units. Bogs that have been in production for decades were slowly becoming cutaway as peat was extracted from the sites. A number of sites had fragmented areas of industrial peat production with areas of cutaway scattered between. A full description of each site is outlined in the site specific rehab plans for each bog unit (Appendix III).

The main categories of land use within any site are cutaway, active peat production (Killeens), access areas and production-related cutaway bog (Table 2). Production-related cutaway bog (Killeens) is defined as cutaway bog that is linked through drainage to adjacent active industrial peat production areas or is required indirectly for active peat production, i.e. by providing access. Other land uses on these sites include conifer forestry, Biodiversity Areas and industrial use (Bruckana Wind Farm). Areas around the margins of the former industrial peat production bogs include, Birch woodland, scrub, remnant high bog and cutover bog. Cutover bog is defined as marginal areas where former (private) sod peat/turf cutting has occurred in past and are developing a mosaic of secondary peatland habitats including scrub and Birch woodland. A secondary category is 'sod peat undefined' where there is active turf cutting being carried out by private individuals.

Table 2. Current Land-use in the Littleton Bog Group IPC licensed area.

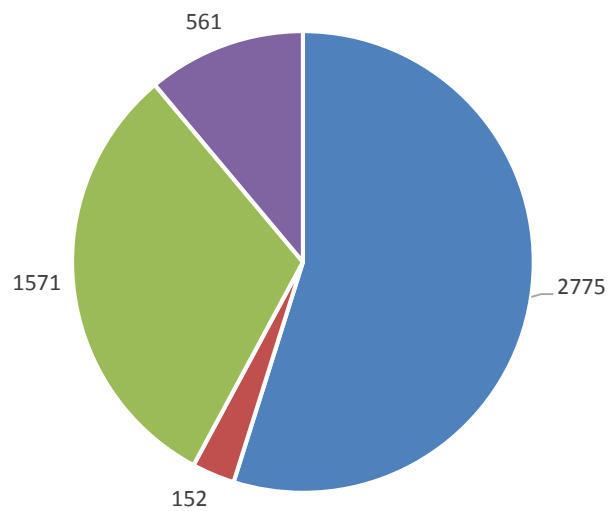
Land use in the Littleton Bog Group Jan 2018	Area (ha)
Access	262.4
Biodiversity Area	685.3
Birch	47.2
Bog remnant	181.4
Coillte	110.0
Cultural	17.7
Cutaway	2727.6
Cutover	106.7
Grassland	19.9
Industrial	20.0
Marginal	19.5
Other	13.4
Peat Production	249.4
Peat Production related	17.0
Riparian	29.0
Scrub	41.8
Silt ponds	51.5
Sod peat	30.8
Sod peat undefined	168.3
Works	29.9
Grand Total	4828.8

The peatland of the Littleton Bog Group can also be categorised according to its rehabilitation status (Table 3 and Chart 1). Currently (2018) there is 152 Ha of peatland where rehabilitation is completed (This includes Loch Doire Bhile and some areas planted with Conifers by Coillte. There is 2775 ha of cutaway peatland available for rehabilitation during the period 2018-2021. The remaining area includes marginal land (Birch woodland, scrub, cutover bog) where no rehabilitation is required and an additional area that includes the remaining active industrial production bogs and the remaining silt ponds (expected to be decommissioned after 2021).

Part of Lanepark (Loch Doire Bhile) are rehabilitated cutaway and contains a fishing lake, walkways, wetland and associated habitats. It was developed in 1999 by Bord na Móna and leased to a local community group (Slieveardagh Rural Development).

Table 3. Area of cutaway in the Littleton Bog Group IPC licensed area.

Rehabilitation category	Area (ha)
Rehabilitation complete	152
Cutaway available for rehabilitation 2018-2021	3316
Marginal Land (no rehabilitation required)	846
Other (Active industrial production, silt ponds)	514
Grand Total	4829

Chart 1. Area (Ha) of cutaway in the Littleton Bog Group

■ Cutaway available for rehabilitation 2018-2021
 ■ Rehabilitation complete
■ Marginal Land (no rehabilitation required)
 ■ Other (active peat production, silt ponds)

4.3 Rehabilitation of the Littleton Bog Group

4.3.1 Baseline

The baseline survey was carried out for the Littleton Bog Group between 2009 and 2013 and updated during the period 2014-2018. Detailed descriptions and habitat maps, land use maps and potential future habitat maps are outlined in the site-specific plans in Appendix III. The baseline survey identified a range of habitats emerging on the cutaway bog areas – largely comprising open water, poor fen, scrub, birch woodland, heathland, dry grassland and transition types between all habitats. The different cutaway habitats developing across the bog units reflect varying environmental conditions. Environmental factors such as remnant peat depths, topography and hydrology are all quite variable. See Bord na Moña Biodiversity Action Plan 2016-2021 for more detail. A specific vegetation classification system was developed for the Bord na Moña bog habitats and this is aligned with existing standard methods such as the Heritage Council Habitats Classification Scheme (Fossitt 2000).

Catchments	The Littleton Bog Group is located mostly within the River Suir catchment, with several portions of bogs draining to the River Nore catchment (Knockahaw, Clonbaugh, Templetuohy).
Topography	The Littleton Bog Group is characterised by relatively variable ground topography that is related to the underlying sub-soils that were laid down during the previous glaciation prior to bog formation. Most of the bogs contain ridges and/or mounds of glacial mixed sub-soil. This topography affects drainage of the sites and basins trapped between ridges/mounds can hold water.
Drainage	<p>Several bogs have a partially-pumped drainage system (Templetuohy, Carrickhill, Derryville, Inch, Bawnmore, Longfordpass, Littleton, Lanespark) with the remainder being gravity-drained. Pumps were required at particular situations due to local drainage as outfalls from the site are higher than the peat surface, which has been lowered by industrial peat production. In several instances, glacial ridges of sub-soil inhibit gravity drainage to the outfall. Pumps were required to lower water levels within the industrial peat production areas to allow suitable conditions for the production of dry milled peat.</p> <p>Some wetland development can be expected within pumped bogs after industrial peat production ceases, as it is expected that pumps will be turned off, where possible, and decommissioned. Water levels would be expected to rise across at least part of the site. The potential impact of decommissioning pumps and various re-wetting scenarios on adjacent lands will also be assessed as part of the rehabilitation planning.</p>
Sub-soils	<p>The majority of the Littleton Bog Group is underlain with glacial deposits made up of mixed till and gravel, which has a Limestone/Sandstone-based geology. This glacial material is relatively uniform and no significant impacts on the variability of pioneer cutaway vegetation was noted across the Littleton Bog Group due to variable deposits.</p> <p>Several bogs have small deposits of shell-marl underlying peat (Bawnmore, Carrickhill, Lanespark). This is generally laid down within the original basins of the bog, during the initial lacustrine (lake-forming) phase of bog formation and is made up of the shells of small crustaceans. The resulting marl has a high pH and this factor along with the fact that shell-marl tends to be deposited in the lowest basins that tend to have wetter conditions in the cutaway phase, means that wet peatland communities with potential rich fen characteristics can develop. This is in contrast to the more typical poor fen and Reedbed communities that are more typical of wetland cutaway. These communities can be seen at Littleton Bog.</p>

<p>Peat type/depth</p>	<p>Peat production history varies across the Littleton Bog Group, so there is a wide range of peat depths at present. Some bogs such as Littleton have had a long industrial peat production history and have large areas that have been extensively cutaway through milled peat production. Other bogs (Killeens, Ballysorrell) have been in production for a shorter period of time and therefore have deeper peat reserves. More acidic peat is present in the upper levels of these bogs and this has a significant effect on natural re-colonisation, which tends to be Heather-dominated, where it is dry Water-logged areas with deep peat have suitable conditions for the development of <i>Sphagnum</i>-rich vegetation and embryonic peat forming habitats. There is potential for bog restoration at both Ballysorrell and Knockahaw.</p> <p>Littleton and Templetuohy both have large sections that were utilised for sod peat production and were never converted to milled peat. Cutaway left after sod peat tends to have deeper peat remaining. More acidic peat can have a greater influence, leading to the development of Heather-dominated communities in places or where it is wet, <i>Sphagnum</i>-rich vegetation (embryonic peat forming communities). Examples of these types of communities can be seen at Templetuohy.</p> <p>Littleton contains large areas previously utilised for industrial sod peat production that still have relatively deep peat. There is some potential for bog restoration in these areas.</p>
<p>Cutaway habitats</p>	<p>Typical pioneer cutaway habitats are developing in the Littleton Bog Group. Habitat development is dependent on local environmental conditions as described above, as well as the time elapsed since the cutaway came out of industrial peat production.</p> <p>Drier areas tend to have a significant Birch influence, developing into mosaics of scrub and open vegetation (dry heath, grassland and poor fen). Pioneer drier areas and mounds with exposed gravel tend to have a wide variety of vegetation types including Rushes, Purple Moorgrass and other Grasses and Sedges, and some Heather. Heather tends to dominate on dry deeper peat.</p> <p>Wetter areas tend to have pioneer vegetation dominated by Rushes, Bog Cotton and Sedges. Birch and Willow also colonise these areas. Littleton contains many typical small wetlands with pools of open water in small basins created by the variable topography also containing emergent wetland vegetation such as Reeds, Rushes, Bog Cotton and Sedges. Much of the wet peatland vegetation dominated by Rushes, Bog Cotton and Sedges is classified as pioneer poor fen as they are developing on minerotrophic peat. Wetlands developing at Bawnmore and Derryvilla are influenced by the underlying shell-marl and have pioneer Sedge-rich communities typical of high pHs (potential rich fen).</p>

4.3.1.1 Conclusions from the baseline study

The baseline survey of each of the bog units provides (a) an outline of the plant communities that have established on the cutaway bog areas within each site, (b) fringe habitats that exist on the edges of the bog units and (c) the range of environmental conditions prevailing on each site (gravity drainage, pumping, mineral soils, topography etc). Detailed survey reports are outlined for each site in Appendix III. The baseline survey has shown that:

- (i) Vegetation begins to establish relatively soon after peat fields are taken out of industrial peat production (generally within one year).
- (ii) Much of the peatland has been excavated to the lower fen peat layers. Some industrial peat production bogs are still have deeper more acidic peat layers in parts (Carrickhill, Inch, Killeens). Some bogs or portions of bogs still have relatively deep peat (Ballysorrell, Littleton with potential for bog restoration. Knockahaw has been drained and developed but has had

- no peat production to date and has potential for bog restoration. Clonbaugh is an undrained bog remnant but is being utilised for private turf production (outside the BnM boundary).
- (iii) Much of the existing cutaway has already re-colonised naturally to a great extent. Natural re-colonisation is most successful on older cutaway. New cutaway (bare peat) is expected to develop in a similar manner. However natural colonisation may progress slower due to deeper peat depths remaining. Field drain blocking will ensure stabilisation of the former peat field in the interim and promote revegetation processes.
 - (iv) Decommissioning pumps (where necessary/possible) at various sites when industrial peat production ceases is likely to have a significant impact on the future cutaway landscape, as water levels are expected to rise across parts of these sites. Decommissioning of pumps will require hydrological assessment and water levels will require management. The topography of several sites (e.g. Derryville) will also lead to wetland development and wetter peatland habitats, as some sites have basins that lie below the level of adjacent rivers for example.
 - (v) Future peat requirements will have a significant impact on the development of Killeens. If Killeens comes out of industrial peat production in the next few years, then relatively acidic deep peat layers will still remain on the portions of the bog. It is proposed to rehabilitate areas with deeper more acidic peat layers with a comprehensive drain-blocking regime. If the time period of industrial peat production lasts longer and more alkaline fen peat is exposed, then more typical cutaway communities would be expected, with drain-blocking promoting wet peatland communities and aiding the trapping of silt in situ.

These observations illustrate the range of conditions within any component bog area and allows for the development of a set of criteria on which successful rehabilitation can be measured (see Appendix III for detailed information on each site including current habitats, future habitats, rehabilitation timeframe and proposed measures, aftercare and maintenance etc.).

4.3.2 Criteria for successful rehabilitation of the cutaway bog

Rehabilitation of the Littleton Bog Group will be considered successful when the remaining bare peat of the former industrial peat production areas has been stabilised, which will involve the establishment of a vegetation cover. Revegetation of the cutaway bog is therefore the primary objective (and basic criterion) of the rehabilitation programme.

To reiterate, the criteria for successful rehabilitation of the cutaway bog are outlined as follows:

- Stabilisation of the peat production areas through revegetation and,
- *In turn* mitigation of potential peat run-off from the site.
- Re-establishment of a diversity of semi-natural habitats appropriate to the characteristics of the site (peat depth, drainage, surrounding land-use etc).

4.3.3. The Lough Boora Discovery Park

The Boora Bog Group was the original centre for the development of a variety of after-uses for the cutaway bogs. Research started in the 1980s and a number of after-uses trialled including agricultural grassland, tillage crops; biomass growing, forestry, fishing lakes, walkways and cycle paths. For the most part this work centred on East Boora, and large areas of East Boora Bog have been transferred for relevant interest groups. The Lough Boora Discovery Park encompasses most of East Boora, with linking amenity trails through West Boora, and wetlands and rehabilitated cutaway areas of Derries, Turraun and Drinagh Bogs. www.loughboora.com

There has been considerable interest in both the biodiversity value and the amenity potential of the Lough Boora Discovery Park. In 2014 Bord na Móna constructed a 'gateway' centre to the Discovery Park area and this was co-funded by Fáilte Ireland and supported by local groups and Offaly County Council. The work carried out in Boora informs future rehabilitation across the midlands bogs.

4.3.4 Developing rehabilitation tools

In considering rehabilitation of any former industrial peat production bog area a range of factors must be taken into account. It will not be possible to apply any one particular approach to the entire area, as there is such a broad range of conditions on site. While flat areas that are wet revegetate with relative ease, sloping areas that tend to dry out in summer months must also be taken into

consideration. One major principle of rehabilitation of cutaway is that it must be carried out in consideration of the local environmental conditions of the site.

In general, there is no potential for raised bog restoration in a typical Bord na Móna midlands milled peat cutaway site. This is because the majority of the peat mass has been removed, significantly changing key environmental factors such as hydrology and water chemistry acidity. Even if suitable hydrological conditions can be re-established, milled peat cutaway tends to have a more alkaline water chemistry, due to the remnant fen peat layers being exposed and the influence of the underlying glacial geology (dominated by Limestone). Typical raised bog *Sphagnum* mosses and other bog species that are a key part of raised bog habitat function and prefer more acidic, nutrient poor, water-logged conditions do not thrive in this type of water chemistry, so there is no potential for raised bog restoration on typical milled peat cutaway in the short-term. However, rehabilitation will establish other habitats depending on the various environmental conditions of the site. While conditions are not suitable for raised bog development, wetland habitats such as Reedbeds and wet peatland habitats such as fen (fen tends to have a more alkaline water chemistry) can develop where hydrological conditions are suitable. These new cutaway habitats would not be unlike some of the initial pre-cursor habitats of the original raised bog development (lake to wetland to fen to bog).

While natural colonisation to a greater extent leads to the creation of rich biodiversity areas on the Bord na Móna bogs, there is therefore scope to develop areas for specific targeted aims. For example, in areas that are currently drained, blocking ditches and/or main outfalls, or turning off pumps will lead to almost immediate development of pioneer wetland habitats. Similarly, if a former industrial peat production area remains dry it will develop Birch woodland habitat if site conditions are right, while further planting with native species could speed up the woodland development.

Re-wetting of the cutaway, where possible, is a general rehabilitation strategy of Bord na Móna. There are several advantages to developing wetland habitats and re-wetting suitable parts of the cutaway for rehabilitation of these sites. Firstly, the baseline ecology survey has shown that wetland communities colonise naturally at a faster rate than some dry pioneer communities. Wetlands also aid the primary objective of stabilizing peat, as when peat is re-wetted it is therefore not vulnerable to wind erosion. Wetlands can also act as sinks for silt and mobile peat, and the wetland vegetation can quickly stabilise this material within local basins on site (by acting like constructed wetlands). Wetlands therefore provide ecosystem services in the form of improving water quality and helping to attenuate water flows from these peatland areas. Cutaway wetlands may also develop into areas that will become carbon sinks in the future (and eventually become peat-forming habitats again). Wet peatland habitats also attract a diverse range of wildlife, such as breeding and wintering birds.

Drain-blocking will not be carried out around the margins of the sites without detailed consultation with stakeholders. Rehabilitation will be carried out in a manner that does not adversely impact on neighbouring land. Hydrological management will be key in relation to managing optimum water levels across the site and avoiding negative impacts, for example to neighbouring land. This is likely to require assessment of potential impacts of ceasing or reducing pumping (if possible) and adjustment of outfall levels on a phased basis.

The rehabilitation management tools used by Bord na Móna are outlined briefly here. The basis for the proposed approaches and implementation is the experience gained in 40 years of research on the after-use development and rehabilitation of the Bord na Móna cutaway bogs, and from research and experience of other peatland restoration and rehabilitation projects (see glossary). Some of these measures will be applied at the Littleton Bog Group, and the appropriate measures are highlighted in the site specific plans in Appendix III.

While any rehabilitation tool may be used in varying degrees depending on the starting condition of any bog area, the selection of rehabilitation tools will be determined by the aims and objectives of each of the site specific rehabilitation plans developed for each bog area. The best examples to date that demonstrate the use of these rehabilitation tools within the Bord na Móna bogs are the rehabilitation works carried out at the Lough Boora Discovery Park in Co. Offaly and the Oweninny Bogs in County Mayo. In both instances, different rehabilitation management tools were applied to achieve specific site aims and objectives. For example field drain blocking was a key measure employed at the Oweninny Bogs, and served to slow down the movement of water across the entire cutaway bog area and restore conditions to favour regeneration of bog moss. Lake creation has been a common feature in the Lough Boora Discovery Park and other community project areas, usually carried out in conjunction with the specific aims of a local community group for amenity use.

In terms of the actual work that has been carried out to rehabilitate bogs, the rehabilitation measures fall into a number of broad categories:

Planting and/or addition of fertilisers

Natural colonisation is the best method in terms of stabilising bare peat surfaces. In some instances, however, cutaway bog areas are slow to colonise naturally. Slower colonisation can have advantages as it improves the habitat structure developing on the cutaway (i.e. different-aged trees or providing niche habitats for a wider range of species).

However, in some cases it is more advantageous to speed up the colonisation of the cutaway to stabilise the bare peat surfaces. Application of a once-off fertiliser treatment can accelerate vegetation establishment in these instances (see Drumman crop trials IPC licensed area Ref. PO-501-01). This measure would be used, for example, after ongoing monitoring of the development of the cutaway highlights there is a particular issue with the rate of natural colonisation. *N.B. Fertilisers will only be used in situations where peat stabilisation through natural colonisation requires nutrient input to progress pioneer colonisation. Long-term fertiliser use is not considered as a desirable or sustainable management option. Trials have been established on Bord na Móna cutaway bogs using fertiliser and nurse crops – this approach will apply to limited areas.*

Use of 'Green Hay' and mulches

Bord na Móna recently carried out a trial using 'green hay' at Kilmacshane, Co. Galway in 2016. The objective of using green hay is to transport native seed from suitable colonising species into an area to help natural colonisation and help diversify the vegetation. In general, cutaway peatland begins to colonise quite quickly with pioneer species as soon as industrial peat production stops. These pioneer species tend to be species that are well adapted to colonising new areas, such as Birch, Soft Rush and other Rush species, grass and sedge species and Common Bog Cotton, and which are commonly found in the surrounding areas. Pioneer species tend to produce a lot of seed that is easily dispersed and also tend to be species that can adapt to a broader range of ecological conditions. However, there are other 'desirable' species that are slower at colonising the cutaway. This is partially because these species are poorer at distributing seed and also tend to be adapted to more specific environmental conditions, and therefore will only be found in these conditions. This rehabilitation technique may have use in helping to import some species to sites that are traditionally slow at colonising cutaway. Constraints include identifying suitable species-rich donor sites with the correct species. Some donor sites may be found within Bord na Móna lands in cutaway that is established already.

The Kilmacshane Green Hay trial was an trial to import some species that are not normally found in pioneer vegetation into the cutaway. At this stage it is too early to make any conclusions about this trial. However, one noticeable impact was that spreading hay acted as a mulch and this had a positive impact on natural colonisation.

A second trial transported Heather mulch to a bare peat headland at Ballycon Co. Offaly in 2013. This trial has been relatively successful and has helped establish Heather on previously bare peat. However, constraints include the fact that it is quite labour intensive and expensive to transport Heather mulch in any great quantities. Interestingly a control area at Ballycon has also been colonised by Heather naturally. The seed colonised the control area from an adjacent bog margin.

These techniques are relatively expensive and labour intensive compared to natural colonisation, and not cost-effective over large areas. However, there may be potential for limited use to establish and diversify selected small areas with target species, which in turn (and in combination with natural colonisation) can then naturally colonise the remaining bog area.

Reedbed creation

This is viewed as a potential management option to rehabilitate cutaway bogs that have had pumped drainage during industrial peat production. Trials using rhizomes of Common Reed (*Phragmites australis*) were established in 2010 at Blackwater Bog Co. Offaly (IPC licensed area Ref. PO-501-01) and further trials established using Reed Canary Grass (*Phalaris arundinacea*) as a potential nurse crop for reed and swamp species to accelerate re-vegetation. This is a relatively new management approach for Bord na Móna, yet viewed as important for bogs with a pumped drainage system, such as those located along the Suck and Shannon. Both trials have been relatively successful. However, the Reed Canary Grass plots now have similar vegetation cover to adjacent

control areas that did not have any treatment but colonised naturally. The Reedbed trial at Blackwater also shows that control areas that were not planted with rhizome are now established with Reeds naturally. Both trials show the value of natural colonisation and that, while it might take somewhat longer, similar results will occur with natural colonisation with the development of Reedbeds. This is also demonstrated by cutaway areas that have developed naturally.

Further research is required to determine more cost-effective ways of spreading reed rhizome. These techniques are relatively expensive and labour intensive compared to natural colonisation, and not cost-effective over large areas. However, there may be potential for limited use to establish and diversify selected small areas with target species (Reeds, Saw Sedge), which in turn (and in combination with natural colonisation) can then naturally colonise the remaining bog area.

Grazing and/or scrub clearance

These are standardised measures used to manage habitats for species diversity and targeted species projects. An example is the scrub clearance employed by the Butterfly Conservation Ireland (BCI) group at Lullybeg (Allen IPC licensed area Ref. PO-503-01) and the further potential use of cattle grazing to control vegetation structure to maintain Marsh Fritillary habitat. The use of these methods will be investigated where the effects are deemed cost-effective and necessary for particular habitats and/or species. Where these measures have already been tested, it has usually been through the involvement of a relevant group such as Butterfly Conservation Ireland and or BirdWatch Ireland (BWI). A trial has been established on Drinagh Bog in a joint venture with BirdWatch Ireland to determine the value of scrub clearance for breeding waders. This was established in 2012 and monitoring is ongoing. In 2017 NPWS carried out some vegetation management (scrub clearance, mowing, mulching) at Boora in a conservation area targeted for breeding Lapwing. It is likely that such conservation management works will have to be repeated on an ongoing basis as scrub re-develops. *Targeted works such as these will not be a feature of the rehabilitation unless additional funding for conservation management is provided, as they are for a specific biodiversity/nature conservation objective that may not be the default scenario for rehabilitation, natural succession and self-sustaining habitats.*

Woodland & biomass management

Bord na Móna has two projects under the State funded Native Woodland Scheme (NWS). The projects were carried out in small areas of Turraun (Co. Offaly) and Clongawney Bog (Co. Offaly) and involved planting of Oak and Scots Pine, fertilizing the transplants, fencing planted areas for deer and rabbit, removal of non-native species and encouragement of natural regeneration. *All costs of the planting, fencing etc were covered under the NWS.*

Birch dominated woodland is developing in some of the older drier cutaways. This woodland is developing naturally. There may be opportunities in the future for some trial woodland management (e.g. thinning, copse planting etc) to enhance the biodiversity value and/or the timber value of these developing woodlands.

While a significant area of conifer forestry has been planted across Bord na Móna bogs in the past, it is not likely to be considered as an option for large heterogeneous areas into the future due to poor timber production and commercial un-viability. Biomass crops (Reed Canarygrass, Willow, Alder, Birch etc) have also been trailed extensively in the past with limited potential so far due to relatively poor productivity and commercial un-viability. There may be some planting of targeted cutaway areas with suitable environmental conditions that are deemed suitable for establishment of conifer plantations and biomass crops. Selection of these areas will require detailed baseline assessment. A small area within Littleton Bog was planted with Eucalyptus in 2018. Eucalyptus is a relatively fast growing species that is being trialled for its biomass potential.

Raised bog restoration

Sites with a more limited industrial peat production history have different environmental conditions (deeper remnant peat, remnant raised bog vegetation) and therefore have some raised bog restoration potential if suitable hydrological conditions can be re-established. The Bord na Móna Raised Bog Restoration Programme has focused on bogs that were initially drained but never fully developed for industrial peat production. An intensive drain-blocking programme to raise water levels, re-wet the bog and encourage the development of *Sphagnum*-rich peat-forming active bog habitat has been implemented, with 1400 Ha of high bog restored so far, mainly on sites in Galway and Roscommon. These sites also have nature conservation value and are currently being considered for SAC or NHA designation by the National Parks and Wildlife Service. Restoration of

ecosystem function at these sites will help Ireland meet its biodiversity objectives including commitments to conserve raised bog habitats under the EU Habitats Directive.

At Abbeyleix Bog Co. Laois (Cúil na Mona IPC licensed area Ref. 507) drains were blocked to restore water levels appropriate for peat-forming conditions to be re-instated. This was viewed as key to restoring active Raised Bog habitat and will be carried out in bogs that were never brought into peat production fully but drained for the purpose.

More intensive field drain-blocking on cutaway may be suitable for areas of deep peat with remnant acidic peat layers to raise water levels to encourage the development of embryonic peat-forming communities (*Sphagnum*-rich communities).

Sphagnum inoculation

Sites with a more limited industrial peat production history have different environmental conditions (deeper remnant peat, remnant raised bog vegetation) and therefore have some raised bog restoration potential if suitable hydrological conditions can be re-established. *Sphagnum*, a key species for the re-development of peat-forming habitat typically does not extensively colonise cutaway peatlands, because the environmental conditions are not suitable (alkaline water chemistry). While it may be present on typical cutaway, it tends to be very rare in abundance. However, *Sphagnum* does have the capacity to colonise areas with deeper peat that are water-logged and have more acidic conditions 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. *Sphagnum*-rich peat-forming habitat is found at particular sites such as Templetouhy, Timahoe North, Derryounce and Baliivor, although in relatively small areas, and its presence can be correlated with deeper peat and more acidic, water-logged conditions.

Bog restoration in Canada and the UK have both used more intensive restoration bog techniques and inoculated cutaway or degraded bare peatland with *Sphagnum* from donor sites (Canadian Moss Transfer Method) or using a new product called BeadaMoss, which 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.

Bord na Móna has established several *Sphagnum* inoculation trials. A trial was established at Kilberry bog in 2012 using *Sphagnum* fragments. While *Sphagnum* has established, both establishment and growth have been slow. A second trial using BeadaMoss was developed at Bunihinly Bog and Lodge Bog in 2017. At this stage it is too early to make any conclusions about these trials, but it is expected to be several years before any significant *Sphagnum* growth has been established.

These techniques are relatively expensive and labour intensive compared to natural colonisation, and not cost-effective over large areas. There may be potential for limited use of Sphagnum inoculation (provided methods like BeadaMoss are effective) to establish and diversify selected small areas with target species, which in turn, and in combination with natural colonisation, can then naturally colonise the remaining bog area. However, suitable areas on the cutaway for Sphagnum growth tend to be colonised naturally. Sphagnum inoculation should only be used in appropriate environmental conditions (water-logged, deep peat with stable water levels and with more acidic water chemistry).

Conclusions

The main rehabilitation measures carried out in the Littleton Bog Group on typical former industrial peat production bog will be targeted drain blocking and hydrological management, following the strategy of re-wetting where possible. The rehabilitation measures will be adapted to the various baseline conditions. For example, the main objective for deep peat sites at Ballysorrell and Knockahaw is intensive drain-blocking and bog restoration. More intensive rehabilitation techniques will be used, e.g. fertiliser application, where it is deemed that cutaway is slow to re-vegetate. Other techniques may also be used to establish and diversify selected small areas with target species, which in turn, and in combination with natural colonisation, can then naturally colonise the remaining bog area.

The application and costs of some of these rehabilitation management tools based on experience on Bord na Móna rehabilitation projects to date are outlined below in Table 4. Some techniques are relatively expensive and labour intensive, are not cost-effective over large areas, but are suited for

selected small areas. Some of these measures that could enhance rehabilitation outcomes could be supported externally through biodiversity schemes. There are options to carry out additional more intensive rehabilitation projects for specific objectives in combination with other industrial development projects or where additional funding is made available. These options are continually being explored by Bord na Móna and others.

Table 4. Outline costs of rehabilitation measures based on actual spend on Bord na Móna projects to date.

Rehabilitation method	Description of work	Cost €/ha to date	Example	Potential Application
Drain-blocking	Shallow dams	250	Ballycon wetlands (Allen 503)	Widespread, cutaway bogs
Intensive drain-blocking in deep peat	Deeper drains and more extensive damming required	400, 950*	Oweninny Ref. 505, Abbeyleix Bog (Cúil na Mona 707), Cuckoo Hill Bog (Blackwater 502)	Deep peat areas, degraded raised bogs and blanket bogs
Fertilisers	Low rate applications on bare peat	150	Drumman 2010 trial (Derrygreenagh 501)	Eroding bare peat
Planting	Reed Canary grass on bare peat	400	Kilmacshane (Blackwater 502) and Drumman (Derrygreenagh 501) 2010 trial	Pumped bogs; eroding peat
Planting	Nurse grass crop on bare peat	300	Kilmacshane (Blackwater 502) and Drumman (Derrygreenagh 501) 2010 trial	Eroding bare peat
Woodland	Birch establishment (natural regeneration)	120	This figure is indicative only, based on a mosaic of woodland and wetland habitats	Gravity drained areas

*The cost of rehabilitation of the Abbeyleix Bogs was higher due to the high frequency of the dams inserted on steep gradients.

4.3.5 Nature conservation-designated sites located within the Littleton Bog Group

There are no sites within or adjacent to the Littleton Bog Group that are designated for their nature conservation value (cSAC/SPA/NHA/pNHA). The Littleton Bog Group is situated within the River Nore and River Suir catchments. Both rivers are designated as cSACs and SPAs for their nature conservation value.

Knockahaw was included in a NPWS assessment of raised bogs for potential SAC/NHA designation (NPWS 2014 - Review of the raised bog National Heritage Area Network), because of its high biodiversity value and bog restoration potential. It was called Dromond-Cullihill Bog in this report.

4.3.6 Species of conservation significance present within the Littleton Bog Group

The Marsh Fritillary butterfly (listed in Annex II of the EU Habitats Directive) has been recorded at Loch Doire Bhile (Lanespark), Littleton, Baunmore, Carrickhill and Knockahaw. Slieveardagh Rural Development is monitoring this species at Loch Doire Bhile and has implemented some sensitive conservation management to maintain the status of this rare butterfly. This species is probably under-recorded and is likely to be found at other cutaway sites in the future. Large Heath, another rare butterfly, is also found at Knockahaw.

White-clawed Crayfish (crustacean listed in Annex II of the EU Habitats Directive) have also been recorded in the lake at Loch Doire Bhile in the past.

Breeding Curlew have been recorded at Derryhogan Bog (part of Littleton Bog) for several years now. Only one pair of breeding Curlew is known from the Littleton Bog Group. This area is being monitored as part of a wider Curlew monitoring programme co-ordinated by Bord na Móna with Birdwatch Ireland since 2014.

Hen Harrier (listed in Annex I of the EU Birds Directive) is occasionally sighted hunting over cutaway and use Littleton bog in winter. It is suspected that there is a Hen Harrier located in south Littleton Bog.

Merlin (listed in Annex I of the EU Birds Directive) have been sighted hunting over the bog at Ballysorrell and have been suspected on breeding in the locality.

Whooper Swan (migratory winter species listed in Annex I of the EU Birds Directive) occasionally uses wetland areas across the Littleton Bog Group but is generally recorded in relatively low numbers. A peak count of 90 swans were counted at Baunmore during winter 17/2018.

Other breeding waders like Lapwing (Red-listed bird of conservation concern) breed in low numbers across some of the cutaway within the Littleton Bog Group. Several pairs of breeding Lapwing were recorded at Baunmore in 2018 (10-15). This Lapwing population would have significant conservation value at a county level. Ringed Plover were also noted breeding in Baunmore in 2018 and this is the first pair of Ringed Plover to breed in Tipperary for some time.

Baunmore, Littleton and Derryville also host small groups of breeding Black-headed Gull (Red-listed bird of conservation concern). Shoveler Duck, a scarce breeding species in Ireland, has been noted in Littleton (Birdwatch Ireland record).

Blue Fleabane (a rare plant) was recorded in Littleton Bog on exposed gravel in cutaway. This species has now been recorded across several Bord na Móna bogs in the midlands and colonises exposed and disturbed gravel.

Other species such as the Otter (listed in Annex II of the EU Habitats Directive) occasionally forage along riparian areas through the bogs. More common species such as Irish Hare (listed in Annex IV of the EU Habitats Directive), which are still of conservation significance are resident on all of the bogs. See Bord na Móna Biodiversity Action Plan for more details. More detailed information about the status of various species of conservation significance is found within the individual site reports in Appendix III.

4.3.7 Management of invasive species

The potential for importation or introduction of non-native plant species (such as Japanese Knotweed, Himalayan Balsam, etc.) during future rehabilitation management, such as drain-blocking using excavators, has the potential to result in the establishment of invasive species within the site. Section 49 of the European Communities (Birds and Natural Habitats) Regulations 2011 prohibits the introduction and dispersal of invasive alien species (particularly plant species) listed on Part 1 (third column) of the 'Third Schedule'.

This section aims to reduce the risk from, and impacts of, invasive species and protecting biodiversity on lands under Bord na Móna ownership. Rehabilitation and decommissioning in the Littleton Bog Group will have due regard to the relevant biosecurity measures outlined below:

- Records of problematic invasive species within the various bog units will be marked out with signs to highlight areas of infestation to personnel.
- All plant machinery will be restricted from disturbing known colonies of invasive species.
- All plant machinery will avoid unnecessary crossings to adjoining lands.
- Good site hygiene will be employed to prevent the introduction and spread of problematic invasive alien plant species (i.e. Japanese Knotweed (*Fallopia japonica*), Himalayan Balsam (*Impatiens glandulifera*), Himalayan Knotweed (*Persicaria wallichii*), etc.) by thoroughly washing vehicles prior to entering the works area.

The biosecurity measures outlined above are in line with best practice guidelines issued by the National Roads Authority (NRA, 2010) – *The Management of Noxious Weeds and Non-native Invasive Plant Species on National Roads* and broadly based on the Environment Agency's (2013) – *The Knotweed Code of Practice: Managing Japanese Knotweed on Development Sites* (Version 3, amended in 2013, accessed on the Environment Agency's website on the 11th of July 2016).

4.3.8 Ecological assessment of the rehabilitation plans

An assessment of the potential ecological impacts of the proposed rehabilitation plans will be carried out. This will include an assessment of the potential ecological impacts of the timing of various works

and an Appropriate Assessment Screening of the potential impacts of the rehabilitation plan on NATURA sites.

Potential ecological impacts of rehabilitation activities include disturbance to sensitive wildlife during the operational phase. Sites will be screened for potential disturbance impacts (e.g. to breeding species such as Curlew) and scheduling of rehabilitation operations will be adapted, where required, as mitigation.

In general, peatland rehabilitation has an overall positive ecological impact. For example, rehabilitation (drain-blocking) of industrial peatlands reduces the potential risk of silt from these sites potentially entering water-courses and affecting down-stream water courses.

4.3.9 Restoring the natural capital value of the Littleton Bog Group.

Natural capital is the world's stocks of physical and biological resources, including air, water, minerals, soils, fossil fuels and all living things. These stocks work together to deliver ecosystem goods and services that in turn provide benefits to society. These benefits include harvestable products like food, materials and fuel, clean water for people to drink and industry to use, clean air to breathe, the natural decomposition of wastes, the conservation and recycling of essential nutrients like nitrogen and phosphorous, medicine, peat control, pollination, flood and drought regulation and beautiful places to visit. But because they are free or sometimes hard to quantify, society does not value them in the same way we value other goods and services (things we pay for).

Peatlands provide several different ecosystem goods and services. Peatlands are an internationally important resource, providing environmental, economic and social benefits including:

- carbon storage and sequestration (storing carbon in the remaining peat, acting as carbon sinks and sequestering carbon from the atmosphere),
- water regulation (improving water quality);
- flood risk regulation, (slowing the release of water from peatland sites)
- biodiversity protection (the provision of habitat and space to species that are rare or under pressure in the wider landscape)
- land-based products (provision of peat, turf, areas for grazing etc)
- Cultural heritage and recreation opportunities (places to visit and enjoy the landscape, tourism and amenity)

Rehabilitation of the former industrial peat production bogs in the Littleton Bog Group has the potential to restore some of these ecosystem goods and services. The development of pioneer cutaway habitats is already providing habitats and space for species that are rare and under pressure in the wider landscape (Section 4.3.4). These include ground-nesting birds such as Skylark. The development of Birch woodland on cutaway will help increase native woodland cover. The development of cutaway wetland habitats will increase cover of a habitat that has been significantly reduced by land reclamation in the past. Restoration of raised bogs and the development of 'active' peat-forming raised bog habitat (EU Habitats Directive Annex I habitat) at Ballysorrell, Knockahaw and Littleton will significantly aid Ireland in meeting its commitments to conserve raised bog habitats under the EU Habitats Directive (NPWS 2015).

Bog restoration will also help carbon storage in these sites and in time the carbon sink function of these sites may return. Cutaway woodlands have the potential to become carbon sinks, depending on the balance between tree growth and release of carbon from the remnant peat. Cutaway wetlands also have the potential, in time, to become peat-forming and eventually become carbon sinks again. The National Peatlands Strategy (2015) and the National Mitigation Plan (DCCA 2017) both outline how restoration and rehabilitation of peatlands will play an important part in tackling the issues of climate change for Ireland by storing carbon in peat, and will help Ireland approach carbon neutrality in its land-use. Research is ongoing on Bord na Moña lands to determine how rehabilitation measures impact on carbon emission/potential sequestration of cutaway bogs and restored raised bog areas.

Natural colonisation and the development of cutaway habitats, particularly wet cutaway peatland habitats, will improve water quality of water flowing from these former industrial peat production bogs by slowing water, trapping silt and absorbing nutrients. Wetlands will also help slow the release of water from these sites and aid the natural regulation of floods. This will be important in helping

Ireland meet its commitments under the Water Framework Directive. A recent public consultation document of the National River Basin Management Plan (2018-2021) (Department of Housing, Planning, Community and Local Government 2017) outlines how peat extraction can be a potentially significant pressure on various water quality parameters. Peatland rehabilitation (in addition to other measures) is part of the WFD (2018-2021) programme of measures. Peatland rehabilitation in the Littleton Bog Group will help improve water quality of high ecological status local water bodies including the River Suir SAC and the River Barrow and Nore SAC by reducing the overall impact of peat extraction.

Bord na Móna is changing away from the traditional peat-based business towards other more sustainable businesses, such as renewable energy. Bord na Móna's company strategy will balance commercial development of the new cutaway landscape with its biodiversity and amenity/social value. The Lough Boora Discovery Park is a great example of how rehabilitated cutaway can provide different recreation opportunities. The development of Mountlucas Wind Farm also shows that amenity value can be combined with renewable energy development. Bord na Móna will seek to continue to develop commercial opportunities on the cutaway in the future (subject to planning etc). The general after-use strategy of Bord na Móna is outlined in the Bord na Móna *Strategic Framework for Future-Use of Cutaway Bogs 2011* (currently being updated by Bord na Móna). Any consideration of future after-uses for the Littleton Bog Group such as renewable energy, amenity, other developments or mixed uses will be conducted following the relevant planning guidelines and consultation with relevant stakeholders.

4.4 Decommissioning of the Littleton Bog Group

Both rehabilitation and decommissioning of the Littleton Bog Group are dealt with in Condition 10 of the IPC licence. Decommissioning covers all areas of general hygiene within the Littleton Bog Group licensed areas: removal of machinery and potentially hazardous material, lifting of railway lines, silt control, remediation of watercourses, etc. The general decommissioning procedure as outlined by Bord na Móna and accepted by the EPA is outlined below and will be carried out in conjunction with the rehabilitation of the Littleton Bog Group, and will precede rehabilitation in most cases as rehabilitation may restrict access or require re-alignment of drainage networks. However, they are recognised as separate procedures within the closure of the Littleton Bog Group. The main areas of concern can be broken down into:

- Removal of stock (harvested peat) and management of old stock-piles
- Silt control and remediation of watercourses
- General hygiene and elimination of potential pollutants

4.4.1 Silt control (decommissioning procedure with respect to watercourses)

Rehabilitation of the Littleton Bog Group is closely linked with silt control. One of the criteria for successful rehabilitation is stabilisation of the Littleton Bog Group through revegetation, which will stabilise all substrates and in turn remove the need for further silt control measures.

Drainage is an important feature of the operation of the industrial peat production mechanism and there were extensive field drains maintained throughout bog areas to facilitate industrial peat production annually, each of which eventually drains into a terminal silt pond that allows for settlement of suspended solids before entering the main river systems. There are currently up to 40 active silt ponds in operation within the Littleton Bog Group and 35 Surface emission points (SWs). The silt that builds up in these ponds is excavated on a regular basis by Bord na Móna to facilitate an efficient level of silt control. Silt ponds will continue to be maintained during the rehabilitation and decommissioning programme. Silt pond decommissioning will be considered when sites are deemed environmentally stable and peatland rehabilitation has been successful.

There are a number of streams and rivers draining the Littleton Bog Group. The majority of the bogs drain to the River Suir catchment, with several portions of bogs draining to the River Nore catchment. Both rivers are designated for their nature conservation value (cSAC) downstream of the Littleton Bog Group. The majority of the streams that drain the Littleton Bog Group flow to the Drinish River, which drains to the River Suir.

The primary concern in relation to watercourses is the prevention of silt run-off into streams and rivers within and adjacent to the Littleton Bog Group. However, there have been very few records of emissions to waters exceeding license limits and the natural colonisation and revegetation of the cutaway areas into the future will prevent any movement of peat outside the bog areas.

4.4.2 General hygiene and elimination of potential pollution (as approved by EPA)

Purpose

The purpose of this procedure is to ensure that Bord na Móna Energy Ltd. will take all the necessary steps to protect the environment from pollution, following termination of use or involvement of all or part of the site in the licensed activities. Bord na Móna Energy Ltd. shall decommission, rendering 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.

Scope

The scope of this procedure covers the following locations.

- Tea-centres
- Workshops
- Transport Centres
- Out loading facilities
- Offices
- Pumps
- Powerline
- Rail-line
- Septic tanks
- Fuel storage facilities

Depending on the commercial reality and conditions at the time, any Bord na Móna site may also be offered for sale. This will be carried out in consultation with the EPA and following an inspection/audit to ensure the site has been appropriately decommissioned.

4.4.3 General considerations relating to decommissioning and rehabilitation

While rehabilitation of the Littleton Bog Group is considered a separate issue to decommissioning, there is a certain amount of overlap with respect to silt control and mitigation of peat run-off. Bord na Móna is committed to maintaining silt control measures until such time deemed appropriate by the EPA.

In the meantime, an integral feature of the rehabilitation plan involves the establishment of replacement siltation areas in the form of wetland areas within bog areas that will complete the functions of terminal and other silt ponds and lead to a redundancy of the silt ponds, which will in time, naturalise. There will be no alteration of flow regimes between sub-catchments or groundwater flow.

PRACTICAL ASPECTS – OUTLINING A REHABILITATION PLAN FOR THE LITTLETON BOG GROUP

The baseline ecological study and the experimental trials carried out Bord na Móna cutaway bogs to date and subsequent consideration of the remaining habitat and/or bog condition types on each site provides the backdrop for development of a site specific rehabilitation plans for each site (See Appendix III).

5.1 Quantifying and costing the work required on site to rehabilitate the Boora Bog Group

An attempt is made here to (a) outline the machinery and resources required for rehabilitation of the Littleton Bog Group, and (b) to describe some of the work completed and the insights provided by this work to date.

The main rehabilitation measures that will be used for the Littleton Bog Group will be hydrological management such as drain blocking, outfall modifications and management of overflows. There may be some localised fertiliser application on bare peat areas where they are deemed to be recolonizing slowly after 5 years. The machinery required involves excavators, dozers and tractors and will be supplied by the Bord na Móna fleet. As in the case of the Oweninny Bogs rehabilitation, the work will

be carried out by local Bord na Móna staff who are best experienced in any given industrial peat production area.

At this point, the final extent of rehabilitation at Killeens cannot be clarified as it will be determined by the final drainage pattern and the extent of natural colonisation that has already occurred within an industrial peat production area.

Similarly, indicative costings for each of the rehabilitation measures have been outlined in Table 4. As the final assessment is carried out to determine targeted rehabilitation in any given bog area, the costings will be determined. At this point in time Bord na Móna has a rehabilitation provision to cover wetlands, woodland and rewetting of deep peat at a rate of €250/ha, €120/ha and €400/ha respectively. This is based on work carried out to date and will be updated as further rehabilitation work is carried out.

5.2 Rehabilitation work completed to date

There has already been some rehabilitation work carried out within the Littleton Bog Group. During the 1980's/1990's about 110 ha of cutaway and marginal bog was developed for conifer forestry by Coillte at Littleton, Lanespark and Derryville. There is ongoing forestry management of these areas by Coillte. Some conifer forestry at Lanespark was felled and replanted recently.

Rehabilitation has also been carried out on 42 ha of cutaway and marginal bog at Lanespark, with the creation of the Loch Doire Bhile amenity area in 1999. This was a joint project between Slieveardagh Rural Development (a local community group) and Bord na Móna. The main focus of this work was the creation of a fishing lake by digging out some cutaway and crating amenity walkways around the lake.

Several trial rehabilitation programmes are being implemented at present. These include bog restoration measures at Ballysorrell and hydrological management (drain-blocking) at Baunmore and Carrickhill.

5.3 Implementation and timeframe for rehabilitation

In 2017, Bord na Móna announced the closure of the Littleton Briquette Factory (closed March 2018) and the cessation of industrial peat production in the majority of bogs within the Littleton Bog Group. The only bog site where it is planned to continue milled peat production (for supply of horticulture) is Killeens. Industrial peat production has ceased in the remaining sites. Decommissioning is ongoing and it is expected that the next phase of rehabilitation will start shortly (Table 5).

It is expected that the removal of existing milled peat stocks on several different Littleton bogs will take at least three years. Currently a peat stock plan is being prepared to manage this. Milled peat stock will be transferred via rail to Littleton, and then transferred by road to other Bord na Móna facilities. This means that the Bord na Móna railway and associated infrastructure can only be decommissioned after peat stocks are cleared from bog units. Therefore, some bog units will not be available for rehabilitation for several years. It is anticipated that decommissioning and rehabilitation will occur on a phased rolling basis. First peat stocks are cleared, then decommissioning occurs, then finally rehabilitation.

The rehabilitation programme and decommissioning programme is expected to take at least three years. Site-specific detailed rehabilitation plans have been developed for each bog unit. Bord na Móna is planning to carry out rehabilitation at several sites in 2018 that are currently available for rehabilitation. Rehabilitation of the remaining areas will be determined by several main factors:

- Availability of the cutaway (the bog units have to be decommissioned initially). This includes removal of peat stocks. Some limited rehabilitation management (such as field drain-blocking) of various sections within bog units still containing stock can be carried out, but targeted rehabilitation including management of outfalls and decommissioning pumps cannot be completed until peat stocks are cleared.
- Development of after-use plans for various bog units. As these bog units have come out of industrial peat production they will be screened for potential after-use development by Bord na Móna. This could include renewable energy, biomass, forestry and amenity.

Rehabilitation would be incorporated in any after-use plans that are developed for these bogs during the period of the rehabilitation programme.

For Killeens Bog, the implementation of the rehabilitation will be determined by the year of cessation of industrial peat production and by the availability and nature of the cutaway. It is expected that two years in advance of peat production ceasing in a bog unit, the final site-specific rehabilitation plan will be developed. In the meantime, there will be updates in terms of emerging cutaway in any given site and progress of natural colonisation. During production, isolated areas of cutaway bog can emerge but are dispersed within larger production areas. Potential rehabilitation of these areas is limited as active management (such as drain-blocking) could affect adjacent active peat production areas. This type of cutaway is known as production-related cutaway bog. Production-related cutaway bog may also still be directly used during active production on various sites for access and for drainage. In the meantime, natural colonisation within these areas is progressing. Partial active rehabilitation (such as drain-blocking) of various sections within a bog could commence when hydrologically discrete units of cutaway become available and they are not being actively used for peat production (e.g. Lanespark – Loch Doire Bhile).

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Table 5. Production outlook, proposed rehabilitation start date and outline rehabilitation measures for the Littleton Bog Group

Bog name	Area (ha)	Production outlook (year)	Rehab (year)	Rehabilitation required
Ballybeg_Lanespark_Derryvilla	486	2017	2018-2021	Targeted drain blocking, Deep peat re-wetting, natural colonisation
Ballysorrell	196	/	2018-2021	Bog restoration, intensive drain blocking, natural colonisation
Bawnmore	531	2017	2018-2021	Already extensively colonised; targeted drain blocking, deep peat re-wetting, hydrological management, natural colonisation
Carrickhill	171	2017	2018-2021	targeted drain blocking, hydrological management, deep peat re-wetting, natural colonisation
Clonbaugh	37	/	/	None
Derryville	250	2017	2018-2021	targeted drain blocking, hydrological management, natural colonisation
Inch	121	2017	2018-2021	targeted drain blocking, hydrological management, natural colonisation
Killeens	632	2030	After 2030	Deep peat rewetting, targeted drain blocking, hydrological management, natural colonisation
Knockahaw	371	/	2018-2021	Bog restoration, intensive drain blocking, natural colonisation
Littleton	995	2017	2018-2021	Already extensively colonised; targeted drain blocking, hydrological management, Deep peat rewetting; natural colonisation. Rehabilitation will be planned in association with future after-use plans for renewable energy
Longford Pass (Popes Bog)	278	2017	2018-2021	targeted drain blocking, hydrological management, natural colonisation
Templetuohy	737	2017	2018-2021	Targeted drain blocking, hydrological management, natural colonisation. Rehabilitation measures will take account of the windfarm infrastructure
Total	4805			

5.4 Aftercare and maintenance programme

Following the main rehabilitation work which should be completed within three years after industrial peat production ceases and peat stock is cleared, all bog areas will continue to be monitored and the requirement for further work to be assessed. Once the sites are deemed stabilised and self-sustaining, a final validation report (as per Condition 10.4) shall be submitted to the EPA for inspection and assessment.

6 REHABILITATION OF THE LITTLETON BOG GROUP: GENERAL CONCLUSIONS

- Bord na Móna has developed a number of rehabilitation methods for cutaway that will be applied to the Littleton Bog Group. These methods have taken site conditions, all habitat types and all issues of concern into consideration. In some cases there are surveys underway to assess the work required. It will not be possible to apply any one particular approach to the entire area, as there is such a broad range of environmental conditions on site.
- Rehabilitation of each of the Littleton Bog sites (apart from Killeens) will commence in 2018.
- Currently, rehabilitation of Killeens is projected to take place after 2030.
- A 14 turbine wind farm (42 MW overall) has been constructed (Bruckana Wind Farm) on Templetuohy bog.
- A number of test programmes have been established to demonstrate the effectiveness of the rehabilitation methods on Bord na Móna bogs. These areas will continue to be monitored to document changes in vegetation cover. To date, rehabilitation methods have successful in accelerating the rate of revegetation in tandem with natural colonisation. In some areas, revegetation will remain slow.
- The criteria that define successful rehabilitation are stabilisation of bare peat and other soils through revegetation. Other aspects include mitigation of potential silt run-off, and the future management of rare or threatened species.
- Re-wetting of the cutaway, where possible, is a general rehabilitation strategy.
- The former industrial peat production sites will develop into a mosaic of peatland cutaway habitats, largely comprising mosaics of wet peatland habitats, heath, scrub and Birch woodland. In some cases there may be potential to develop embryonic peat-forming communities where acidic peat is present.
- In general, there is no potential for extensive raised bog restoration in the short-term in cutaway areas where there has been extensive peat extraction. Some sites with deeper remnant peat do have potential for raised bog restoration.
- Rehabilitation will be carried out in a manner that does not have a significant impact on neighbouring land. Hydrological management will be key in relation to managing optimum water levels across the site and avoiding negative impacts, for example to neighbouring land.
- Rehabilitation of these former industrial peat production sites can significantly enhance the biodiversity value and other ecosystem services value of these sites.
- The rehabilitation and decommissioning of the sites will be completed having taken account of issues of concern identified by the consultees. There will also be regular updates provided of the progress of rehabilitation work.
- The sites will continue to be monitored for a number of years after the rehabilitation work has been completed. The purpose will be to document the successional development of the new landscape and to remediate possible breaks in embankments, etc.
- The sites will remain in Bord na Móna control until the rehabilitation and decommissioning of the Littleton Bog Group is completed. Change of ownership will only occur following consultation and agreement with third parties.

9 REFERENCES

Supporting documents

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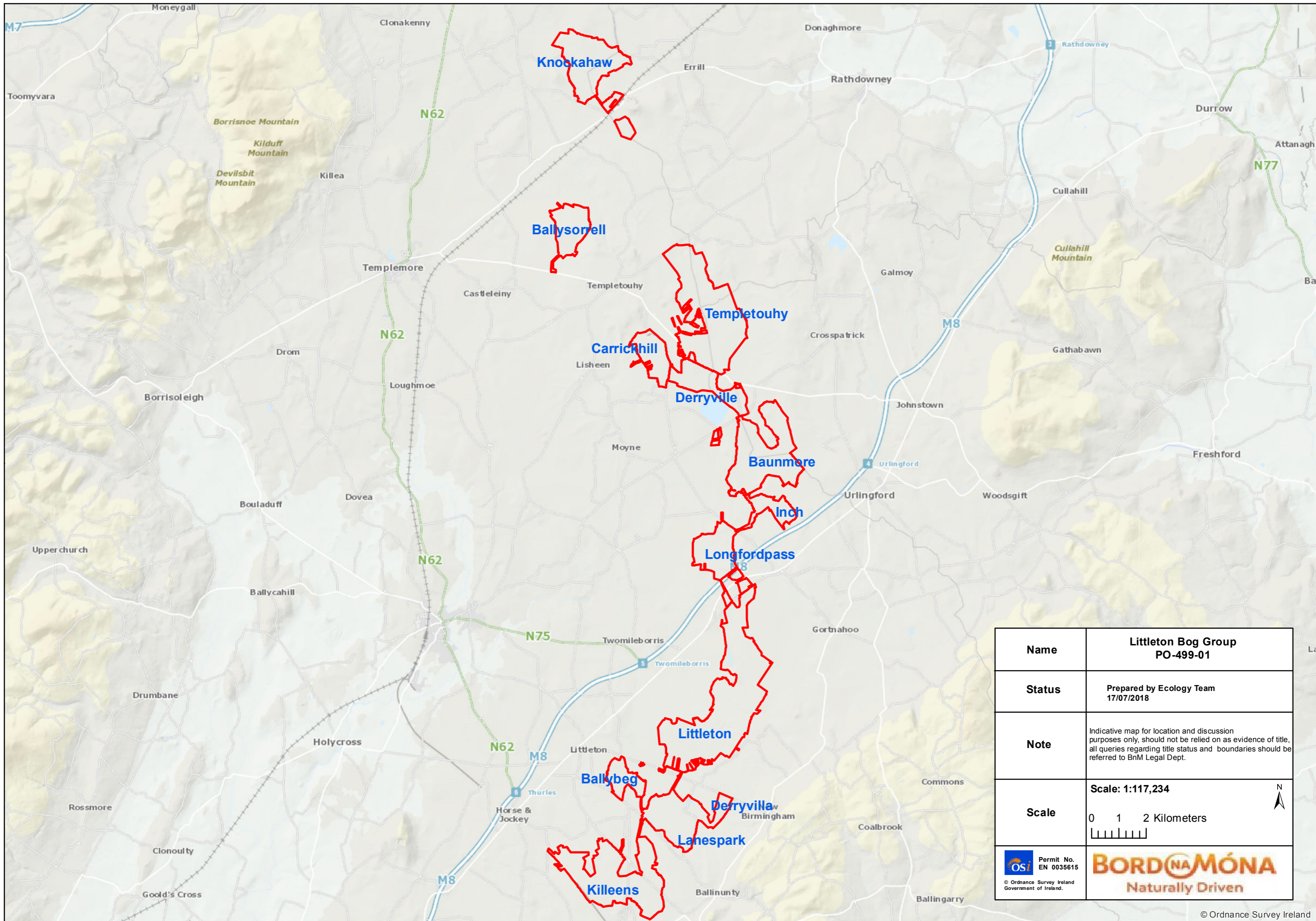
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Name	Littleton Bog Group PO-499-01
Status	Prepared by Ecology Team 17/07/2018
Note	Indicative map for location and discussion purposes only, should not be relied on as evidence of title, all queries regarding title status and boundaries should be referred to BnM Legal Dept.
Scale	Scale: 1:117,234 0 1 2 Kilometers
 Permit No. EN 0035615  Naturally Driven	

APPENDIX I

Condition 10 Cutaway Bog Rehabilitation

10.1 Following termination of use or involvement of all or part of the site in the licensed activity, the licensee shall:

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.

10.1.2 Implement the agreed cutaway bog rehabilitation plan (refer Condition 10.2).

10.2 Cutaway Bog Rehabilitation Plan:

10.2.1 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 plan shall be submitted to the Agency for agreement within eighteen months of the date of grant of this licence.

10.2.2 The plan shall be **reviewed every two years** and proposed amendments thereto notified to the Agency for agreement as part of the AER. No amendments may be implemented without the written agreement of the Agency.

10.3 The Rehabilitation Plan shall include as a minimum, the following:

10.3.1 A **scope** statement for the plan; to include outcome of consultations with relevant Agencies, Authorities and affected parties (to be identified by the licensee).

10.3.2 The **criteria** which define the successful rehabilitation of the activity or part thereof, **which ensures minimum impact to the environment**.

10.3.3 A programme to achieve the stated criteria.

10.3.4 Where relevant, a test programme to demonstrate the successful implementation of the rehabilitation plan.

10.3.5 A programme for aftercare and maintenance¹.

10.4 A final validation report to include a certificate of completion for the Rehabilitation Plan, for all or part of the site as necessary, shall be submitted to the Agency within six months of execution of the plan. The licensee shall carry out such tests, investigations or submit certification, as requested by the Agency, to confirm that there is no continuing risk to the environment.

Reason: To make provision for the proper closure of the activity ensuring protection of the environment.

¹ Note CF: This refers to any specific ongoing management or long term aftercare, for example scrub clearance, water management or flood control. These will be assessed on a site by site basis but are not expected to be onerous once the initial rehabilitation has been completed.



**CUTAWAY BOG REHABILITATION:
Condition 10 Integrated Pollution
Control Licence**

Management guidelines for the planning and implementation of cutaway bog rehabilitation in accordance with condition 10 of IPC Licences Nos. 500-507

**Bord na Móna
January 2002**

SUMMARY

Bord na Móna currently owns 80,000ha of land, which has been largely developed for industrial peat production. In compliance with Integrated Pollution Control (IPC) licensing, a rehabilitation plan must be prepared for all areas of bog where peat production has ceased, i.e. cutaway bog. The primary aim of the rehabilitation programme for cutaway bog is the development of sustainable after-uses. Where possible, these uses will be of a commercial nature, such as forestry and grassland. In other areas the appropriate after-use will be the creation of wetland and/or wildlife habitats, which will enhance the national biodiversity resource through the provision of habitat for flora and fauna. A number of factors affect the choice of potential after-use. Primary factors include peat depth and type, drainage, sub-surface contours, subsoils and economics. Secondary factors include accessibility, adjacent land-use, proximity to Natural Heritage Areas (NHAs) and Special Areas of Conservation (SACs), archaeological interest and community imperatives. The triggers for development and implementation of cutaway rehabilitation plans for each of the Bord na Móna Works are outlined, as well as a decision tree that incorporates influencing factors to illustrate the thought pathways that must be considered in establishing the best-suited after-use for any area of cutaway bog. This document essentially serves as a guide to the after-use of Bord na Móna owned industrial peat production sites in Ireland, based on the knowledge acquired to date.

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1. INTRODUCTION

1.1 Bord na Móna Compliance with Condition 10 of IPC Licensing

Bord na Móna are required to provide rehabilitation plans for areas of cutaway bog under Integrated Pollution Control (IPC) licensing. This will ultimately apply to most of the area currently in ownership of Bord na Móna, which covers approximately 80,000ha of land. This land is largely comprised of peatland - either production bog or un-developed bog, distributed between discrete units of bog, which are in turn interspersed with agricultural areas. Bord na Móna own in excess of 150 of these discrete units of bog, which range in size from 400ha up to 5,000ha, and spread across the Irish midlands belt between the counties Kildare and Galway, Roscommon and Tipperary. Each industrial peat production site (known as individual *Works* in Bord na Móna, e.g. *Blackwater Works* and *Boora Works*), comprises a complex of administration centres, peat production centres and workshops, travel paths, railway lines, headlands, silt ponds, production bog and cutaway bog.

A number of potential after-uses for cutaway bog have been proposed by Bord na Móna, including forestry, grassland and/or renaturation of the cutaway bogs for creation of wildlife habitats. The potential after-uses depend on a number of aspects including physical and economic factors, which are described in detail in this document. It is however, not possible to state exactly what after-use will be applied to any particular cutaway bog area until the condition of the post-industrial peat extraction site is assessed after completion of peat extraction, i.e. peat depth and type remaining, accessibility, etc. This applies to the majority of Bord na Móna holdings, therefore, despite the vast knowledge base that Bord na Móna has acquired on potential after-uses of the cutaway bog (*See References*), only a general broad-based plan can be outlined for all Bord na Móna Works at this point in time.

This document outlines rehabilitation work and after-uses implemented on Bord na Móna cutaway bog to date. It is recognised that ultimately all areas of Bord na Móna bog will be classified as cutaway bog and the same methodologies described here will be applied to all Bord na Móna Works, with modifications, as the knowledge-base continues to grow.

This document aims to outline the following:

1. The main factors affecting potential after-uses of cutaway bog – physical, chemical, economic and social.
2. A description of the characteristics of potential after-uses of the peat extraction sites that have been considered to date.
3. An outline of the process whereby cutaway bog rehabilitation plans will be developed, incorporating practical aspects, levels of decision making and consultation.
4. A decision tree that outlines the thought pathways that will be followed when considering the most suitable after-use for a cutaway site, taking all influencing factors (both primary and secondary) into consideration.

1.2 Consultation

Bord na Móna recognise that there will be a national interest in the after-use of extensive areas of cutaway bog. Consultation with government departments and other agencies will be conducted during the development of rehabilitation plans, both on a local and national level.

These organisations will include:

- Department of the Marine and Natural Resources (Forestry and Fisheries Boards)
- Department of Agriculture, Food and Rural Development
- Department of Arts, Heritage, Gaeltacht and The Islands (Dúchas - Parks and Wildlife; Research, Bogs and Wetlands; Archaeological)
- Local Authorities
- Local communities
- Bord na Móna employees
- Teagasc
- The Heritage Council
- Non-governmental organisations
- National universities and colleges

1.3 Peatland Types in Ireland

Peatlands are specialised ecosystems, in which the rate of production exceeds the rate of decomposition, resulting in the annual accumulation of peat and eventually in appropriate conditions, to extensive and deep peat deposits. The factors that favour the development of peatlands include impeded drainage, climate, hydrology, geomorphology, nutrient status and glacial geology. Peatland development is promoted where permanently waterlogged conditions prevail. This occurs where (a) precipitation exceeds evaporation, as is the case for blanket bog habitats, or (b) where there is adequate rainfall, no distinct summer drying period and impeded surface drainage, as in the development of raised bogs and fens.

Peatlands cover 17.2% of the area of the Republic of Ireland, of which Bord na Móna owns approximately 7% of this figure. There are four types of peatland found in Ireland – fen, raised bog, mountain blanket bog and Atlantic blanket bog. Bord na Móna produce peat predominantly from raised bogs in the midlands, with one Works based on Atlantic blanket bog in North-west Mayo (*Oweninny Works*). A brief outline is provided here of the development of peatlands, peat types and the peat extraction methods employed by Bord na Móna.

Peatland development in Ireland commenced after the last Ice Age, *circa* 10,000 years B.P. (*the following description of peatland development deals mainly with raised bogs, as this is the most extensive peatland type in Bord na Móna ownership*). As the glaciers retreated, glacial till was deposited over the limestone of the midlands plain and the shale and sandstone in the western regions. The resulting landscape was undulating, comprising scattered depressions of varying depth and inter-linking high areas. Post-glaciation, fresh water lakes formed in depressions. In many instances alluvial material was washed into these depressions, resulting in the original glacial deposits being covered by 0m to 2m of alluvial material (silty blue clay). In deeper depressions the alluvial material was overlain with shell marl. Marl is 70% to 90% carbonate in composition and contains the shells of gastropods and other creatures that colonised these freshwater bodies. The areas between those fresh water lakes remained uncovered and soil formation processes began. In time, these areas were colonised by extensive forests.

Peat formation commenced in the sediment filled depressions (minerotrophic fens), gradually spreading outside of the basins of origin and eventually covering the higher areas and coalescing to form the extensive bog landscape that is typical of raised bogs and blanket bogs. This gives the impression of a homogenous surface that belies the undulating glacial topography underlying the peat, and it also highlights the origin of distinct fen peat types (woody fen-peat formed on higher ground and *Phragmites* fen-peat largely formed in depressions). This process of peatland development occurred slowly over a period of thousands of years.

Fens are formed in areas where there is constant flushing of base-rich ground water. They are described as *minerotrophic* (fed by ground water). Fen peats in Ireland have a relatively high pH ranging from 4.5 to 8.0 (Doyle & Ó Críodáin 2002). Fen peats are mineral-rich with a relatively high ash content (20%) and subject to a constant influx of nutrients in in-flowing water. Fen vegetation is comprised mainly of sedges, with a diverse bryophyte layer and a relatively rich herb component. Fens have been largely drained and cultivated for agricultural use but there are some remaining examples in Ireland. Pollardstown Fen in Co. Kildare is the best remaining example of a fen in Ireland. This fen was previously the only fen area in Bord na Móna ownership and was handed over to the Irish State for conservation purposes in the 1970s. In the Irish midlands, fen peat development was generally superseded by raised bog development. In extensive areas of cutaway bog, fen peat will be the main peat type remaining after removal of the upper ombrotrophic peat layers in raised bogs developed by Bord na Móna for fuel production.

Raised bogs are dome-shaped peat masses that once covered extensive areas in the Irish midlands. Development of this bog type is dependent on the presence of *Sphagnum* species or peatmosses. The vegetation is dominated by these bryophytes, which keep the peat surface waterlogged as the peat moss grows above the water-table, while maintaining an acid environment (typically less than pH 4) that favours continued *Sphagnum* establishment. The peat is *ombrotrophic* (fed by precipitation only). The contrast between *minerotrophic* fen and *ombrotrophic* peatland is extreme and the distinction rests primarily on the water regime. In the successional development of raised bogs, the transition from fen to ombrotrophic peat occurs once the vegetation is elevated above the influence of base-rich waters, and the vegetation is solely supplied by nutrient-poor water derived from the atmosphere. The depth

of ombrotrophic or *Sphagnum* peat varies between bogs. Generally the basal layers comprise lake-mud and fen peats. This shallow fen peat layer (generally 1m to 2m) is overlain with highly humified *Sphagnum* peat, which is in turn overlain with poorly humified *Sphagnum*-peat (Fig. 1). Total peat depth in any raised bog can be up to 15m in an un-drained state.

Within the upper peat layer, an active surface layer has been identified and is known as the acrotelm. The acrotelm is generally 0.5m deep and forms the main water conduit in the bog. It is in this active layer that physical and chemical processes occur. The underlying layer is referred to as the catotelm and comprises the remaining inactive deep peat deposits. There are no chemical processes ongoing in this layer and water movement is particularly slow. In development of raised bogs for peat production, the acrotelm is destroyed and most of the catotelm is removed. Once the acrotelm is destroyed, there is little possibility of restoring a raised bog to its previous condition.

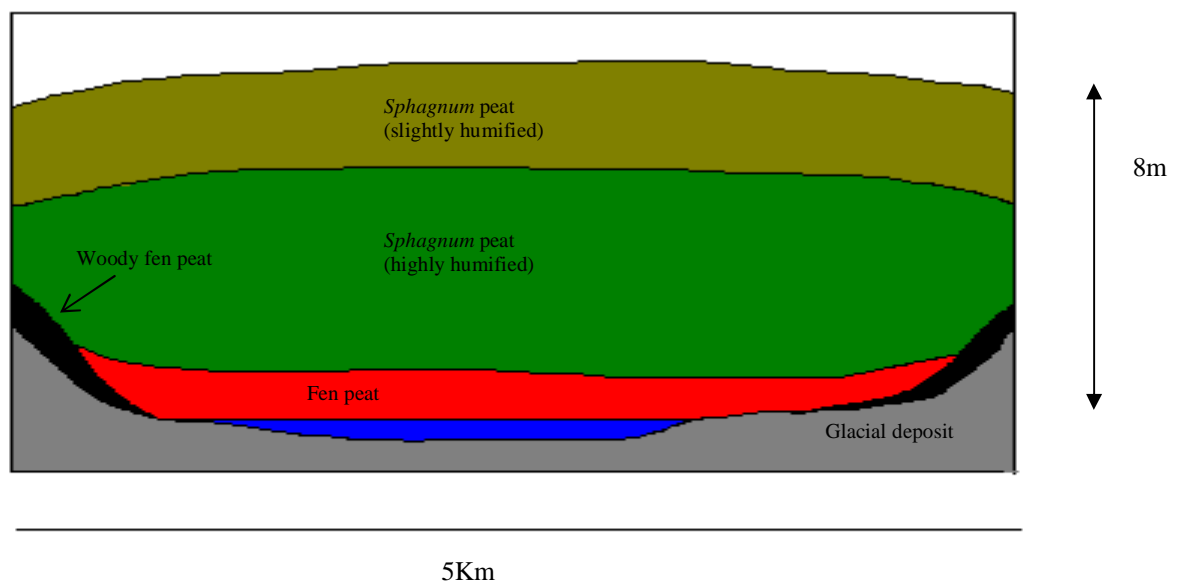


Fig. 1 Outline of raised bog development (after Mitchell 1986; *N.B. not to scale*). The lower blue layer comprises lake-mud that overlies glacial deposit. The upper slightly humified peat layer is utilised for horticultural peat while the lower highly humified layers are utilised for energy production.

Blanket bogs have developed in Ireland in areas of high rainfall, covering entire landscapes. Mountain blanket bogs have formed across mountain plateaux and gentle slopes (usually up to 15°, but on slopes of up to 25° in the extreme south-west in mountainous areas of counties

Cork and Kerry) (Doyle & Ó Críodáin 2002). Atlantic blanket bog has developed on lowland areas, occurring at altitudes below 200m. Rainfall in these areas exceeds evaporation and leads to the development of permanently waterlogged soils, and hence conditions that favour the development of peat.

Bord na Móna developed two peat extraction sites on Atlantic blanket bog in the west of Ireland, at Bellacorick and Bangor Erris in North-west Mayo. The peat in Atlantic blanket bog systems is generally shallower (average depth 4m) and the underlying topography is comprised of a series of gravel hills and ridges. In the case of the cutaway Atlantic blanket bogs, the remaining shallow peat (usually less than 0.5m) is ombrotrophic with occasional pockets of relatively deep minerotrophic peat (more than 1m). This is a consequence of the bog developing over acidic glacial till as opposed to forming in calcareous influenced lake basins as is the case for raised bogs.

1.4 Industrial Development of Peatlands

Peat is a highly organic soil type consisting of partially decomposed remains of plants and animals. Its exploitative value for fuel has been recognised for centuries, but mechanisation of the process in the last sixty years has allowed extensive areas of peat to be exploited more efficiently and economically. Bord na Móna was established in 1946 to promote production and marketing of peat products.

The Bord na Móna extraction policy favours harvesting of as much peat as is possible, until (a) the underlying substrate is reached, (b) a layer of bog timber is encountered, or (c) continued drainage is no longer feasible. The peat extraction methods employed by Bord na Móna allow for efficient extraction of peat. Subsequently, the peat cover remaining in an industrial cutaway bog can vary from a few millimetres to a few metres. This variation reflects the degree of undulation of sub-surface contours. The variability of sub-surface contours is one of the primary factors affecting the choice of after-use of cutaway bog (*See 2.2.1*).

The different layers of peat have very different physical properties and this in turn relates to their potential commercial use. The preferred peat for horticultural purposes is the upper, poorly humified *Sphagnum*-peat layer, and this is related to the high water retention properties of the peat. In Irish raised bogs this peat is generally confined to the upper 2m to 3m of peat. The lower, highly humified peat is suitable for fuel production. Where bogs are utilised only for horticultural peat, the remaining bog is referred to as *cut-over* bog to reflect the relatively deep layers of ombrotrophic peat. If the remaining peat however, is targeted for fuel production, peat will continue to be harvested until the ash content of the peat exceeds accepted levels, or until it is not economically viable to do so. This results in a broad range of cutaway habitats that are outlined in the next section (*See 2.1*).

Before peat can be harvested a series of steps must be taken to drain the bog and develop the site for operation of Bord na Móna machinery. The surface of the bog is prepared for peat extraction by drainage and stripping of the surface vegetation. Drains are inserted at 15m intervals, giving rise to a network of long, parallel peat fields. Within three years the surface vegetation is removed and the bog is sufficiently dry for peat extraction to commence.

Peat harvesting is generally between the months of May and September, when drying conditions are optimal. The main methods of peat extraction are milling and sod peat cutting, but currently milling is the most widespread method. The milling method involves the use of machinery that scarifies and loosens a thin layer of peat (15mm to 20mm) on the surface of the peat fields. This loosened peat is subsequently turned to facilitate solar drying to attain moisture content of 45% to 50%. The peat is then stored in stockpiles adjacent to the production fields until required. Milling may continue for up to forty to fifty years on any peat field, depending on peat depth and market demand. The peat surface is lowered by 1m over a ten-year period. The annual rate of peat removal is variable, and this is a consequence of shortened (and occasionally prolonged) harvest seasons due to climatic variability.

The peat extraction infrastructure comprises a narrow gauge railway network used predominantly for transporting peat from stockpiles to the final destination, e.g. an electricity generating station. An extensive railway network has proven successful for transport across the peat production areas and development and maintenance of a road network was considered unpractical. All other travel on the bog is generally along peat fields and/or headlands, employing the use of low bearing pressure machinery that is suitable for bog conditions.

2. REHABILITATION OF CUTAWAY BOG

2.1 Cutaway Bog – Habitat Conditions

Cutaway bog can be loosely defined as former production bog. This can range from a single cutaway (former production) field that is surrounded by active peat production fields, to an entire former production area comprising several peat fields, extensive drainage network, railway beds and intact bog remnants. Cutaway bog is therefore, a broad term under which a number of conditions and/or habitats are included.

When production ceases, cutaway bog can be broken down into one of (or a number of) habitat types (conditions) as follows:

1. Intact bog remnants – areas of bog that vary in size from less than 1ha up to extensive areas, usually bordering production bog but may comprise separate entities, which were never fully developed for peat extraction.
2. Deep ombrotrophic peat – more than two metres of peat, typically acidic (e.g. horticultural cut-over peat).
3. Shallow ombrotrophic peat – less than 2 metres of peat, also acidic (e.g. Atlantic blanket bog cutaway).
4. Shallow minerotrophic (fen) peat – usually less than 2m peat, typically influenced by calcareous groundwater (e.g. energy-peat cutaway).
5. Shell marl – basal calcium-rich deposit underlying fen peat (former lake deposits).
6. Mineral soil – comprised of glacial tills and gravel, generally acidic in western regions and alkaline in the midlands region of Ireland.

Therefore, conditions within any production – cutaway bog can be variable, often with each habitat type represented. This highlights the need for a comprehensive baseline study of each cutaway bog unit to be carried out before a suitable after-use can be applied. There may be more than one after-use applicable within any cutaway bog.

The primary aim of the rehabilitation programme for cutaway bog is the development of sustainable after-uses. Where possible, these uses will be of a commercial nature, such as forestry (both hardwood and coniferous) and grassland. In other areas the appropriate after-use will be the creation of wetland and/or wildlife habitats, which will enhance the national

biodiversity resource through the provision of habitat for flora and fauna. A number of research projects were conducted to examine these after-uses reflecting the current trend in other countries (Grosvenier *et al.* 1995, 2000; Money, 1995 a, b; Price 1998; Quinty & Rochefort 1997, 2000; Rochefort & Campeau 1997; Sliva 2000; Wheeler & Shaw 1995; Wheeler *et al.* 1998; 2000). Commercial after-uses include development of grassland, forestry and creation of angling lakes (Boyle *et al.* 1998; Caffrey 1998; Egan 1995, 1998a, b; Jones & Farrell 2000; McNally 1984). Non-commercial after-uses include the development of wetland areas and wildlife areas (Egan 1995; Farrell 2001; Farrell & Doyle 1998, 2002; Feehan & Kaye 1998; Feehan & O'Donovan 1996; Kavanagh 1991, 1996, 1998; Leader 1999; O'Connor 2000; O'Connor & Reynolds 2000; Rowlands 2001; Rowlands & Feehan 2000 a, b; Trodd & Murray 2000). Where there are intact bog remnants, these areas will be preserved and where possible they will be managed to conserve and/or restore peat-forming conditions.

We are therefore presented with cutaway bog complexes that comprise a diversity of habitat conditions, which may lead to the eventual establishment of a mosaic of after-uses that will ultimately form a diverse landscape in place of the industrial peat production landscape that currently exists.

2.2 Factors Affecting After-use of Cutaway Bog

2.2.1 Primary factors

A number of factors affect the choice of after-use option for cutaway bog. While a proposal for after-use of total Bord na Móna cutaway bog areas has been outlined (Table 1), this serves only as a guide, as the after-use will be largely dictated by the physical and chemical characteristics presented by any cutaway bog. The main factors affecting after-use selection are peat type, peat depth, drainage, sub-surface contours and subsoil type. While each primary factor is discussed under a separate heading, the discussion for each overlaps in some places highlighting how closely inter-related each factor is, e.g. peat type and sub-surface contours, drainage and peat depth, etc. The secondary factors *that may be primary factors in some situations* are accessibility, community imperatives, adjacent land-use, proximity to NHAs and SACs and presence and/or absence of objects of archaeological interest.

Policy and economics

Bord na Móna cutaway bog policy will be that where an economically viable after-use can be established on cutaway bog, that will be the most favourable option. This will not result in a loss of potential wildlife habitats as it has been shown that more than 25% of the cutaway will be unsuitable for any economic after-use. As well as that, consideration will be given where cutaway bog is located adjacent to SACs and NHAs, and where there may be potentially damaging effects to the local biodiversity resource. McNally (1997) outlines the breakdown for proposed uses of cutaway bog (Table 1).

Table 1. Post-industrial future of Bord na Móna cutaway bog

Potential use	Percent of BNM holdings
Coniferous plantation forestry	40%-50%
Wetland rehabilitation	20%-30%
Agricultural grassland	20%-30%
Hardwood forestry	10%-20%

A number of factors will alter these proposed figures, as research is ongoing and market demands for forestry and/or grassland fluctuates. Nonetheless, research and development

into these after-uses is ongoing and the techniques involved are being continually refined. Other after-uses such as wind-farms, gravel pits, etc. are also being explored, but these options are generally small-scale and/or once-off operations where site-specific conditions are suitable, e.g. the wind-farm at Bellacorick.

Cost of after-use will be a major factor of consideration for Bord na Móna in the post-industrial development of cutaway bog. While a number of after-uses have been proposed for cutaway bog, the market available and the cost of establishing, for example grassland, even if conditions are suitable, will play a major role in deciding whether or not that will be the chosen after-use. The economic viability of any commercial venture will be a product of all of the factors outlined below, particularly factors such as accessibility, local demand, national demand and cost of materials and/or labour.

The cost of any commercial venture is expected to largely exceed the cost associated with renaturation and establishment of wildlife habitat, so where there is no commercial venture practicable for a cutaway area, it will automatically be targeted for wetland development and/or replacement wildlife habitats. Therefore, on-site conditions and economic considerations ultimately control Bord na Móna policy for the after-use of cutaway bog.

Peat-type and depth

Peat depth and type are fundamental to the selection of after-uses for cutaway bog. Both factors are inter-related, and are in turn a function of original peat depth, undulation of the bog floor and the degree to which peat extraction was conducted.

Midland raised bogs consist of two distinct *peat types*, with a number of sub-types within each category. The most abundant peat type is the ombrotrophic *Sphagnum* peat type (2m to 10m deep) that is largely utilised for horticultural peat (the upper poorly humified layer) and energy production (the lower highly humified layer). The basal peat layers are minerotrophic and comprise a number of types that are a consequence of origin within raised bog development, and in turn related to the sub-surface contours (*See 1.3*). Fen peat can be broken into two sub-types, namely *Phragmites* fen-peat and woody fen-peat. The *Phragmites* and woody fen peat types each have specific characteristics that influence their

suitability for after-uses. In general, *Phragmites*-peat requires a higher level of treatment for development of grassland and forestry than woody fen-peat. Fen peat will be the most extensive peat type remaining in cutaway bog areas, although there will be ombrotrophic peat where peat deposits are not utilised completely.

Peat depth can be a critical factor in determining the after-use of any cutaway bog. An attempt is made here to define certain critical peat depths, however, this delimitation can be affected by site-specific characteristics.

- Deep ombrotrophic peat, typically more than 2m – There are two situations where deep ombrotrophic peat may be encountered: **(i)** Deep peat that has a vegetation cover - this applies to bog remnants that usually form a fringe around a developed peat production bog. These bog remnants generally have a relatively intact vegetation cover comprising typical peatland plants and are therefore, considered stable habitats. These areas will not require any active rehabilitation work. **(ii)** Deep peat remaining after peat production (compressed peat, bare field surface), which is ombrotrophic in nature. To date, there has been no economic after-use developed for deep ombrotrophic peat. This is a consequence of drainage difficulties, acidity and nutrient requirements. The most appropriate after-use for these deep peat areas is considered to be the establishment of wildlife habitat areas. These areas become colonised by *Calluna vulgaris* and *Eriophorum angustifolium*, largely developing heathland vegetation and in wetter areas, embryonic peat-forming communities re-establish. The peat is stabilised and the after-use is considered sustainable with minimal maintenance required. Deep peat deposits remaining after peat extraction ceases are generally termed *cut-over*, as the peat resource hasn't been exhausted completely. This is in contrast to the term cutaway that generally refers to an area where the peat depth does not exceed 2m.
- Shallow minerotrophic peat, 1m to 2m deep – Provided drainage of the cutaway bog is good, shallow minerotrophic peat areas will be designated for coniferous forestry. Research has shown that deep peats are unsuitable for forestry and while forestry can be successfully established on peat depths less than 1m, the current policy (State Forest Service) is that trees will not be planted on peat depths less than 0.5m. A range of hardwood species can be established on all peat depths (0m to 2m), and research is

ongoing in this area to determine the optimal conditions for commercial growing of hardwood tress on cutaway bog (Jones & Farrell 2000).

- Peat depths 0m to 1m – Bord na Móna research has shown than on peat depths up to 1m that are underlain with suitable soils and with good drainage conditions, agricultural grassland can be successfully established. Where drainage is poor however, and/or the area is frequently inundated with floodwaters, the cutaway bog will be allowed to revegetate naturally with typical fen vegetation. Fen establishment has occurred successfully on a number of shallow, minerotrophic cutaway bog areas, e.g. Turraun. Where there is no peat remaining, the underlying marl and/or glacial till will be revealed. These areas are generally interspersed with areas of shallow peat, and will either be incorporated into grassland areas or naturally revegetated fen areas.

In summary, shallow minerotrophic peats are more suitable for commercial after-uses than deep ombrotrophic peats (Table 2), while essentially all cutaway bog areas could be managed for non-commercial after-uses (wetlands and/or wildlife habitat). The former will be a consequence of peat extraction for energy peat where all layers of peat are removed (and also the most extensive scenario that will be encountered), while the latter is generally a consequence of horticultural peat extraction.

Table 2. Critical peat depths for potential after-uses of cutaway bog.

		Grassland	Forestry	Wetlands/wildlife habitat
Peat depth	Shallow (1m –2m)		*	*
	Shallow (0m-1m)	*		*
	Deep (>2m)			*
Peat type	Minerotrophic	*	*	*
	Ombrotrophic			*

There is one exception to the above delimitation of peat depths, and that is the cutaway Atlantic blanket bog situation. Because of the nature of development of the bog, all peats are ombrotrophic – both shallow and deep, and therefore there is no economic after-use suitable for the *Oweninny Works*. The proposed after-use is therefore re-establishment of replacement wetland plant communities that will allow the area to blend in with the surrounding Atlantic blanket bog landscape.

Drainage

The peat production drainage network is the most important factor for efficient peat extraction. Therefore, until peat extraction is completely finished within a peat production unit, it is not possible to close drains to encourage revegetation. When peat production is completed in an area of bog, the field drains and main out-falls are typically left open and will remain as such where commercial after-uses such as forestry and grassland are selected.

While all raised bogs are drained by gravity in initial years, as peat extraction continues and the level of the peat is lowered, in some cases the peat production fields are lower than the level of the regional arterial drainage network. It then becomes necessary to install artificial pumps for peat extraction to continue. Such is the case for production bogs along the River Shannon in West Offaly – these bogs are continually pumped to allow peat production to continue. Once the pumps are turned off, the area will be flooded. The only after-use available for these pumped areas is therefore renaturation of the site and establishment of wetland habitats (Leader 1999). Where the drainage is good, usually where the regional water-table lies below the peat surface, there is an improved opportunity for development of the site for commercial operations. Therefore, drainage of the cutaway bog and drainage of the surrounding land are inter-related, while also a product of peat depth and sub-surface contours.

Ultimately, if cutaway bog is difficult to drain, the cost of maintaining or improving drainage outweighs the benefits of developing the area for commercial forestry and grassland. These areas will be allowed to revert to wildlife habitat areas, as has been shown to occur successfully on a number of cutaway bog areas. Converse to that scenario, in

some places drainage of surrounding private agricultural land is dependent on the maintenance of an intact drainage infrastructure through the adjacent Bord na Móna industrial peat production area. In such cases, Bord na Móna may be required to maintain the integrity of the drainage network of former production areas.

Sub-surface contours

Even though conventional diagrams of raised bog development show a typically uniform sub-surface, the landscape underlying bogs in general is not uniform. Sub-surface contours vary greatly from bog to bog. In any raised bog, the floor contours may vary within a couple of metres or may vary over extensive areas – this is a consequence of glacial deposition that is not uniform. As industrial peat extraction continues from a drained raised bog, occasionally gravel hills and/or depressions in an otherwise level peat field are encountered. If these features are abundant within a production bog they lead to difficulties for peat extraction and drainage. Where the sub-surface contours are undulating, pockets of peat may be relatively deep and difficult to drain, leading to difficulties in developing a site for grassland and/or forestry.

Subsoil type

The underlying subsoil type of any bog largely determines the chemical nature of the basal layers of peat. Limestone underlies the central plain of Ireland and this is generally overlain with glacial deposits. Calcareous waters therefore, largely influence the mineral soil underlying the midlands raised bogs. Carboniferous shales underlie the glacial deposits beneath Atlantic blanket bog and there is therefore, no large-scale calcareous influence. There are however, occasional calcium and iron-rich up-wellings across the Bellacorick cutaway, but the subsoil is largely acidic. The economic viability of grassland and/or afforestation is largely reduced where the underlying subsoil is acidic, the cost of increasing nutrient status generally outweighing any economic benefits. Subsoil type is strongly related to the sub-surface contours, particularly in relation to post-glacial events (*See Peat depth and type*).

2.2.2 Other factors

A number of secondary factors will also be taken into consideration on selection of appropriate after-uses for cutaway bog. Each of these factors may be applicable in one or more sites and in some cases may be over-riding features.

Accessibility

Accessibility is a product of location and proximity to established settlement areas, and is important for all potential after-uses in relation to access for machinery, public access for amenity purposes and/or access for maintenance work. Access may be by railway line only, or old railway beds (there is no road network established in any Works). In extensive bog areas, conditions can be difficult for travel, particularly during winter months with rehabilitation work therefore, largely restricted to drier months. To improve access, a road network would have to be established and this would be dependent on a proximal source of material for development of such a network. A consideration relevant for establishment of wind-farm and other alternative energy options, would in turn be access to a main electricity gridline. Accessibility is also inter-related with adjacent land-use.

Adjacent land-use

While there are currently restrictions on agricultural output within the European Union, there are still opportunities for farming under less intensive conditions. This would provide an outlet for new land coming on stream for farmers. Conversely, if a cutaway bog area is in a poorly developed region there may be little call for 'green land'. Nevertheless, there may be a requirement for local employment opportunities and forestry may be the option as long as the area is easy accessed. Consultation with local landowners would be required to determine what the needs of the local area are. Adjacent land-use would also have to account for the proximity of NHAs and SACs and/or local community interests.

Proximity of NHAs and SACs

If an area of cutaway bog lies between NHA and SAC areas, then the 'best' option would be to rehabilitate the cutaway bog to provide a wildlife corridor between such areas. This is

particularly relevant where Red Data species present could benefit from an expansion of the local habitat available. An example of this is the case of the grey partridge, a rare bird species whose breeding population in Ireland is confined to an area of cutaway bog within the Boora Parklands area (Kavanagh 1991). Also, development of cutaway bogs adjacent to SAC areas (for example for forestry or grassland), may have a negative impact on the integrity of the protected area and would therefore not be a suitable practice. If the protected area had been compromised by peat production developments, the adjacent area of cutaway bog could be rehabilitated to enhance the habitat and wildlife value. In the case of a raised bog, a number of options are available such as rewetting the lagg zone, extending SAC area, etc. Consultation with Dúchas and other conservation and/or ecology groups will play an important role in these situations.

Community imperatives

Community imperatives will be taken into consideration, particularly where cutaway bog areas are close to settlement areas. Any prominent needs of the local community will be considered, for example, there may be a local requirement for grassland and/or industrial development land. Community involvement ultimately would depend on the interest of the local people. An example of this is the Boora Parklands in Co. Offaly. Since the development of (a) extensive wetland, grassland and woodland communities at Turraun, (b) amenity lakes and (c) grassland within the Boora parkland area, the local community has incorporated these developments into their community development strategy (Anonymous 1998; Barron *et al.* 1994). This will be a case study for consideration by other community groups that lie at the margins of cutaway bog. In the case of Killaun bog in Co. Offaly, a portion of this bog was handed over to a local school and has contributed greatly to a number of aspects of the secondary school curriculum including geography, biology, social studies, history, art and economics.

Archaeological interest

Bord na Móna manages the archaeological implications of peat extraction under a formal agreement with Dúchas. Under this agreement mitigation measures are applied under licence from Dúchas where archaeological sites are discovered in the peat. In certain cases

portions of bog are set aside either temporarily or permanently where mitigation/excavation is not a preferred option in the short term. When the bog is cutaway these areas will continue to be preserved because of their archaeological importance. Discussions have begun with Dúchas as to the maintenance of the required conditions (moisture content, etc.) in these areas in order to prevent deterioration of the archaeology. Dúchas will be consulted in deciding the best approach in all such cases.

2.3 After-use Options

A number of after-uses have been proposed for industrial cutaway bog. The main after-uses are grassland and forestry development (commercial) and establishment of fen communities (the non-commercial wetlands option). A general description of the methods of developing the cutaway bog for these after-uses and inter-related issues is outlined here. A more detailed account can be attained from the references listed (*See References*). The main features of these after-uses are outlined here under the following headings:

- *Technical parameters*
- *Development works*
- *Supporting infrastructure*
- *Indicative costs*
- *Nutrient requirements*
- *Timeframe*
- *Influencing issues*

2.3.1 Grassland

The grassland after-use option has been developed over the last thirty years on cutaway bog in the midlands. Grassland development has been concentrated largely in Co. Offaly and to date approximately 1,000ha of land has been developed successfully and sold to local farmers in varying lot sizes. Grassland development was also studied on Atlantic blanket bog cutaways but inclement weather conditions and nutrient poor conditions led to the developments being economically inviable.

Technical parameters

The cutaway bog must be drained by gravity drainage to establish sustainable commercial grassland. Peat depth must be less than 1m deep on 75% of the site and the underlying soil should comprise boulder drift and/or silty clay that is devoid of large boulders in the top 15cm.

Development work

Development of the cutaway bog for grassland requires initial, overall levelling of the site. The area is then deep ploughed, mixing all of the residual peat and 15cm of the underlying soil. Once ploughed, the area is left for twelve months that is followed by re-levelling to further the mixing of peat and soil. This peat and soil mix is then left to settle for a further twelve months. This period is required to identify and subsequently rectify any drainage deficiencies. The seedbed is then prepared and any fossil timber is removed. At this stage nutrients are applied according to the nutrient requirement of the soil. Grass seed is sown between mid-July and mid-September.

Supporting infrastructure

The necessary infrastructure for sustainable grassland developments requires (a) development of road access; (b) installation of water supply; (c) erection of fencing and (d) installation of open drainage channels.

Indicative cost

The cost of developing grassland is generally in the range of €5,000-€6,000/ha. Costs can be elevated however, where infrastructure costs are increased due to on-site conditions.

Nutrient requirements

The base level of available phosphorus and potassium in peatland systems is relatively low. Following soil test results, the nutrient status of the ploughed peat and soil is elevated to meet grass growth requirements (8-10ppm P and 150ppm K at a pH of 5.5-6). Once this level is achieved, the normal annual addition of nutrients to match stocking levels is all that is required.

Timeframe

The exposed soil is left in the ploughed state for at least 12 months during which its structure is significantly changed due to the action of frost, rain, sun and wind. When re-levelled and mixed the area is then allowed to settle for a further 12 months, during which

time the necessary drainage is installed. From initial levelling to grass establishment, the time for grassland establishment is two and half to three years. Work can only be undertaken in the drier months and therefore, the length of the dry period in any year influences the timeframe of development.

Influencing issues

A number of issues must be considered as follows:

- The area developed as grassland must be capable of carrying the infrastructure costs.
- There must be a market for the land developed.
- Agricultural support mechanisms are continually changing and could impact negatively or positively on land yet to be developed.

2.3.2 Forestry

Afforestation of cutaway bog has been under development for the last thirty years however, a number of factors have hindered the successful establishment of crops. The afforestation of industrial cutaway peatlands is now under active research through the BOGFOR programme, which is co-ordinated by the Forest Ecosystem Research Group, U.C.D. The research programme is funded by COFORD, Coillte and Bord na Móna and is now in the fourth year of a fifteen-year programme. The aim of the research programme is to develop commercially viable techniques for afforestation of cutaway bog and to overcome difficulties with growing trees that have arisen in the past (Jones & Farrell 2000).

Technical parameters

The cutaway bog must be drained by gravity drainage. Peat depth must be more than 0.5m and less than 2.5m. In general, an acidic cutaway bog surface is required with minimal influence from the underlying soil.

Development works

Research to date indicates that the growing medium into which the trees are sown must be aerated and therefore, some disturbance of the residual peat prior to planting is necessary.

Installation of the appropriate drainage infrastructure prior to planting is a major factor and this in turn is related to site-specific characteristics.

Supporting infrastructure

The available infrastructure (peat production infrastructure) is usually adequate to establish the forest but at thinning stage (year 20) it will be necessary to create a road network to facilitate extraction of timber from the site.

Indicative costs

Currently costs of development, planting and after-care are approximately €2,800/ha.

Nutrient requirements

As with grassland, the peats require the addition of phosphorus and potassium for commercial tree growth. A major part of the BOGFOR project is to research (a) the timing of fertilisation; (b) the potential nutrient run-off and (c) mitigation measures such as the creation of wetlands to intercept drainage waters etc. The present recommendations are to apply 350 kg P/ha as ground rock phosphate and 250kg K/ha as muriate of potash in a split application (two applications - year 1 and year 3 or year 4).

Tree species

Species selection is a key task of the BOGFOR project and the recommended planting species (January 2002) are as follows:

Conifers: Norway Spruce, Hybrid Larch

Hardwoods: Oak, Birch, Alder

Timeframe

Preparation of the site takes place in the summer of initial year of development, while tree planting can commence in the following planting season.

Influencing issues

Currently grant aid is not available for the afforestation of non-agricultural land and this policy is under active negotiation with the Forest Service. Another influencing issue will be the outcome of the BOGFOR research programme.

2.3.3 Wetlands

The establishment of wetland systems has been well documented for midlands raised bogs, with extensive alkaline fen systems establishing on shallow minerotrophic peats (Egan 1995, 1998a, b; Feehan & Kaye 1998; Kavanagh 1996, 1998; O'Connor 2000; O'Connor & Reynolds 2000; Rowlands 2001; Rowlands & Feehan 2000 a, b; Trodd & Murray 2000). The success of this after-use option can be readily viewed at the Turraun wetland site, which has established over the last twelve years and forms part of the Boora Parklands. An alternative research programme has been ongoing in the west of Ireland to study the establishment of wetland communities on industrial cutaway Atlantic blanket bog (Farrell 2001; Farrell & Doyle 1998, 2002). Rewetting of the cutaway Atlantic blanket bog has proven successful in establishment of poor fen communities and also embryonic peat-forming communities, which are characterised by typical peatland species with an active layer of *Sphagnum* (peatmosses). The wetland option is considered a stable and sustainable after-use that could play a significant role in enhancing the national wildlife habitat area and biodiversity resource. There is minimal requirement for maintenance, reaching a stable equilibrium as natural succession occurs.

Technical parameters

The designated site must be capable of being permanently inundated with water for twelve months of the year.

Development work

In order to maintain a wetland system, the peat drainage infrastructure must be reversed. This usually involves the removal of pipes and blocking of field drains to impede the movement of water and create inundated areas. Other work required includes the creation

and stabilisation of peat embankments, where appropriate. These developments apply to both minerotrophic and ombrotrophic cutaway bog areas. All development work for wetland creation is site-specific and will have to take underlying contours and variability of peat depth into consideration.

Supporting infrastructure - not necessary

Indicative cost

The cost of reversing drainage of production areas (blocking field drains, pipes, etc.) currently runs at €320/ha.

Nutrient requirement - not relevant

Timeframe

Development work must be carried out during dry summer months. Inundation of the cutaway bog generally begins at the onset of wet months. Colonisation by aquatic plants usually begins as soon as the area is flooded, passing through a pioneer colonisation stage that is followed by successional development stages that comprise alkaline fen communities where there is minerotrophic influence and poor fen and/or embryonic peat-forming communities in ombrotrophic conditions. Revegetation commences within the first year of rewetting and generally within three to five years a continuous vegetation cover is established.

Influencing issues

The principal issue that would affect the creation of alkaline fen is the degree of removal of the peat. Peat extraction should generally proceed to the degree to which the residual peat is inundated with alkaline ground waters, which in turn would support typical alkaline fen species. Where ombrotrophic peat remains the most important factor is to maintain waterlogged conditions (either maintaining the water-table at the peat surface and/or permanent inundation).

2.3.4 Other options

A number of other after-use options have been proposed for industrial cutaway bog, but these have not been studied at the same level as the grassland, forestry and wetland options. These alternative after-uses are generally considered *niche opportunities* and are either at early developmental stages or at the initial proposal stage. One example of this niche opportunity is the established wind-farm at Bellacorick. This wind-farm was established on an area that was comprised largely of cutaway bog and isolated from large settlement areas, in a location where the wind regime proved economical for electricity generation. The viability of any wind-farm depends on the wind regime and this varies with altitude and proximity to coastal areas. Other options include the establishment of general amenity and/or angling lakes and industrial development sites. It is likely that other potential after-uses will come to light, particularly where consultation with other interested parties is ongoing. These after-uses may be subject to planning permission and/or Environmental Impact Assessment depending on statutory requirements.

3. CUTAWAY BOG REHABILITATION PLANS

At this point a general overview of Bord na Móna policy towards industrial cutaway bog has been outlined, as well as a description of the factors influencing the range of after-uses that have been proposed to date and a description of the main features of each after-use option. There are however, more practical aspects to consider such as when does rehabilitation commence and how will rehabilitation plans be developed. In an attempt to deal with these issues the triggers for development of a rehabilitation plan and its implementation are outlined below.

3.1 Triggers for Development and Implementation of a Rehabilitation Plan

A series of stages and/or triggers (*1* to *6*) can be identified in the development and implementation of cutaway bog rehabilitation plans. Following from stage *1* below, each subsequent stage deals with individual Bord na Móna Works, e.g. *Blackwater Works*, *Oweninny Works*, etc. The stages and/or triggers are outlined as follows:

- 1. January 2002:** A broad-based plan is developed for all Bord na Móna holdings (see Table 1 and this document). Each Bord na Móna Works continues to report on progress of cutaway rehabilitation and potential future work as part of the Annual Environmental Report.
2. Isolated areas of cutaway bog become available but are dispersed within larger production areas. Even though extensive peat extraction is ongoing, at this stage a general impression of what conditions will remain on cessation of peat extraction can be attained and possible after-uses identified (preliminary outline of after-uses noted).
3. The final peat drainage infrastructure is installed and an executive decision is taken on the level of peat extraction that will proceed within the bog unit, i.e. what further depth of peat will be extracted, what acreage of bog will be required to meet market demands, etc. Generally at this stage the operations in the bog would be winding down and/or a realistic time-plan established for closure of the bog unit. At this stage a rehabilitation plan should be developed for the cutaway bog, ideally incorporating time frames, cost estimates and realistic objectives. Consultation with interested parties will be conducted.
4. Hydrologically isolatable units of bog are available. Rehabilitation can commence within discrete areas of cutaway bog, e.g. the Boora Parklands complex.

5. The entire bog out of peat production. Only at this point can the complete rehabilitation plan be implemented, as well as decommissioning procedures for workshops and workstations.

These stages and triggers will occur within the next thirty years for all bog units in Bord na Móna ownership. Within this framework, the most appropriate after-use must be established on the basis of research and trials conducted and the conditions required for each potential after-use, while taking all primary and secondary factors into consideration.

3.2 Development of a Rehabilitation Plan

An important aspect of each rehabilitation plan will be the completion of a baseline study of the cutaway bog in each bog unit. A number of aspects will be covered within this study, including: peat depth and type remaining, a bottom contour map, surface drainage patterns, a vegetation map and details of site-specific biological and/or physical parameters that will yield information for the development of a site-specific rehabilitation plan. Following that, a desk study will be required to look at aspects such as cost, accessibility, etc. and relevant organisations will have to be consulted.

Development of a cutaway bog rehabilitation plan therefore involves a number of aspects:

- Triggers for development of the rehabilitation plan as outlined here, will be followed
- A baseline study of the cutaway bog will be carried out at an early stage to evaluate the conditions (primary factors) and outline potential after-uses
- Potential after-uses will be considered in the light of secondary factors (the best option for after-use will be determined, *See 3.3*)
- Consultation with other organisations will be conducted, i.e. Dúchas, etc.
- A rehabilitation plan will be produced based on the best-option after-use(s)
- The rehabilitation plan(s) will be implemented on cessation of peat production *

*In general, rehabilitation of Bord na Móna peat production areas will be implemented as conditions on site allow and that is typically when peat production ceases completely in an isolatable unit of bog. However, where there is scope for rehabilitation work to be carried out, as much work, as possible will be carried out before the complete shutdown of operations in any one area. This is however, not generally possible for the reasons outlined already. Bord na Móna are however, committed to rehabilitation and will complete rehabilitation within a minimal period of time following cessation of operations. Rehabilitation will also require a number of years with subsequent monitoring of each site to ensure the work is implemented (the degree of monitoring required will depend on the chosen after-use).

3.3 Determining the ‘Best Option’ After-use

A simple model illustrates the thought pathways that will be followed in selection of potential after-uses (Fig.2). The model can be used only after an on-site baseline study has been conducted to yield information on peat depth and type, drainage, etc. While the baseline study will provide information on physical and biological parameters, other factors will have to be studied by looking at the area as a whole (accessibility, adjacent land-use) and consultation with relevant parties (local groups, Dúchas, etc.)

The model begins with an area of cutaway bog that is isolated from adjacent production bog. Before anything can be established a baseline study, as outlined previously, will be conducted. This will identify the baseline conditions, such as is there peat remaining, how deep is the peat and what kind of peat is it, is the topography relatively uniform or undulating. Following on from that drainage is considered i.e. is the area easily drained or poorly drained. Once these primary issues have been established, secondary factors come into play, such as is the area accessible for construction of a road network, etc.

All of these questions, and several others, will be addressed in identifying the most appropriate after-use for any area of cutaway bog. The model outlined in Fig. 2 shows the main after-uses and incorporates drainage, peat depth and peat type (*See Table 2*). Other factors, such as accessibility are difficult to incorporate into such a model, as relativity will have to be considered in each case. It should be noted as outlined already that secondary factors may be an over-riding influence in the selection of an after-use and are termed secondary here to distinguish from natural restrictions. For example, in a situation where deep ombrotrophic peat is remaining and the area is well drained, there may be a potential for afforestation. Market demand however, may be low or the area may be considered inaccessible. Other options would have to be considered at this point.

The model is simple, yet effective and will be modified as further work is carried out and a greater understanding of cutaway bog areas is attained.

Fig. 2

4. GENERAL CONCLUSIONS

Based on the work carried out to date and taking into consideration the main factors affecting the after-use of cutaway bog areas, a number of general comments can be highlighted:

- No two cutaway bog areas can be assumed to be the same
- Following that, each cutaway bog has its own characteristic features and will require a specific on-site physical and biological description before any rehabilitation plan can be produced.
- It is not possible to predict the conditions that will remain after peat production ceases completely in any bog, however, based on a knowledge of cutaway conditions to date, it can be assumed that one or more of the conditions already described to date will be present.
- It is also not possible to say for definite when peat production will cease in any bog, as this is related to the continued existence of the peat-fired electricity stations and the demand for horticultural peat.
- It is possible to gather all the data amassed to date and build a general picture of possible after-uses and the factors that will affect selection of the after-use(s), which is the purpose of this document.
- A number of after-uses may be appropriate within one area of cutaway bog, highlighted the requirement for an integrated use plan that will involve a broad range of interest, such as Dúchas and local farmers. The Boora Parklands is the best example of this scenario.
- Following that, any general overview must guarantee that rehabilitation and decommissioning of cutaway bog will be conducted in such a way that: (a) the after-use is implemented; (b) the areas will be self-maintaining and/or maintained; (c) an economic output will be generated where the after-use is considered a commercial venture; (d) the national wildlife resource enhanced where renaturation is the objective, as well as (e) contributing to community development and the general good of the national economy.

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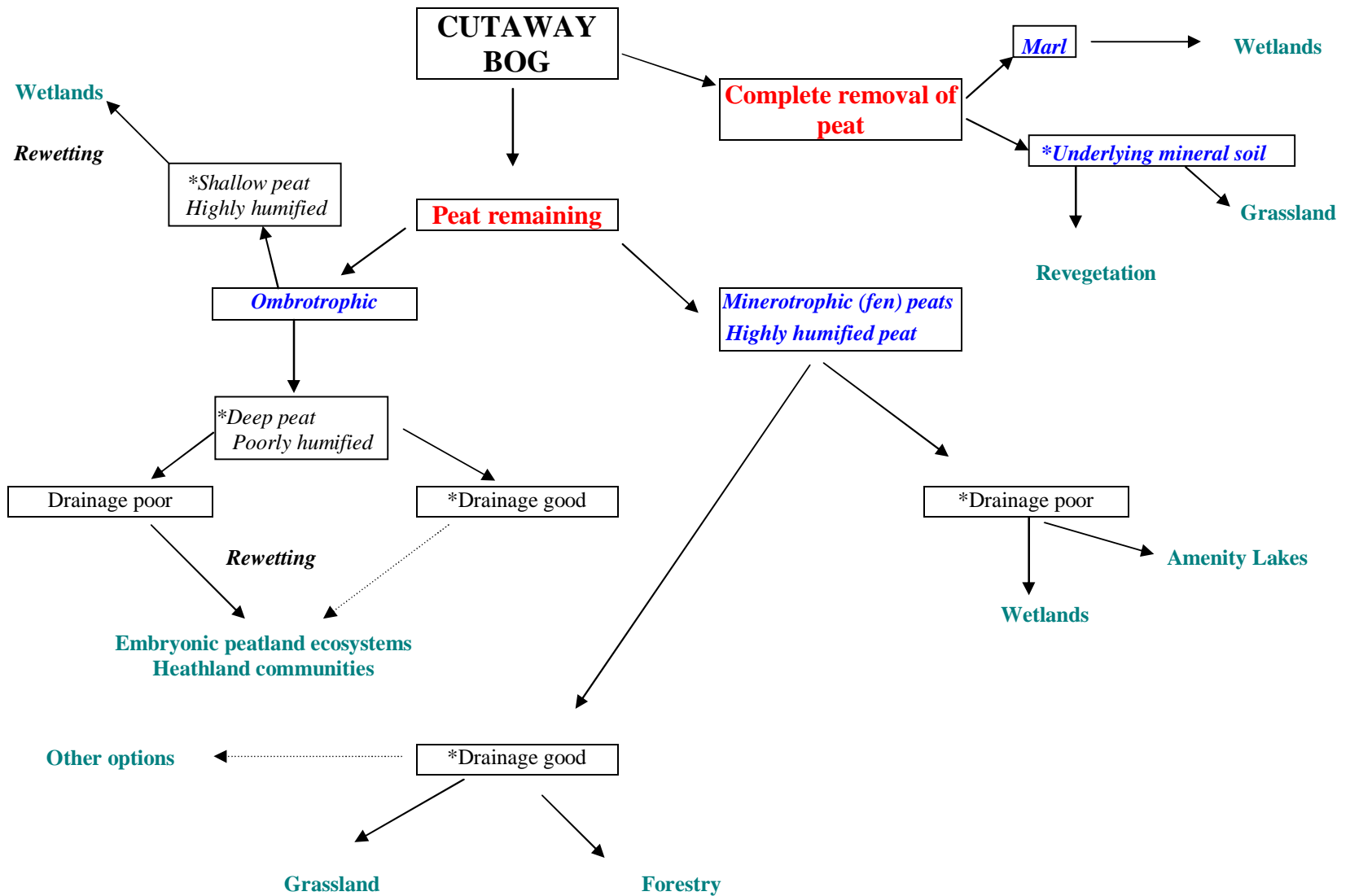


Fig. 2. A Schematic model outlining the potential after-uses for industrial cutaway bog in Ireland. The potential after-uses are highlighted in green and the arrows indicate the direction of questioning. Primary factors are incorporated while secondary factors should be considered where an asterisk is shown.

