BORD NA MÓNA - EDERA BOG

Drainage Management Plan

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EXECUTIVE SUMMARY

The Edera Bog sits on the eastern shore of Lough Ree, and is bisected by the Bilberry River which flows into the lough. There is an area in the centre of the bog that is subject to fluvial flood risk from Lough Ree/ the Bilberry River.

The catchments drain through the bog have been delineated. These catchments are a mixture of bog, pastures and transitional cutover / woodland areas. The catchments have relatively poorly draining soils underlain by permeable bedrock layers. The area is drained by a gravity drainage system, much of it maintained by Bord na Móna without the need for pumping.

The rehabilitation measures are generally aimed at restoring a more natural drainage regime in the existing peat fields through a mixture of techniques including drain blocking, cell bunding, re-profiling, berm construction and wetland creation. It is assumed that these measures will not significantly alter the existing topographical catchments and that the spine of the drainage networks, those which the upstream catchments drain through, will be retained by Bord na Móna.

Three potential impacts were considered: the potential to reduce the drainage function to upstream lands, the potential for increased flows downstream and the potential for increased groundwater levels impacting adjacent lands. There is no potential for increased flows downstream and the rehabilitation of Edera Bog, based on evidence from other sites, will reduce the runoff from the bog. The avoidance of reduced drainage function to upstream lands depends on Bord na Móna actively retaining the drainage routes which enter the bog.

The potential for increased groundwater levels and to a lesser extent marginal alteration of the topographical catchments has been assessed based on a precautionary approach. With gravity drainage routes retained it is assumed that groundwater levels will reach the surface of the re-profiled peat fields. Standing water may occur in wetland areas which form depressions within the bog landscape. In both scenarios adjacent lands which are at a lower level than the bog could potentially be impacted and the vulnerable area has been defined through a zone of influence approach.

Each of the land parcels have been assessed based on their vulnerability to increased groundwater levels within the bog. In most cases there exists a boundary drain separating the rehabilitation area from the potentially vulnerable lands. Best evidence has shown that these drains provide a positive gravity drainage function and through retaining them they will prevent any groundwater impacts on adjacent lands due to the hydrogeological break / cut-off they provide.

There are some limitations with this approach namely the effect of backwater levels and the lack of detailed survey of the boundary and external drainage network. Given the low level of risk at Edera Bog it is appropriate in most cases that the DMP measures involve survey, monitoring and retention of the boundary drainage network. A suite of measures is identified in order to mitigate any deterioration in the drainage to adjacent lands should monitoring of these lands indicate a groundwater or drainage impact on these lands.

1 INTRODUCTION

Edera Bog is part of the Mount Dillon Bog Group. Bord na Móna operated peat extraction within the Mount Dillon Bog Group under IPC Licence (Ref. P0504-01) issued and administered by the EPA. Condition 10.2 of this licence requires the preparation of a Rehabilitation Plan for permanent rehabilitation of the boglands within the licensed area.

It is proposed by Government that Bord na Móna carry out enhanced decommissioning, rehabilitation and restoration under the Peatlands Climate Action Scheme on peatlands previously used for energy production. This proposed Scheme will significantly go beyond what is required to meet rehabilitation and decommissioning obligations under existing EPA IPC licence conditions. Improvements supported by the Scheme will ensure that environmental stabilisation is achieved and significant additional benefits, particularly relating to climate action and other ecosystem services, will also be delivered.

A key issue for Bord na Móna is the potential hydrological impact rehabilitation of this bog may have on the bog, surrounding lands and lands downstream which may be hydrologically linked to the bog. Rehabilitation measures generally seek to increase groundwater levels and surface water retention such that they are closer to the surface to encourage peat formation, the associated ecological benefits and carbon sequestration capacity. While in general terms this will reduce the volume of water released from the bog following a rainfall event, the impact on flood run-off is not well understood. Furthermore the increase in the local water table could result in negative impacts to surrounding lands if mitigation measures are not applied (e.g. to agriculture).

This Drainage Management Plan (DMP) for Edera Bog seeks to establish the baseline hydrological performance of the bog and the surrounding drainage network. The plan sets out the characterisation of the bog and surrounding lands, the existing performance of the drainage network and the level of flood risk. The plan identifies the potential hydrological zone of influence of the bog and the objectives, risks and opportunities associated with the rehabilitation of the bog. The plan assesses the potential impact of the various rehabilitation measures which are proposed on the local drainage network and flood risk. It sets out, where necessary, mitigation measures required to reduce impacts to an acceptable level. The plan sets out the measures which are required to be delivered in advance or in parallel with the rehabilitation plan as well as the long term operation and retention of the drainage network and associated infrastructure. The plan assesses the level of residual risk, the potential impact due to climate change and the adaptability of measures in response to these climate change impacts.

1.1 Bog Details

Edera Bog is located approximately 4.5km to the west of Ballymahon in Co. Longford on the shore of Lough Ree. The surrounding landscape is a mosaic primarily consist of low-lying agricultural land (pasture) interspersed with other raised bogs, many of which have also been managed by Bord na Móna for peat production with some areas utilised for domestic turf-cutting. Lough Ree is immediately adjacent to the south-west corner of the site and the Bilberry River flows through the site. A relatively large section of wet grassland along with a remnant section of raised bog still exist on the site.

A rail line connects Edera bog with Derrycolumb Bog to the north, and this is the main access to the site, with a small tea centre and machinery travel path at this entrance to the bog. A machinery bridge and separate rail bridge are present in the centre of the site to cross the Bilberry River.

Edera Bog has only been in peat production since 2003, with all commercial peat extraction ceasing on site in 2018. The peat was harvested from this site was used for fuel peat Lough Ree Power in Lanesborough.

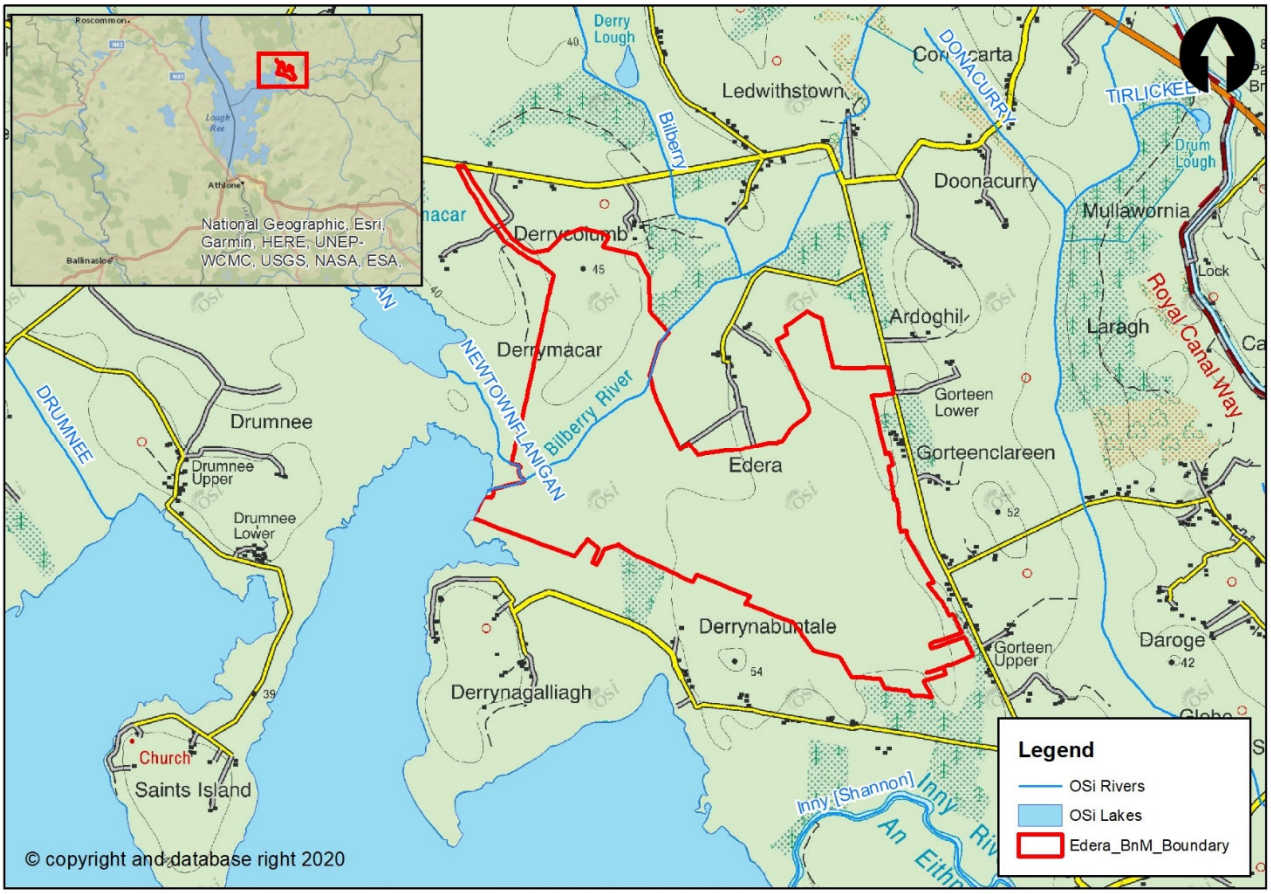

Figure 1.1 Location of Edera Bog

2 BASELINE ASSESSMENT

Through cessation of peat extraction, since 2018, and implementation of the Edera Bog rehabilitation plan there is the potential to impact the adjacent land. The extent of the impact will depend on the existing baseline characteristics of the catchments which drain the bog and the adjacent lands.

The purpose of characterising the catchment area is to develop an understanding of how the catchment currently operates and drains. The characterisation also investigates the risks, constraints and opportunities to the operation and drainage.

2.1 Study Area

To characterise the catchments a study area was determined encompassing the total catchment area draining the bog and adjacent lands through the bog. The drainage under the influence of Edera Bog discharges into the Bilberry and Inny Rivers at various locations. In addition to these discharge points there is one inflow location directly into Lough Ree. A review was carried out to delineate the external drains around the bog as presented in Figure 2.1 along with their associated hydrological catchment area.

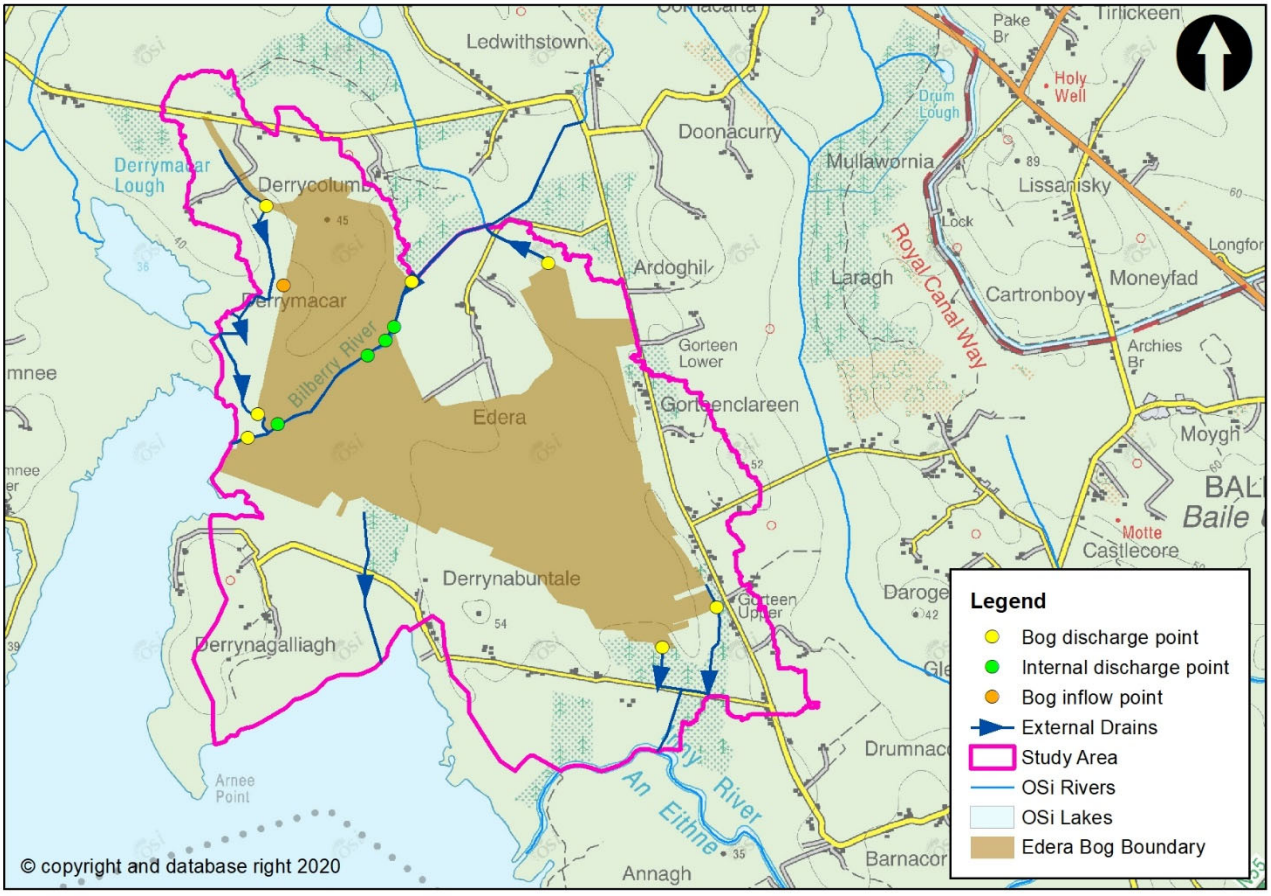

Figure 2.1 Study Area for Edera Bog

2.2 Catchment Runoff Characterisation

A hydrological analysis was carried out within the study area to delineate the sub catchments of the bog drains and the external drains. The recent Bord na Móna drainage survey was reviewed and the bog sub-catchments confirmed. Sub-catchments of the external drains were identified using ARC GIS tools. The sub catchments are presented in Figure 2.2.

Surface runoff drains to the receiving watercourses at the catchment outfall points indicated in Figure 2.2, however in times of high rain or flooding surface water is known to spill out of the bog in the location shown on the figure. This spill water is collected by a drain that borders the bog and adjacent land and conveyed to the Bilberry River.

The FSU catchment characteristics provide an overview of how much rain a catchment receives, how impermeable the catchment is and how quickly the water will runoff the catchment due to topography and drainage. Table 2.1 summarises the FSU catchment descriptors for the sub-catchments identified in Figure 2.2.

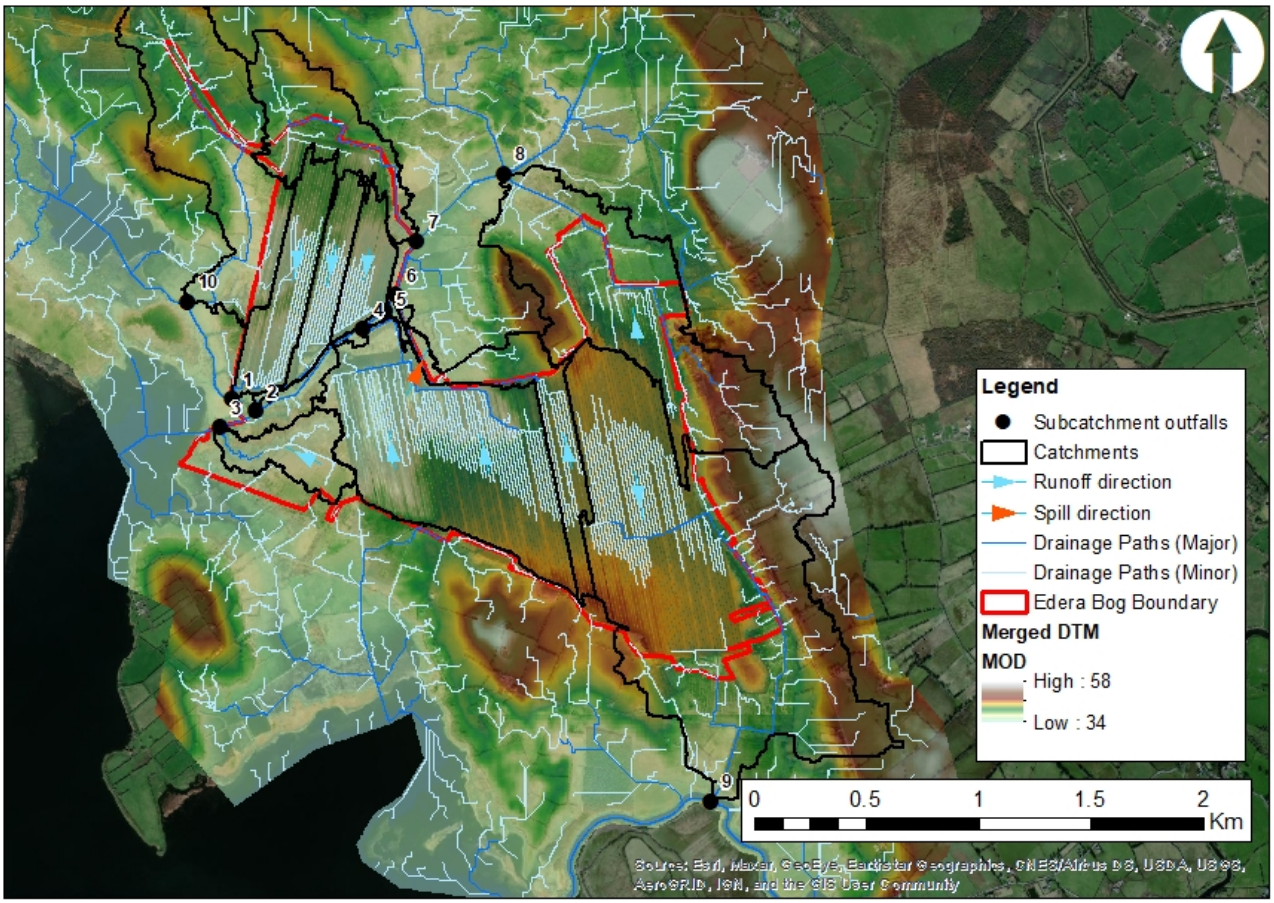

Figure 2.2 Drainage Networks and Sub-Catchments Draining Edera Bog

There are ten sub-catchments draining Edera Bog and adjacent lands ranging in area from 0.132 km^2 to 1.54 km^2. The catchments are all subject to moderate / low amounts of annual average rainfall. The Baseflow Index

for all of the catchments ranges from 0.36 to 0.54 representing a range from fairly impermeable to moderately permeable. The catchments range from very flat to moderately flat.

The Index Flood Flow (Q_{med}) values, which represent the typical peak flood flow which might be anticipated (a 50% chance of being exceeded in any given year), for each of the sub-catchments have been calculated. This is based on two different methods, the Flood Studies Update (FSU) 5 variable equation designed for small and / or urbanised catchments in Ireland, and the RPS derived Peat Q_{med} equation, derived in support of the Drainage Management Plan project for SAC sites on behalf of NPWS. Both methods result in very similar Q_{med} values where the proportion of arterial drainage (ARTDRAIN2) is assumed to match the proportion of the catchment managed by Bord na Móna (drained).

Table 2.1 Physical Catchment Descriptors of Sub-Catchments Draining the Bog

Sub-Catchment Number	Area (km^2)	SAAR (mm)	BFI	FARL	ARTDRAIN2	PEAT (%)	S1085 (m/km)	FSU5 Q_{MED} (m^3/s)	Peat Q_{MED} (m^3/s)
1	0.132	900.8	0.531	1	1	100.0	2.31	0.040	**0.050**
2	0.218	900.9	0.531	1	1	99.7	4.02	0.073	**0.078**
3	0.286	901.1	0.532	1	0.65	65.2	1.52	0.073	**0.087**
4	1.542	900.3	0.537	1	0.74	73.5	1.98	0.366	**0.391**
5	0.566	888.5	0.458	1	0.67	67.2	2.47	0.174	**0.179**
6	0.727	900.3	0.531	1	1	100.0	3.87	0.219	**0.224**
7	0.201	888.5	0.458	1	1	100.0	2.89	0.070	**0.081**
8	0.128	900.8	0.531	1	1	100.0	2.09	0.038	**0.049**
9	0.108	900.9	0.531	1	1	100.0	3.5	0.037	**0.042**
10	0.730	900.3	0.357	1	0.72	71.7	5.68	**0.346**	0.299

2.3 Hydrogeological and Soil Characterisation

Edera Bog and the catchments under the influence of the bog are primarily underlain by dark limestone and shale bedrock of the Luccan formation with some areas to the north underlain by Visean limestones and areas to the east underlain by Waulsortian limestones. For the most part these bedrocks represent a locally important aquifer which is moderately productive in places with limited areas to the north representing a more productive, regionally important, karstified aquifer. Geological Survey of Ireland (GSI) tracing of karst features has not identified any significant features such as springs, swallow holes or turloughs in close proximity to the bog. The bedrock underlying Edera has potential to facilitate moderate rates of baseflow / groundwater transfer rising to higher rates in localised pockets. The soils covering the catchments are primarily peat, with some peaty and groundwater gleys outside the extent of the bog but within the catchments. These soils would be considered to be generally impermeable however in areas of the bog the peat has been cut to very low depths exposing the underlying marl substrate and potentially offering a route for transfer between groundwater flows and surface flows. A small area to the south of sub-catchment 10 is underlain by alluvium in the floodplain of the River Inny which would be considered to be highly permeable.

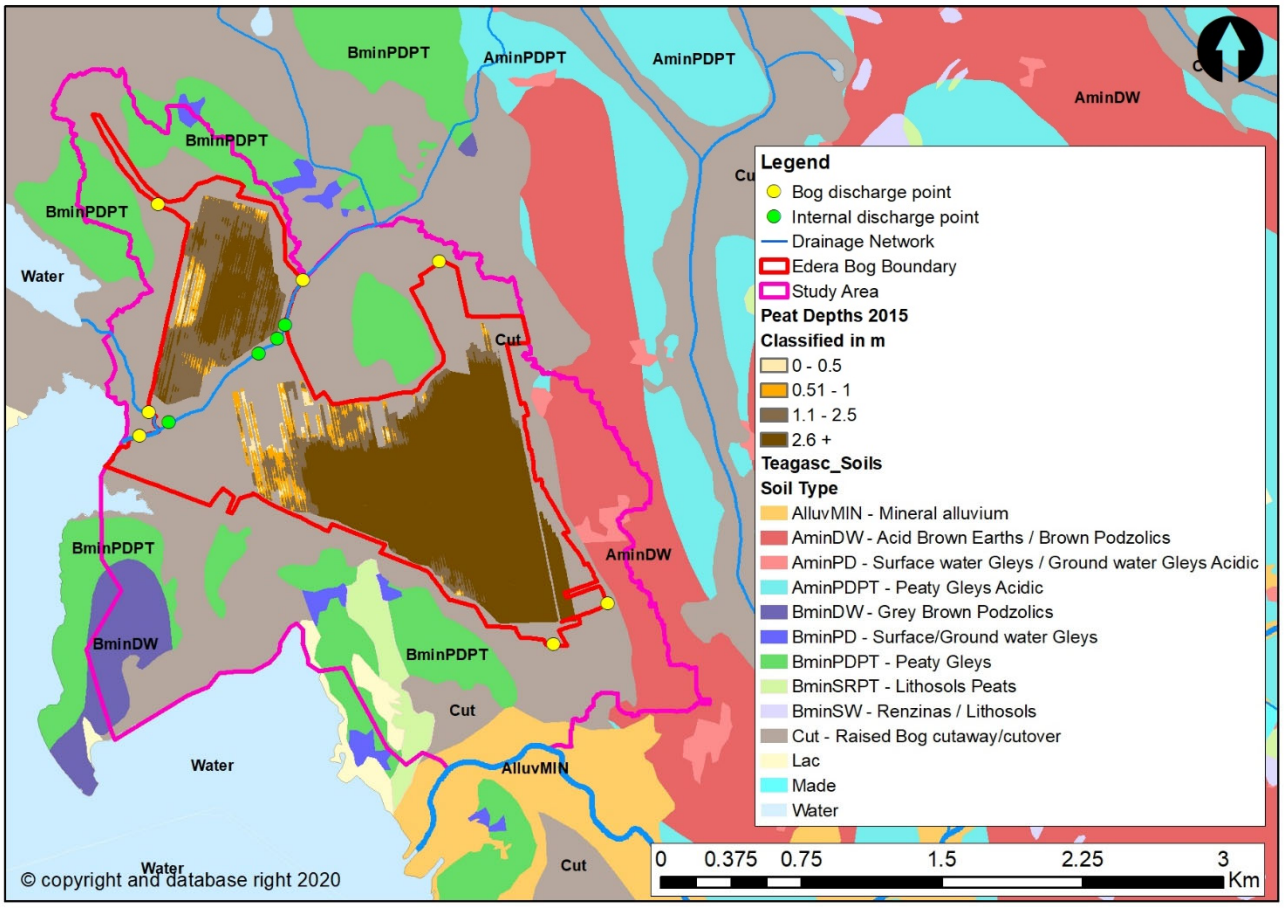

Figure 2.3 Hydrogeological and Soil Characteristics of Edera Bog

2.4 Morphological and Hydraulic Characterisation

A desk top review was carried out of bog drains and external drains. Morphological and hydraulic features were identified.

The external drains are generally small with gentle bed slopes and the Bilberry River has a very flat channel bed. Aerial photography shows no signs of erosion or deposition however given that the drains have gentle bed slopes there would be a risk of deposition, and therefore reduced land drainage efficiency. Risk of deposition would occur where there is potential for an erosion or debris source from the surrounding land and where there is potential head loss in the channel due to instream features. Figure 2.4 details the reaches of the external drains where there are potential erosion or debris sources and where instream features may facilitate deposition. The figure shows that due to the location of commercial forests, woodlands and disturbed peat in the adjacent lands there are existing potential sediment sources that could enter the external drains. Given the presence of culverts, sharp bends and inflows along the external drains there would be a potential of sediment deposition occurring. The potential for Edera bog being a sediment source to the external drains is considered low due to the presence of silt ponds and that peat extraction activities have ceased.

A review of the bog drains was carried out. The Bord na Móna drainage survey details the open drains, pipes, silt ponds and discharge points. The drains in the bog have gentle bed slopes and progress from field drains to a collector pipe network to open drain before discharging from the bog. Three discharge points draining minor catchments of the bog require silt control measures as part of the rehabilitation activities before discharging to the Bilberry River.

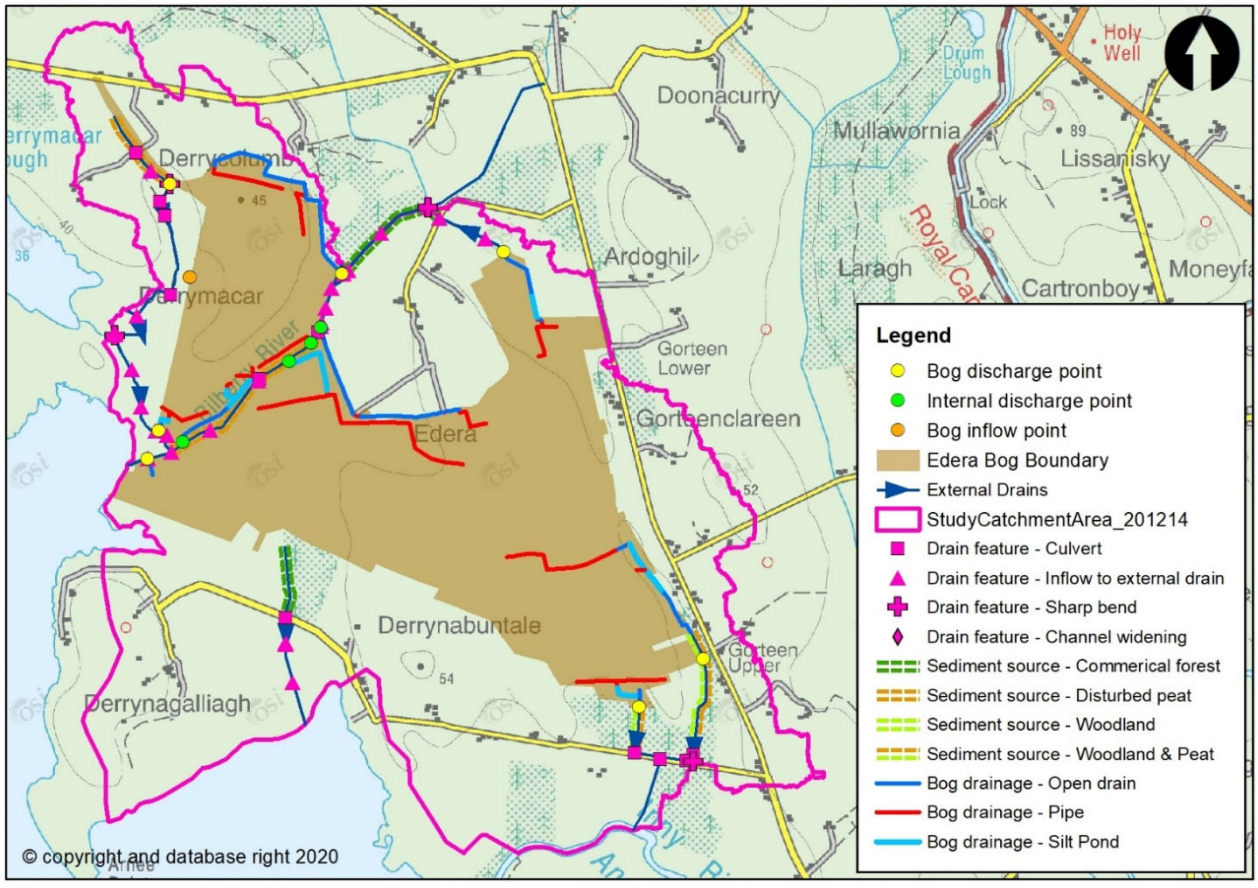

Figure 2.4 Morphological and Hydraulic Characteristics of Edera Bog and environs

2.5 Land Use Character

The majority of the land within the study area is peat bog and pasture. The remaining areas of the study area consist of less productive agricultural land, natural vegetation, woodland and commercial forest. The CORINE land use dataset was used to identify landuse types. This dataset was then reviewed using aerial photography to establish landuse amendments or land use alterations. The review found that additional commercial forests and woodland areas are located in the study areas. There are properties and some minor roads located in the study area also.

The pasture land is mainly used for livestock which provides food production. The commercial forests provide for timber production. Areas of undisturbed peat bog contribute to carbon storage and biodiversity. The woodland areas are likewise providing carbon storage and biodiversity albeit as a different habitat to the peat bogs. The minor roads within the study areas service individual properties and provide access to the pastures, forests and peat bogs.

Lough Ree is designated an SAC with qualifying interests including Otter, eutrophic lakes. Semi dry grasslands and scrubland, degraded raised bog, alkaline fens, limestone pavements, oak woods and bog woodland. Lough Ree is also designated an SPA with the objective to maintain and restore favourable conditions for bird species listed as Special Conservation Interest.

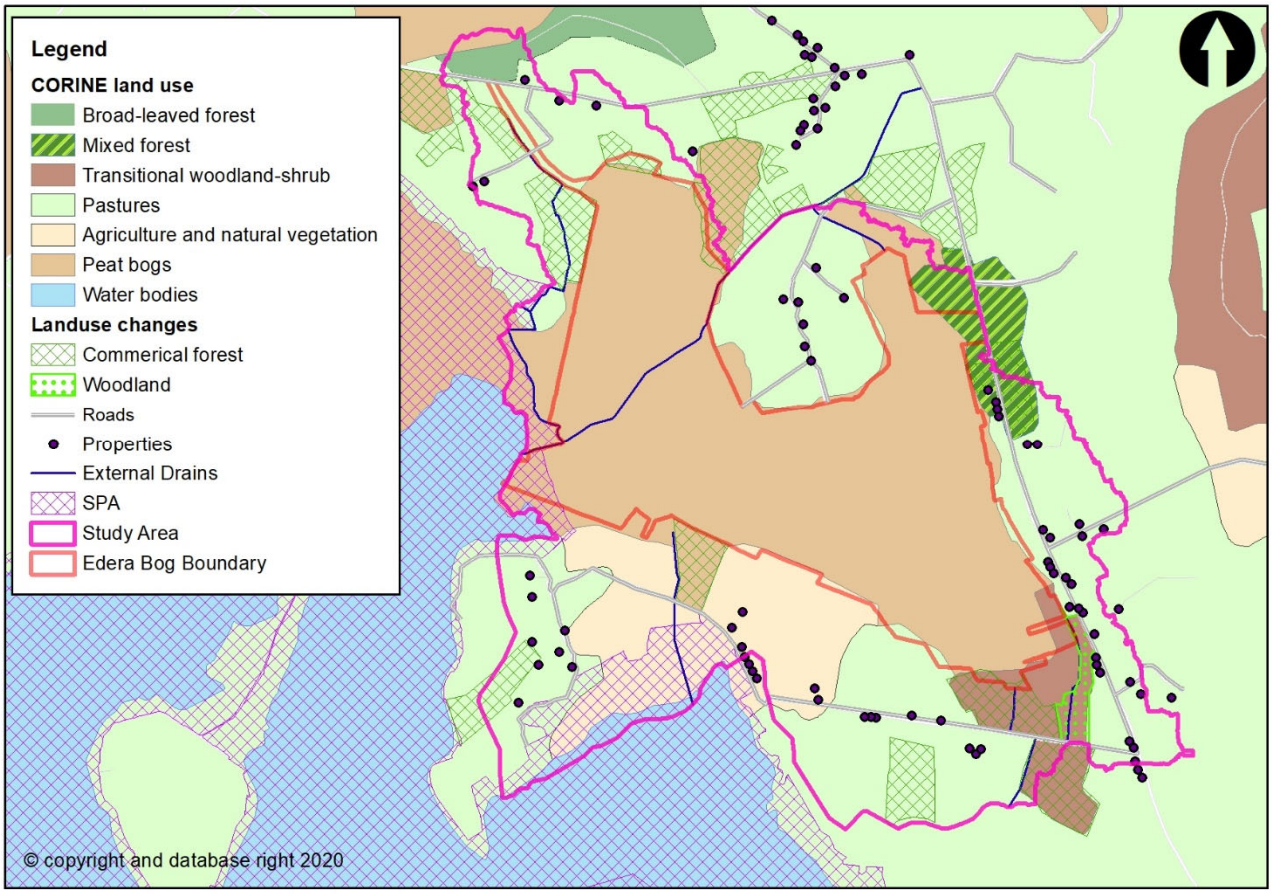

Figure 2.5 Land Use Characteristics of Edera Bog and environs

2.6 Flood Risk

A number of sources of flood risk information are available, both predicted and simulated, in proximity to Edera Bog. These include:

- CFRAM Study maps setting out the predicted fluvial 10%, 1% and 0.1% Annual Exceedence Probability (AEP) fluvial flood scenarios for the River Suck
- Mapped fluvial flood extents for the 2009 flood event
- Mapped flood extents for the 2015 flood event (from Sentinel-1 satellite imagery) and a GSI surface water flooding dataset for the same event
- Anecdotal evidence from Bord na Móna

GSI predicted groundwater flood maps were also available however no flood extents were identified in the study area.

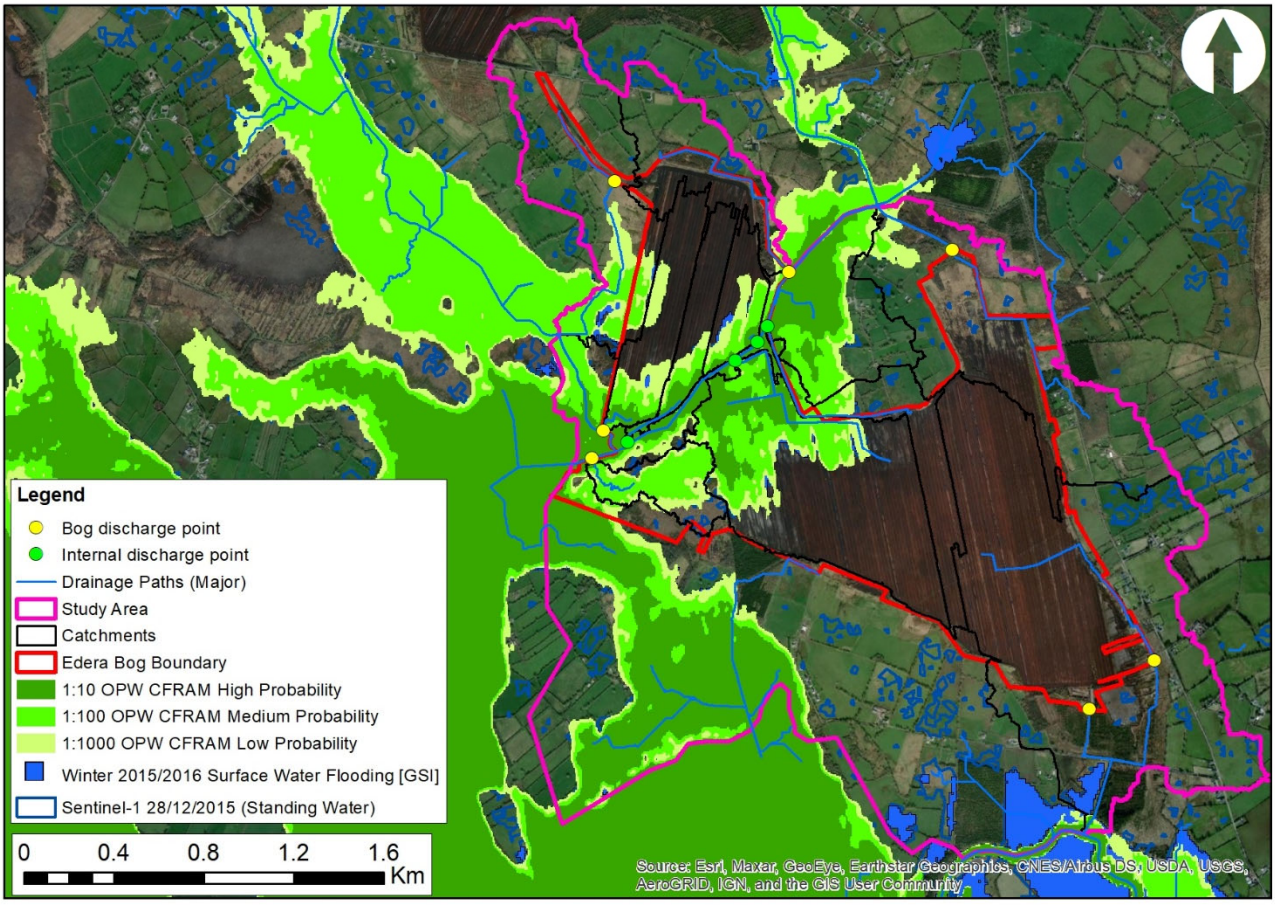

Figure 2.6 Flood Risk at Edera Bog

The 2009 and 2015 events are estimated to have had a flood return period of around a 1 in 100 year flood return period which matches well with the predicted flood extents from the CFRAM Study.

There is no predicted groundwater flooding to the bog indicated on the GSI datasets.

Observed and predicted flood extents both identify large proportions of Edera bog and the adjacent lands as being a flood risk from Lough Ree, the Bilberry River and Newtownflanigan River. This is known to occur on

a yearly basis within the bog and a high frequency of flooding is also estimated in the adjacent lands. During flood events the drainage network from within the bog is expected to be impeded resulting in wetter conditions and raised ground water level. Surface water is known to spill out of the bog at one location as detailed in Section 2.2. The drainage network in the adjacent lands is also expected to be impeded resulting in wetter conditions and raised ground water level.

2.7 Summary

The drainage network sub-catchments within Edera Bog and its environs were used to delineate the study area for the Edera Drainage Management Plan. The overall catchment area was characterised within the context of hydrology, hydrogeology, morphology, landuse and flood risk.

A detailed drainage network delineation was carried out. Drains within the bog and external drains were identified. The drainage under the influence of Edera Bog discharges into the Bilberry and Inny Rivers at various locations. In addition to these discharge points there is one inflow location directly into Lough Ree.

The sub-catchments draining the bog are considered to be relatively small, flat, fairly impermeable to moderately permeable in places and with a low to moderate annual rainfall. Peak flood flows range from around 0.25 – 0.5 m^3/s per square kilometre (2.5 – 5 l/s per hectare) for the Q_{med} event to 0.7 – 1.3 m^3/s per square kilometre (7 – 13 l/s per hectare) for the Q_{100} year plus climate change event.

The bedrock within the catchment is limestone and shale which is productive only in pockets. No karst features were identified in GSI records which could influence groundwater movement and flooding however the cutting of peat to low depths in places may make these areas of the bog susceptible to groundwater flooding. The soil on top of the bed rock is mainly peat with some other soils in the higher ground.

The morphological and hydraulic characteristics of the external drains were assessed. No signs of erosion of deposition could be observed. Areas of deposition risk were identified along each drain. Culverts, bends, inflows, were identified as potential factors for sediment deposition. Woodlands and bare peat adjacent to the drains were identified as potential sources of sediment. Given that the drains are relatively flat the risk of deposition in the external drains is considered high.

The land use was assessed within the study area. The majority of land is peat bog, some of which has been drained for agricultural purposes. Pasture land makes up a significant proportion of the study area also. The remaining land is made up of less productive agricultural land with natural vegetation, woodland and commercial forest. The land provides important services such as food production, timber production, carbon storage, biodiversity and habitat creation.

Table 2.2 summarises the constraints, risks and opportunities identified as part of the baseline assessment.

Table 2.2 Potential Opportunities / Constraints

Land Parcel / Feature	Risk or Opportunity?	Details
Agricultural land	Constraint	It is important to maintain the productivity of agricultural land surrounding the bog
Roads	Constraint	A minor road is located in the study area providing access to dwellings, agricultural land and peat bogs. Access to these roads should be maintained.
Lough Ree	Constraint	Lough Ree is located close to Edera Bog. No activity should adversely impact this water body.
External drains	Risk	Risk of deposition in the drains is considered high due to potential sediment sources in adjacent lands and features within the external drains. External drains may be sensitive to change.
Bog and adjacent land	Risk	Parts of Edera bog and adjacent lands are subject to flooding on an annual basis. The drainage network would likely be affected during times of flooding.
Adjacent lands and Lough Ree	Risk	The known spill point allows surface water to leave the bog over the headland. This is intercepted by a boundary drain but bypasses the existing silt pond. There is a risk of excessive amounts of peat entering Lough Ree and there is a risk that should the boundary drain silt up that it will not intercept the spill water and the adjacent land may flood.
Bog rehabilitation plan	Opportunity	To improve water quality discharging from the bog; stabilisation or improvement in water quality parameters (e.g. suspended solids)
Bog rehabilitation plan	Opportunity	To add to carbon sequestration services in the catchment through bog regeneration. To reduce carbon emissions from the bog and to set bog on a trajectory towards naturally functioning peatlands habitats. Edera has potential to develop embryonic Sphagnum-rich vegetation that has potential to be a carbon sink
Bog rehabilitation plan	Opportunity	To improve biodiversity by vegetating bare peat and creating more habitat for flora and fauna.
Bog rehabilitation plan	Opportunity	To reduce runoff and restore a more natural runoff regime, thus contributing to flood risk management.

3 BOG REHABILITATION PLAN

The Edera Bog rehabilitation plan[1] consists of the following measures as summarised in Table 3.1 and presented in Figure 3.1.

Table 3.1 Edera Bog rehabilitation measures

Restoration	Description of measures
Deep peat restoration	Regular drain blocking (up to 7/100 m) + blocking outfalls and managing water levels with overflow pipes
Dry cutaway restoration	Blocking outfalls and managing water levels with overflow pipes
Wetland creation	Turn off or reduce pumping to re-wet cutaway + blocking outfalls and managing water levels with overflow pipes
Other	Creation of a low berm to retain water on site between former production area and Bilberry River. Re-alignment of piped drainage. Maintain silt ponds.

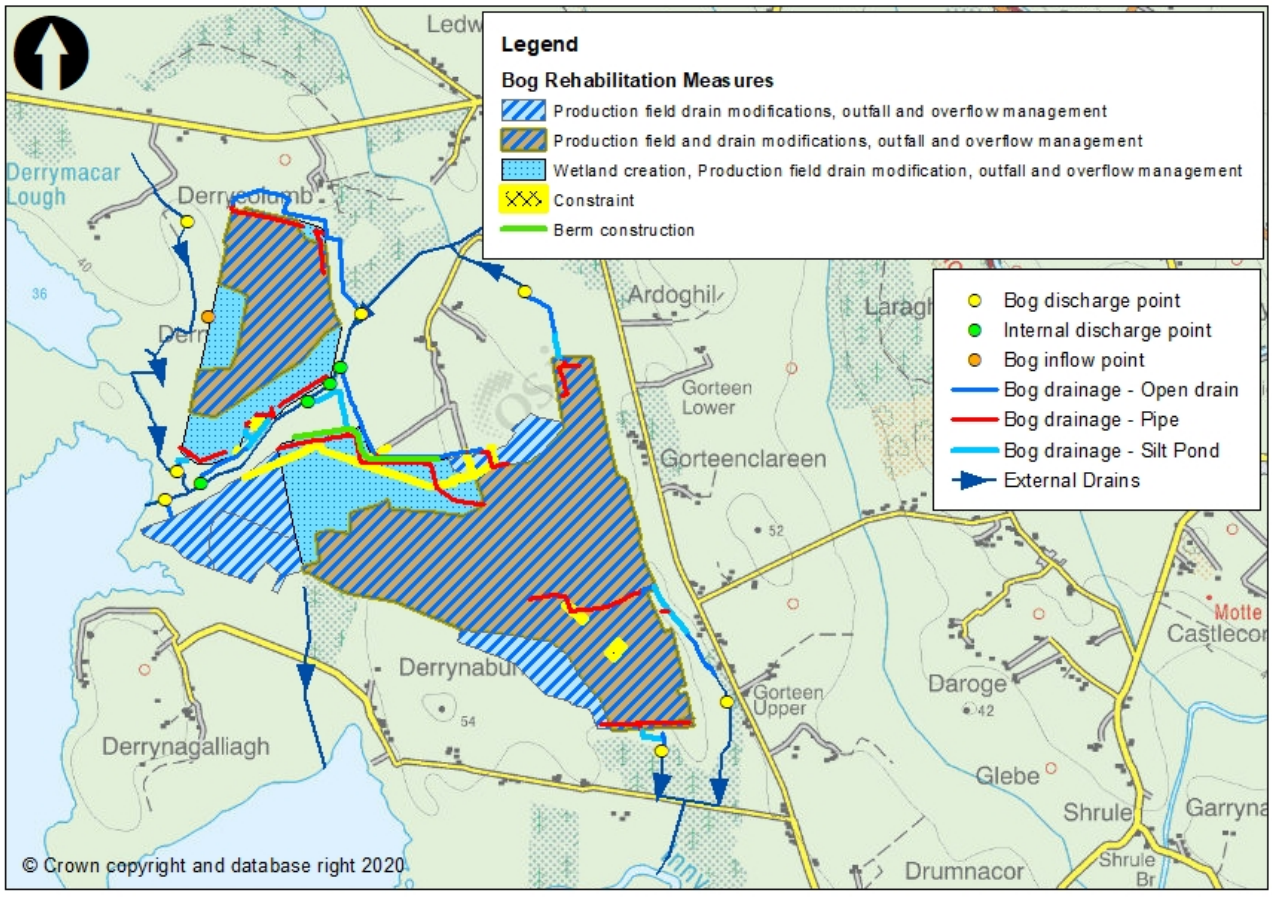

Figure 3.1 Edera Bog Rehabilitation Plan

[1] For further details see Edera Bog Cutaway Bog Decommissioning and Rehabilitation Plan 2020 report

Each measure while designed to promote the rehabilitation and re-wetting of the bog will have a potentially positive and/or negative impact on the adjacent land. This section identifies and assesses these potential impacts.

3.1 Impact Screening

Table 3.2 summarises the rehabilitation measures proposed for the Edera Bog and their potential impact to adjacent land.

Table 3.2 BRP measures proposed at Edera Bog

BnM rehabilitation measure	Description	Potential Impact	Potential Impact Description
Berm construction	A low level berm is proposed across the bog in order to retain water within the bog and to remove the existing spill point into adjacent lands.	Positive and negative	Reduced runoff from the bog at spill point resulting in less flow in the external drains located downstream. Raised groundwater levels to the bog surface will create a hydraulic gradient across the bog into the adjacent land. Land within this hydraulic gradient will potentially rise. The effect will be greatest immediately beside the bog.
Blocking outfalls	Most production field drain systems drain into a headland pipe running perpendicular to the peat field. This intersection is known as an outfall. By blocking the outfalls each production field drain will be prevented from operating resulting in the ditch storing water and raising the groundwater level in the bog. This will allow the bog to store more water and bring the groundwater level to the surface.	Positive and negative	Reduced runoff from the bog discharge points resulting in less flow in the external drains located downstream. Raised groundwater levels to the bog surface will create a hydraulic gradient across the bog into the adjacent land. Ground water levels in lands within this hydraulic gradient will potentially rise. The effect will be greatest immediately beside the bog.
Drain blocking, cell blocking, berm and field re-profiling	Existing production field drains within the bog areas that convey surface water away from the former peat production fields towards the bog discharge points will be modified to reduce conveyance or removed altogether by infilling. Surface water runoff through the bog will be slowed allowing the bog to store more water	Positive and negative	Reduced runoff from the bog discharge points resulting in less flow in the external drains located downstream. Reduced conveyance at bog inflow point resulting in increased water volume in external drain located upstream if conveyance channels through the bog are blocked.

Drainage channel for excess water	This measure will work in conjunction with the overflow structures. Where suitable drainage channels do not exist or are of insufficient capacity along the bog boundary, a new or upgraded drainage channel will be provided. These drainage channels will convey all flows from the bog to suitable watercourses.	Positive	Drainage channels of sufficient capacity will ensure any overtopping water from the bog does not enter adjacent land. Drainage channels will also act as a hydraulic break in groundwater limiting the impact of bog measures to the groundwater in adjacent lands.
Managing overflows with overflow pipes	This measure is usually combined with blocking outfalls which cause groundwater levels to rise. As the bog fills up it will want to overtop at the lowest part of the bog boundary. Weir outfalls and overflow pipes control the location this occurs and where the overtopping water is discharged to.	Neutral	The control feature will determine the location of the discharge from the bog. However the flow leaving the bog once it is full will be the same as prior to remedial works. Overall the volume of water discharging from the bog will be reduced but will contribute to raised groundwater levels within the bog and potentially within the zone of influence (subject to mitigation).
Sphagnum moss inoculation	This measure will propagate sphagnum moss within the bog. Sphagnum moss will cause bog regeneration as it grows and layers.	Positive	Sphagnum moss can hold up to 10 times its weight in water. As such this measure will store water reducing the runoff from the bog into the exterior drains. This will help retain the external drainage efficiency which adjacent land relies on. This measure may also contribute to runoff reduction and wider catchment FRM goals but in a piecemeal way.
Silt ponds	Existing silt ponds will be maintained to store runoff water from the bog and allow any suspended peat to settle out of the water before it is discharge to the external drains.	Neutral	Maintained capacity from the bog discharge points to the external drains and river located downstream. Maintained quality of water being discharged from the bogs into the external drains or river.
Wetland creation	Areas prone to flooding are designated for wetland creation. Standing water will be allowed to occur resulting in increased water storage. Establishment of reeds and other rhizomes will form part of the wetland creation.	Positive and negative	Reduced runoff from the bog discharge points resulting in less flow in the external drains and river located downstream. Raised groundwater levels to the bog surface will create a hydraulic gradient across the bog into the adjacent land. Ground water levels within this hydraulic gradient will

potentially rise. The effect will be greatest immediately beside the bog.

3.2 Impact Assessment

Three potential impact sources were identified; groundwater rise, increased runoff from the bog and reduced drainage capacity into the bog. These impact sources have the potential to make the adjacent land wetter and drain less efficiently. An assessment was carried out to delineate the zone of influence resulting from these potential impact sources. Figure 3.2 presents the areas which are at potential risk.

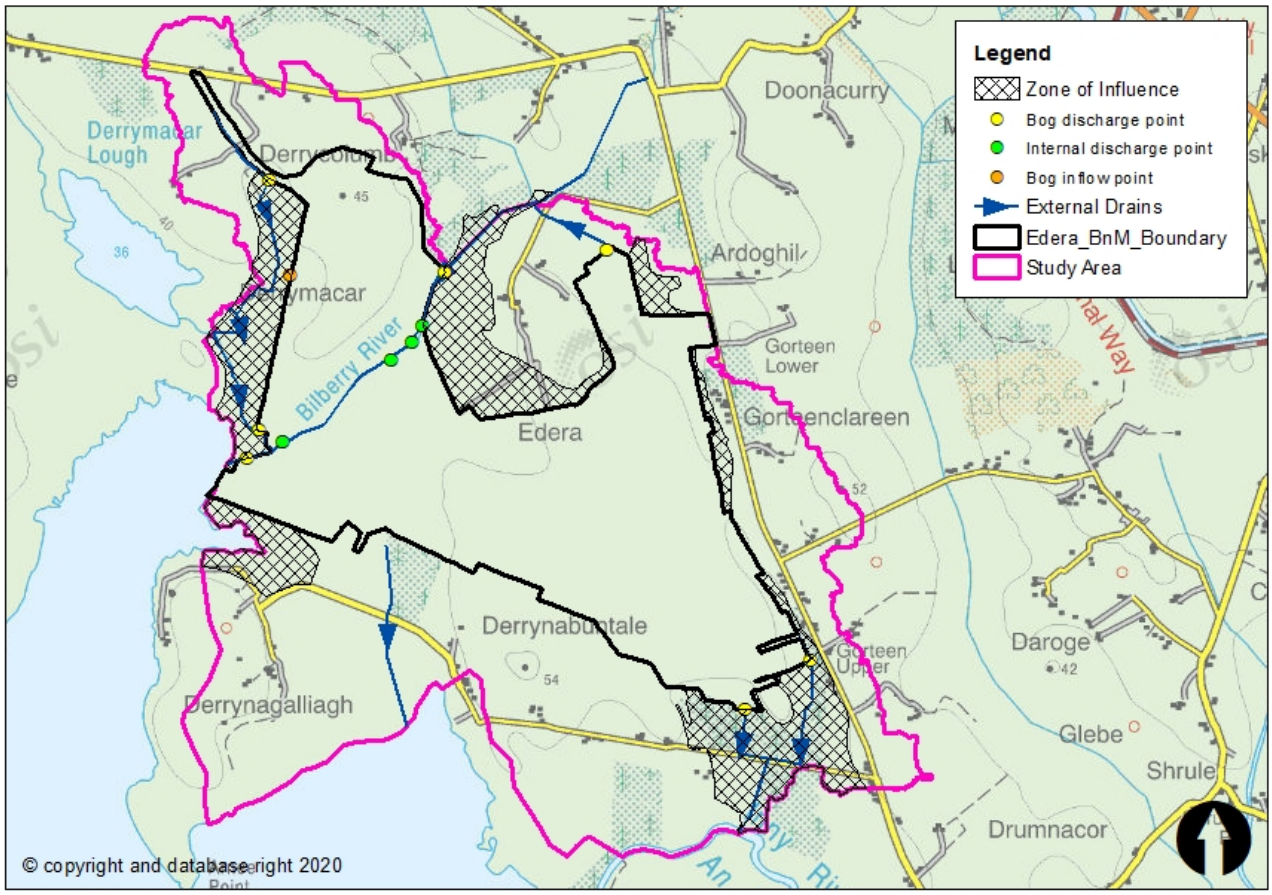

Figure 3.2 Edera Bog Rehabilitation Plan – Zone of influence

3.2.1 Groundwater Impact

The impact of rehabilitation measures on groundwater levels within and adjacent to the bog is difficult to assess quantitatively in the absence of long term monitoring data and hydro-geological models of the bog. Nevertheless it can be assumed that groundwater levels will rise within the bog itself given that this is an objective of the rehabilitation measures – to restore the hydrological conditions for peat formation. It can also be assumed that the maximum level which groundwater will reach is the surface of the peat fields post-

rehabilitation. This is because topographical flow paths for surface water out of the bog (by gravity) will be retained and the bog is not dependent on a pumping regime to ensure ponding does not occur.

Groundwater rise in lands adjacent to the Edera Bog was assessed firstly by estimating the potential rise in groundwater within the bog. The drainage system in the bog is, on average, 1.2m deep. It can be expected that groundwater would rise typically by 1.2m to bring it to the surface. As the groundwater rises in the bog to ground surface level a head water difference will be created between the bog and adjacent land forming a hydraulic gradient (see Figure 3.3). Groundwater will flow across the hydraulic gradient. This flow will be dependent on the porosity of the ground it flows through and the head difference. This will determine the extent of the zone of influence and the area of potentially wetter ground. Where external drains are located in the zone of influence they will act as a hydraulic break or groundwater cut-off and reduce the zone of influence (see Figure 3.3c). This however is dependent on the drain's ability to convey water away. Drains that are inefficient with high water levels (independent from the bog rehabilitation measures) will also raise the groundwater and the adjacent lands to the bog would be wet (see Figure 3.3d). The avoidance of the drain full condition is dependent on maintenance of a positive gravity drainage function of the boundary drains through monitoring and maintenance.

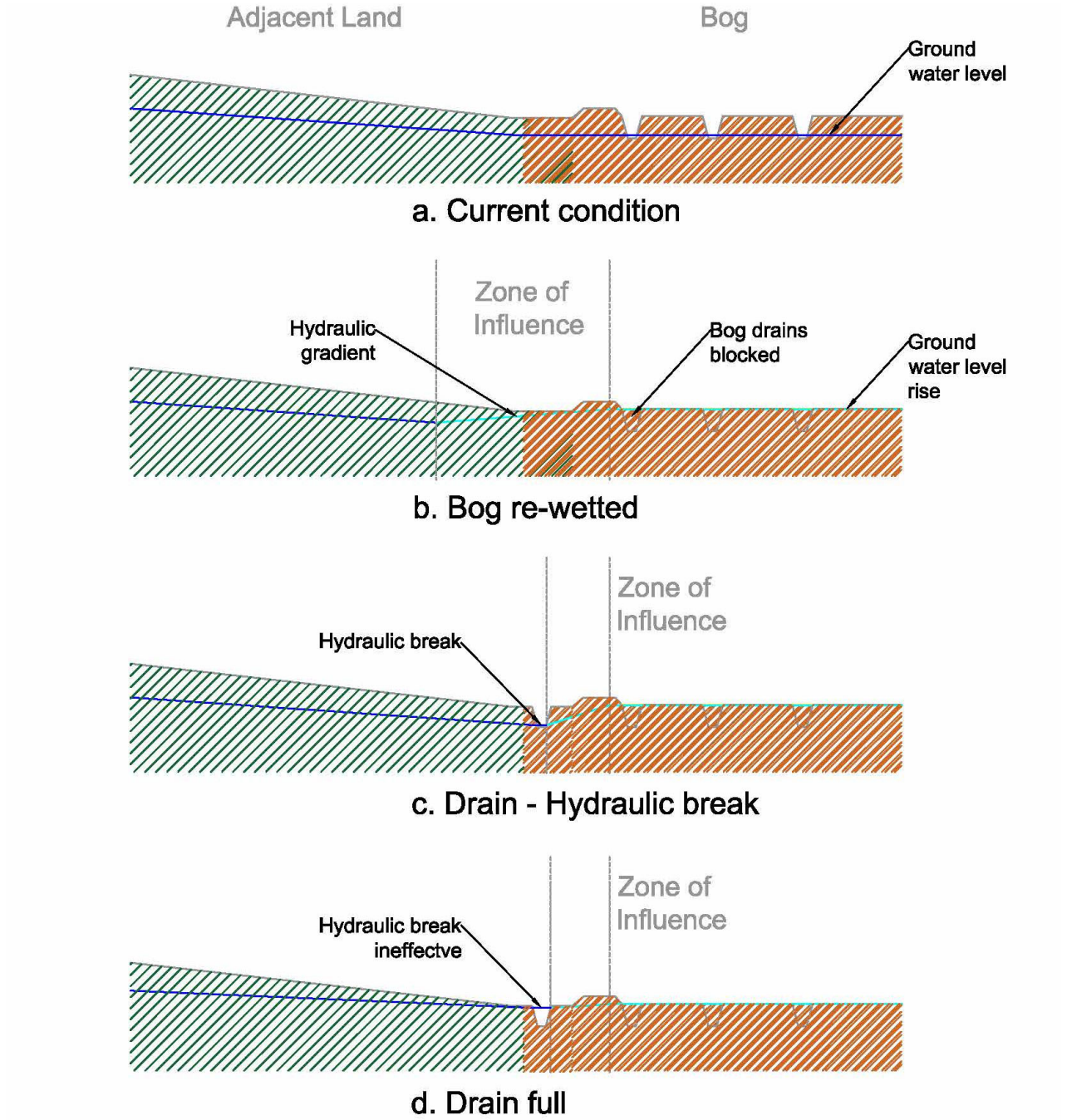

Figure 3.3 Conditions affecting groundwater

A complete survey of the boundary and external drains which provide the groundwater cut-off function to agricultural lands was not available for Edera Bog. It is assumed that these drains would be able to convey Q_{med} (2 year return period) flows under non-backwater conditions which would be typical of natural watercourses in Ireland. Therefore under non-flood conditions it is expected that the external drains identified around Edera Bog will act as a hydraulic break to any hydraulic gradient created by bog re-wetting. However there is a risk that should the flow regime in any external drain be changed post rehabilitation that the land adjacent to the drain would become wetter.

There is also a risk that as the bog fills with water and wants to discharge, that unintended spill locations would occur. A review of the bog boundary was carried out. One spill location is known to occur currently but will be addressed by the proposed berm within the rehabilitation plan.

No other low points were identified that may become an unintended spill locations. As such there is little risk to adjacent lands should there be increased flows from the bog owing to elevated groundwater levels. However as previously set out this is based on the ability of the existing boundary drainage network, separating the bog from adjacent lands at a lower level, to provide a positive gravity drainage function in relation to groundwater entering the drain. In other words capacity to convey Q_{med} or 2 year return period flows and a free flow (constantly falling) away from the bog.

3.2.2 Insufficient Drainage

It is a significant concern for adjacent landowners that restoration and rehabilitation measures could lead to localised impacts in terms of reduced drainage leading to flooding of agricultural lands upstream of the bog.

There is one inflow location to Edera Bog which connects the northern portion of the bog to an external drain to the west. It is located in a low lying, flat area and potentially flows in either direction depending on water levels in the external drainage network. Should this inflow location be modified or the downstream drainage capacity be reduced / current drainage function increased, low lying parts of the upstream land may reduce in drainage efficiency. This low lying land was identified and included in the zone of influence.

Various features were identified in Chapter 2 that may reduce the drains flow capacity. Culverts, bends, deposition and flooding backwater were identified as potential features that could reduce flow capacity. An assessment of the external drains is provided in Section 5.2. The area potentially draining into the bog does so because the bog levels are extremely low, possibly due to peat abstraction, with the marl substrate exposed. A positive drainage outfall from this area must be retained if lands outside the bog are not adversely affected.

3.2.3 Increased Runoff

Evidence from bogs that have previously been the subject of restoration works demonstrates that the measures proposed at Edera, which are all aimed at reducing runoff and retaining water within the bog, have the effect of reducing the frequency and magnitude of flood events by restoring a more natural hydrological regime. Restoration / rehabilitation has been successfully applied to numerous Bord na Móna bogs as well as SAC sites such as Clara Bog (East), Raheenmore Bog, Carrownagappul Bog and Lisnageeragh Bog. Elsewhere, the restoration of peatland catchments in numerous sites across the UK, such as Exmoor National Park in Snowdonia, has demonstrated positive flood alleviation following rehabilitation measures. Monitoring found that this occurred as runoff from the moorland was reduced due to increased storage in the peat.

The risk of increased runoff from Edera Bog is low. All rehabilitation measures being proposed will reduce runoff. However there is a potential that if bog re-profiling is carried out as part of the bog rehabilitation measures that the bog sub-catchments will be modified. Changes in sub-catchments could result in certain discharge points draining larger areas. This would result in increased flows that could outweigh the effect of the reduced runoff arising from the rehabilitation. This is a moderately low risk at Edera as the re-profiling of the bog will generally result in the same topographical flow paths, catchment watersheds and discharge locations as in the pre-rehabilitation state. However in the absence of a full pre and post rehabilitation runoff model and in line with a precautionary approach it is prudent that all drainage infrastructure from the bog is fit

for purpose and retained such that at a minimum capacity to convey high frequency flood events (Q_{med} or 2 year return period) is provided.

3.3 Potential Risk Areas

The assets have been identified as being at potential risk from flooding or wetter conditions are shown in Figure 3.4.

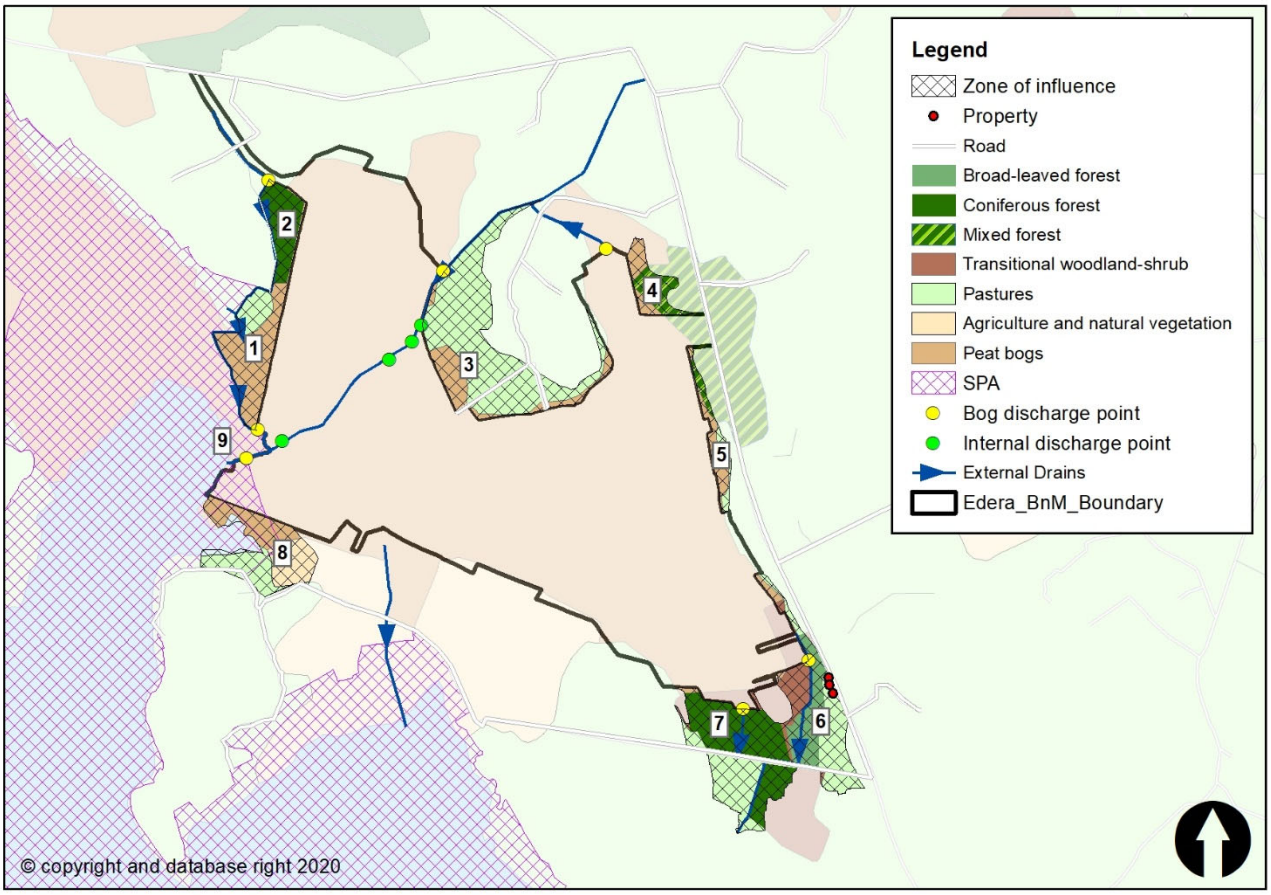

Figure 3.4 Edera Bog Rehabilitation Plan – Assets at risk

The assets at risk are set out in Table 3.3 along with the vulnerability, based on the current landuse, of the asset. It should be noted that the appraisal of the assets at risk is considering the consequences of flooding or wetter conditions, not the likelihood of flooding or wetter conditions occurring.

Table 3.3 Assets at risk

Item	Asset	Vulnerability to flooding and/or wetter conditions
1	Agricultural land	High Vulnerability. Risk of ground water rise and reduced drainage efficiency from the agricultural land into the bog. Land would become less productive should it be made wetter.

2	Commercial forest	High vulnerability. Commercial trees require good drainage. The risk of reduced drainage from the forest into the bog is high. Although trees will have some tolerance to wetter conditions the health of the trees may deteriorate.
3	Agricultural land and access roads	High Vulnerability. Risk of ground water rise. Land would become less productive should it be made wetter. Inclusion of berm in rehabilitation plan will prevent water spilling from the bog. This will reduce the risk of flooding to the adjacent land and of peat sediment entering Lough Ree.
4	Agricultural land	High Vulnerability. Risk of ground water rise. Land would become less productive should it be made wetter.
5	Woodland and peat bog	Low vulnerability. Land is mainly woodland and bog which can tolerate wetter conditions
6	Woodland, peat bog and agricultural land	Moderate vulnerability. Land adjacent to bog is woodland and bog which can tolerate wetter conditions. Woodland acts as buffer between Edera bog and agricultural land dampening any potential ground water rise.
7	Commercial forest and agricultural land	Moderate vulnerability. Land adjacent to bog is commercial forest. Commercial trees require good drainage. Should the ground become wetter the growth rate of the trees may be reduced. Forest acts as buffer between Edera bog and agricultural land dampening any potential ground water rise.
8	Agricultural land	High Vulnerability. Risk of ground water rise. Land would become less productive should it be made wetter.
9	Lough Ree	High Vulnerability. Works may cause increased suspended sediment to be discharged into the Lough which may be detrimental to the river habitat.

In addition to the above risks there is a general low risk that should degradation of the bog boundary occur surface water could be released into adjacent lands.

4 OBJECTIVES

The overarching objective of the Edera Drainage Management Plan is to facilitate the rehabilitation of bog through management of potential adverse impacts to adjacent land and waterbodies. SMART[2] objectives were developed for the Drainage Management Plan that provides direction for the overarching objective. These objectives consider constraints, risks and opportunities that were identified in chapters 2 and 3 and are detailed as follows:

1. To manage potential groundwater impacts between adjacent land and Edera Bog during and after rehabilitation measures.
2. To retain the current drainage capacity of the agricultural land flowing into Edera Bog both during and after the rehabilitation measures.
3. To retain or reduce flows released from the bog at the discharge locations.
4. To reduce sediment entering the Bilberry River and Lough Ree during and after rehabilitation measures to ensure compliance with current discharge limits in IPC Licence.

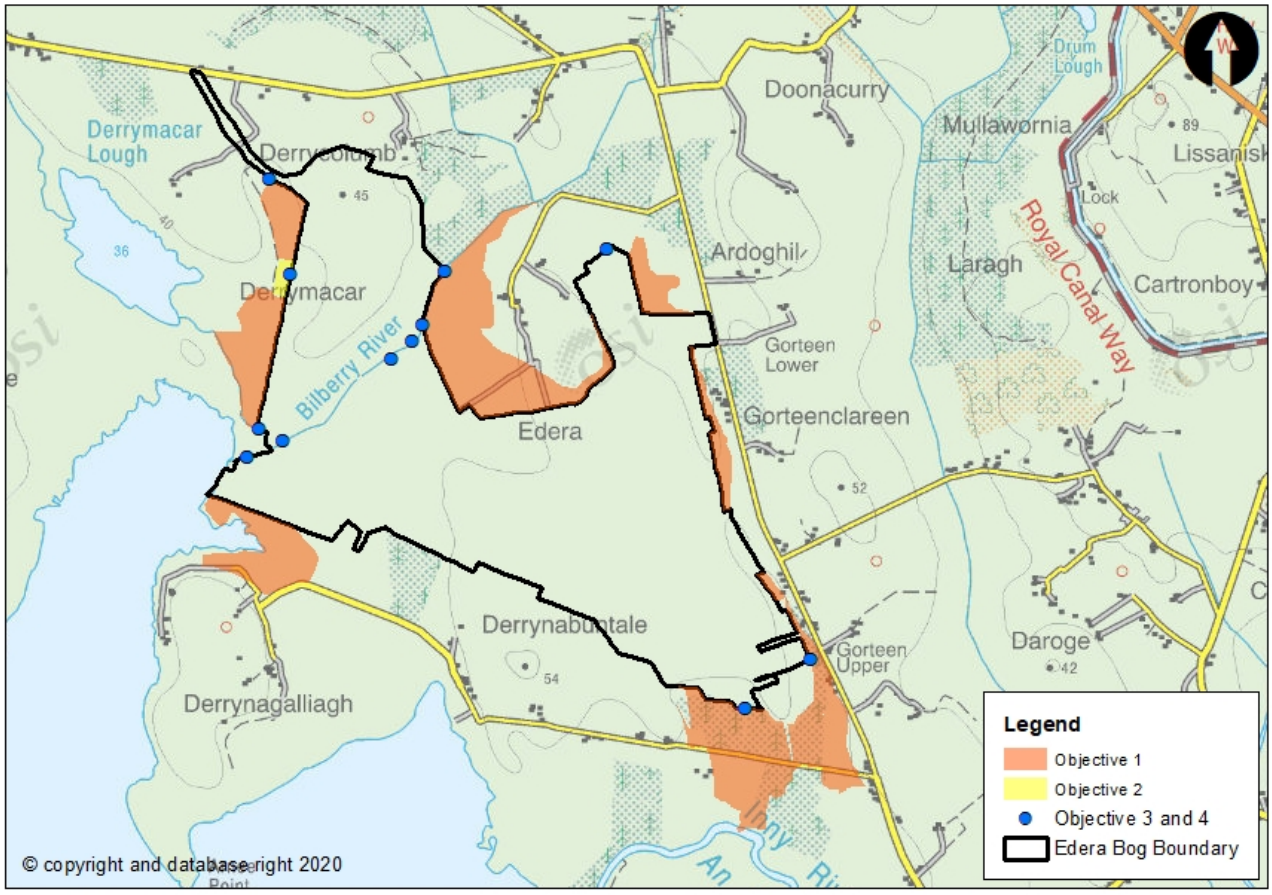

Figure 4.1 Edera Bog DMP objectives

[2] SMART – Specific, Measureable, Achievable, Relevant, Time bound

5 DRAINAGE MANAGEMENT MEASURES

5.1 Key Drainage Features

Drainage management measures were identified in relation to the objectives set in chapter 4 and are described below. Objectives 1 and 3 consider the potential impact to adjacent land from groundwater rise. Objective 2 considers the existing drainage network flowing into and through the bog. Objectives 4 and 5 consider the control mechanisms to flow discharging from the bog.

An assessment was carried out to identify the key drainage features required to meet the objectives set. Figure 5.1 presents these features. It can be seen in the figure that for groundwater level rise to be managed between the bog and adjacent land that hydraulic breaks will be required. To ensure that the land draining into the bog is not impacted a drainage path through the bog will need to be retained. And to ensure that the flow and sediment discharging from the bog is managed the discharge control points and the Bilberry River will need to be retained.

Although outside the Bord na Móna bog boundary key external drains were identified. These drains are hydrologically connected to the bog drainage network. While no drainage issues were identified along these external drains, see section 2.4, a risk of sediment deposition was highlighted from sources outside the bog. The maintenance of the existing silt ponds will ensure that the bog will not contribute to an increased risk of sediment deposition arising from rehabilitation. Should this occur drainage from the bog could be impeded and adjacent land could become wetter.

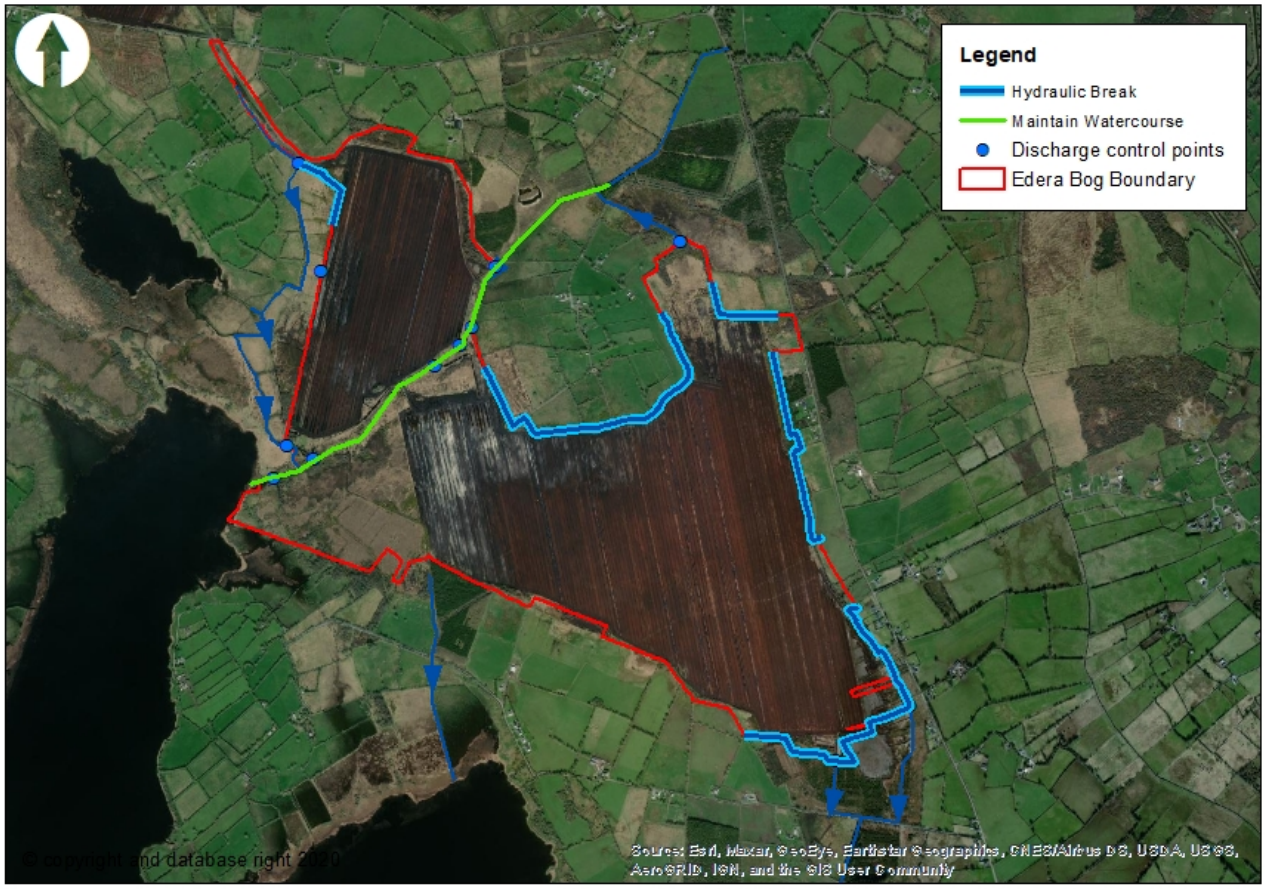

Figure 5.1 Key drainage features for Edera Bog

When identifying measures to provide the key drainage features a review was carried out of the drains. The review found that there is limited data available for boundary drains to the bog and external drains within the adjacent land. While data is available for internal drains this was found to be limited also. It was therefore required to produce a Drainage Management Plan that could offer a suite of measures whereby the most appropriate measures can be selected based on level of certainty and on-site observations. The DMP would therefore allow the bog to be managed and adapted as the rehabilitation plan progresses in the future. The following sections describe the suite of measures that can feasibly be implemented for the Edera Bog Drainage Management Plan.

5.1.1 Boundary Drains

Boundary drains can provide hydraulic breaks between the bog and adjacent land, see Figure 3.3. In most areas of the Edera Bog there are existing boundary drains. Available information indicates that these drains are suitable to provide hydraulic breaks and can be designated as such and retained in the future. Observing and recording the suitability of the boundary drains is recommended and where they are found to be not functioning as predicted upgrade works will be required. Where they are not suitable it may be possible to upgrade the drains. This would involve modification of the drain to make them larger/deeper/wider/steeper. This may be only in specific locations along the drain or an entire reach may require upgrading. Where there is no boundary drain present a new drain can be excavated in order to create the hydraulic break required. In these cases a channel of specified dimensions and slope will be required.

5.1.2 Bog Rehabilitation Modification

Where a boundary drain is not suitable to act as a hydraulic break or where none exists it may be possible to review the bog rehabilitation plan to provide the required mitigation measure. This can take the form of sacrificing rehabilitation of the last peat field, closest to the adjacent land where an existing field drain could act to provide the hydraulic break function. . The field's drainage network would be retained keeping the groundwater to current conditions and providing a groundwater cut-off in relation to the adjacent land.

In some locations flow discharges from Edera Bog via drains which require silt control measures. To address this the rehabilitation plan measures can be adapted to function as a silt pond such as wetlands functioning a large silt sinks. Rehabilitation measures can also be modified to block these discharge locations and direct runoff towards other discharge locations where silt ponds are present.

5.1.3 Internal Drain Retention

Drains within the bog that include adjacent land within their sub catchment may need to be designated as key drainage features and retained to ensure that the drainage to the adjacent land does not deteriorate.

5.1.4 Maintenance of Silt Ponds

Existing silt ponds are located upstream of the bog discharge points. They help regulate the flow and level of suspended peat leaving the bog into the external drains and rivers. Bord na Móna have legal responsibility to

maintain these silt ponds and ensure their proper functioning capacity under the existing IPC Licence (Ref. P0-504-01).

5.1.5 Monitoring

As mentioned above DMP measures were selected based on level of certainty and on-site observations. The most appropriate measure was selected from a suite of measures representing varying levels of intervention. Monitoring of the measure and adjacent land will be required prior, during and after the rehabilitation measures. A monitoring programme can be implemented to observe the impact from the bog rehabilitation to the adjacent land. Monitoring would be observational where the condition of the asset in question is assessed in relation to present day conditions accounting for seasonal variability. Where negative impacts are observed other measures can be implemented that will establish a hydraulic break. Otherwise monitoring should continue until environmental stabilisation.

5.2 Drainage Assessment

A review was carried out of the existing drainage networks falling within the key drainage features as shown in Figure 5.1. These drainage networks were reviewed to the confluence with streams in order to identify potential downstream control features.

The estimated flood flows were compared with the hydraulic capacity of each of the control structures / features which are important to the effective performance of the drainage network.

Two methods have been considered for the derivation of the Index Flood flow (Q_{med}) as set out in Section 2.2. There is a high degree of uncertainty in the estimation of flood flows at the small catchment scale and therefore the largest of the two estimates has been chosen for each sub-catchment in line with a precautionary approach to uncertainty. Flood flows for Q_{med} (50% AEP) and Q_{100} (1% AEP) peak flows for each sub-catchment have been calculated. A generalised growth curve for peat catchments in the midlands has been used, whereby a growth factor of 2.3 has been used to scale up the Q_{med} peak flow to determine the Q_{100} event (100 year return period flood event).

The best projections on the effect of climate change have been applied to determine the Mid-Range Future Scenario (MRFS). This represents a 20% uplift over the present day flood flows.

Table 5.1 Peak Flows in Each Sub-Catchment

Sub Catchment	Q_{med} / 50% AEP	Q_{100} / 1% AEP	Q100 / 1% AEP - MRFS
1	0.050	0.116	0.139
2	0.078	0.180	0.216
3	0.087	0.201	0.241
4	0.390	0.897	1.077
5	0.179	0.413	0.495
6	0.224	0.516	0.619
7	0.081	0.187	0.225

8	0.049	0.113	0.135
9	0.042	0.097	0.117
10	0.346	0.796	0.955

5.2.1 Assessment Points

Assessment Points have been assigned at key / critical points within the drainage network identified in Figure 5.1 as providing a key drainage management function. The location of the Assessment Points is provided in Figure 5.2.

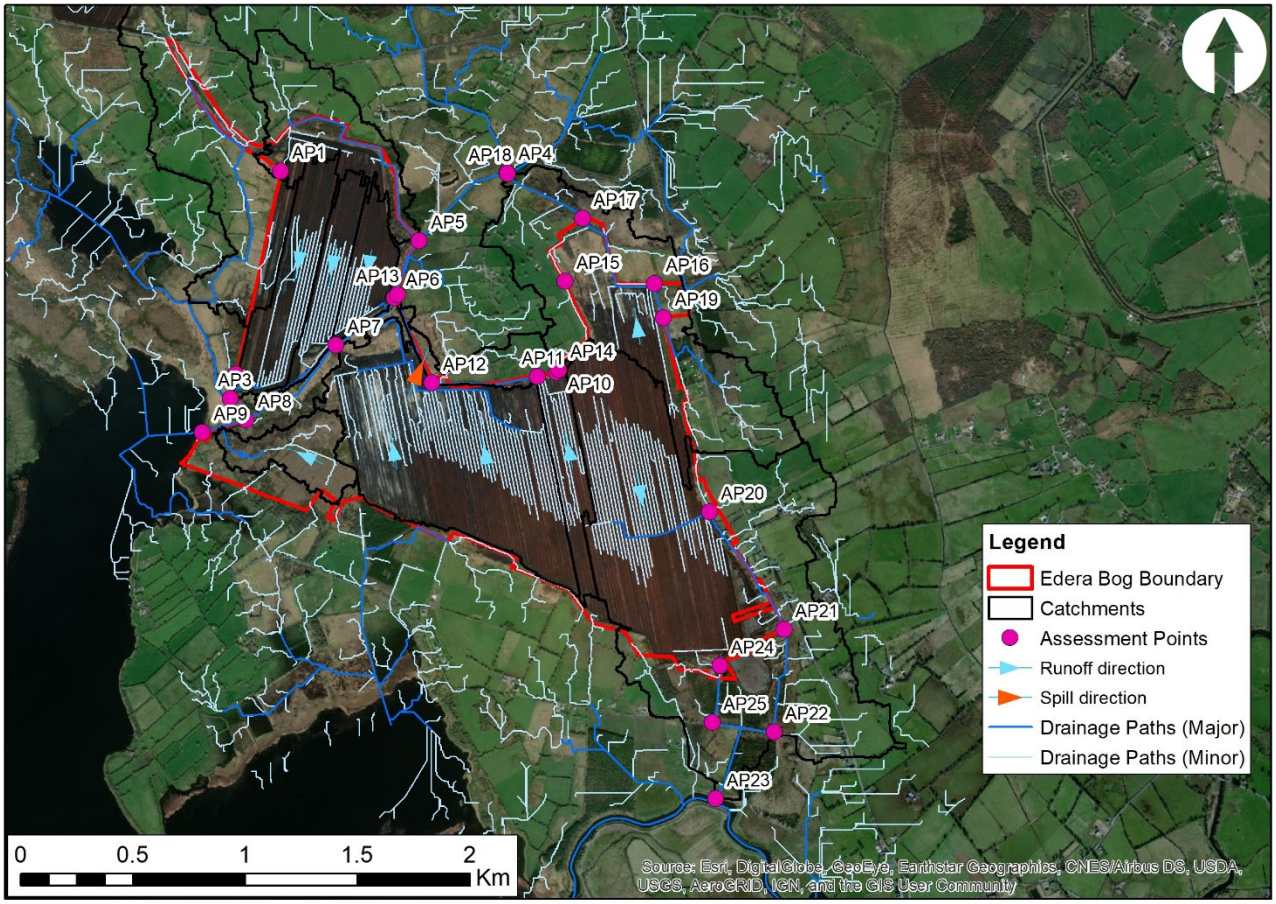

Figure 5.2 Assessment Points at Edera Bog

5.2.2 Hydraulic Analysis

The peak flows at each Assessment Point (AP) have been compared to the estimated hydraulic capacity of each of the features. A summary of the flood flows that may be generated at each AP along with their likely capacity to convey these flows is summarised below in Table 5.2. Note that the Assessment Points for each sub-catchment are ordered from upstream to downstream and as such capacity issues at an AP may have

knock on impacts in terms of flooding for the AP upstream (preceding APs in the table within the same sub-catchment)

Table 5.2 AP Capacity

Assess. Point	Sub-Catch.	Feature Type	Flood Flow Range (m^3/s)	Capacity & Recommendations
AP4	Bilberry	Watercourse channel	0.304 - 0.839	Assumed that run-off to Bilberry River will be reduced post rehabilitation. Flows provided for information / future operation and maintenance.
AP6	Bilberry	Bridge / culvert	0.922 - 2.544	
AP7	Bilberry	Bridge / culvert	1.033 - 2.852	
AP8	Bilberry	Watercourse channel	1.625 - 4.484	
AP9	Bilberry	Watercourse channel	1.703 - 4.7	
AP2	1	Boundary drain potential additional flows post rehabilitation	0.039 - 0.106	Wide but potentially shallow / backwatered drain. Likely capacity to convey range of flows.
AP3	1	External / Boundary drain, potential increased usage / capacity needed post rehabilitation.	0.179 - 0.494	Wide but potentially shallow / backwatered drain. Likely capacity to convey range of flows.
AP14	6	No channel at this location	0.003 - 0.009	No obvious channel at this location but very small contributing catchment. **Survey and establish small channel if necessary.**
AP10	6	Boundary drain potential additional flows post rehabilitation	0.007 - 0.02	Small channel at this location suitable for conveying flows post rehabilitation.
AP11	6	Culvert in main drain of catchment 6	0.042 - 0.117	Wide channel at this location. **Survey depth and falls to ensure drain function.**
AP12	6	Culvert in main drain of catchment 6	0.063 - 0.175	**Survey pipe diameter and condition.** Known drainage issues at this location.
AP13	6	Main channel outlet for catchment 6	0.069 - 0.192	Wide, deep channel. May be subject to backwatering.
AP1	7	Boundary drain potential additional flows post rehabilitation	0.006 - 0.017	Shallow channel at this location but required flow capacity is low.
AP5	7	Boundary drain potential additional flows post rehabilitation	0.125 - 0.345	Wide, deep channel. Capacity controlled by backwater effects.
AP15	8	Boundary drain potential additional flows post rehabilitation	0.037 - 0.101	Wide channel at this location. **Survey depth and falls to ensure drain function.**
AP19	8	Boundary drain potential additional flows post rehabilitation	0.108 - 0.297	Wide channel at this location. **Survey depth and falls to ensure drain function.**
AP16	8	Boundary drain potential additional flows post rehabilitation	0.111 - 0.307	Sufficient width and depth at this location. **Survey falls to ensure drain function.**
AP17	8	Main channel draining much of catchment 8	0.226 - 0.624	Sufficient width and depth at this location. **Survey falls to ensure drain function.**

Assess. Point	Sub-Catch.	Feature Type	Flood Flow Range (m^3/s)	Capacity & Recommendations
AP18	8	Discharge channel catch 8 into Bilberry	0.278 - 0.768	Wide but potentially shallow / backwatered drain. Likely capacity to convey range of flows.
AP24	9	Channel draining portion of catchment 9	0.058 - 0.159	Sufficient width and depth at this location. **Survey falls to ensure drain function.**
AP25	9	Main channel draining catchment 9	0.122 - 0.337	Unknown depth and width at this location. Survey to ensure channel dimensions and falls provide positive gravity drainage function.
AP20	9	Main channel draining catchment 9	0.17 - 0.469	Sufficient width and depth at this location. **Survey falls to ensure drain function.**

5.3 Identification of Measures

The review of drain capacities found that most open drains are likely to have sufficient capacity to convey flow away from the bog. They would therefore be suitable to act as hydraulic breaks provided they are retained with their current estimated carrying capacity. Some areas were identified for exclusion from the rehabilitation measures and other areas have been identified for adaptation and to function as silt sinks in order to provide silt control measures. Table 5.3 and Figure 5.3 detail the level of intervention required along each reach of drainage network.

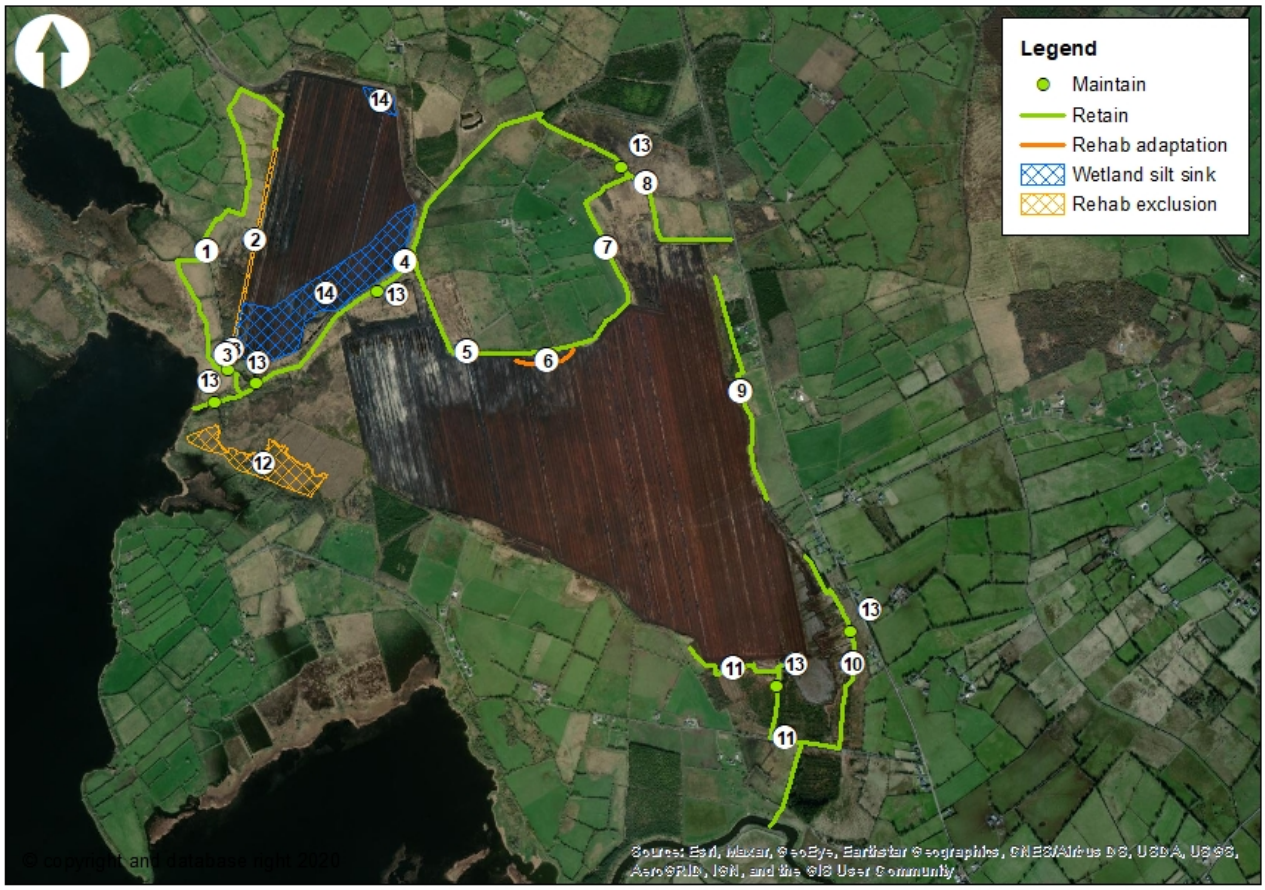

Figure 5.3 DMP measures for Edera Bog

DMP measures 2 and 12 propose areas to be excluded from the rehabilitation measures. This is due to there being no suitable hydraulic break feature present between the adjacent land and the bog.

DMP measure 6 proposes an adaptation to the bog rehabilitation plan in order to ensure that the bog sub-catchment, which currently discharges to the Bilberry River via a boundary drain, would drain into adjacent sub-catchment and discharge via the existing silt pond.

DMP measures 14 identifies proposed wetlands within the rehabilitation plan that can be adapted to function as silt control measures before the relevant part of the bog discharges to the Bilberry River. A review of the internal drains would be required to ensure no drain bypass the wetlands. OR OTHER

DMP measures 3 – 5 and 7 – 11 have been identified as key drains and rivers to be retained. A free draining fall is required on all of these watercourses to ensure the features can act as effective hydraulic breaks.

DMP measures 13 identified all discharge point with existing silt ponds that should be maintained.

The remaining measures are of low intervention consisting of retaining the existing features or monitoring lands or features.

Table 5.3 Selection of DMP measures

Measures Item	Feature	Function required	Suite of measures Level of intervention			
			Low			High
1	External drain	Drainage of adjacent land	**Retain drain**	Upgrade drain	Retain outside bog field	Create new drain
2	Field bog	Hydraulic break	Retain pipe	Upgrade pipe	**Retain outside bog field drains**	Install new pipe
3	Boundary drain	Hydraulic break	**Retain drain**	Upgrade drain	Retain outside bog field	Create new drain
4	River	Drainage of bog	**Retain river**	Upgrade river	-	-
5	Boundary drain	Hydraulic break	**Retain drain**	Upgrade drain	Retain outside bog field	Create new drain
6	Internal drain	Flow/silt control	-	-	**Rehabilitation adaptation**	Create new silt control feature
7	Boundary drain	Hydraulic break	**Retain drain**	Upgrade drain	Retain outside bog field	Create new drain
8	Boundary drain/External drain	Hydraulic break	**Retain drain**	Upgrade drain	Retain outside bog field	Create new drain
9	Boundary drain/Adjacent land	Hydraulic break	**Retain drain**	Upgrade drain	Retain outside bog field	Create new drain
10	Boundary drain/External drain/Adjacent land	Hydraulic break	**Retain drain**	Upgrade drain	Retain outside bog field	Create new drain
11	Boundary drain/External drain/Adjacent land	Hydraulic break	**Retain drain**	Upgrade drain	Retain outside bog field	Create new drain
12	Field bog	Hydraulic break	-	-	**Retain drains in area of bog**	Install new drain

Measures Item	Feature	Function required	Suite of measures Level of intervention			
			Low			High
13	Silt ponds	Flow/silt control	**Maintain pond**	Upgrade pond	-	-
14	Wetlands	Flow/silt control	-	-	**Rehabilitation adaptation**	Create new silt control feature

5.4 Interaction with Monitoring Plan

As part of the bog rehabilitation plan groundwater level monitors will be installed at Edera Bog. These monitors will record groundwater levels over the coming months. It will therefore be possible to ascertain if groundwater is rising within the bog following the implementation of the rehabilitation plan.

This data should be considered during the monitoring measures of adjacent land. When groundwater levels are known to be rising within the bog, monitoring of the adjacent land (as described in Section 5.1.5) should take place on a more regular basis to ascertain if impacts to lands outside the bog are observed.

5.5 Residual Risk and Limitations

In certain areas of Edera bog and adjacent lands the level of flood risk to the bog and the surrounding lands has been shown to be significant (Section 2.6). During flood events it is likely that flood water will back up the key drains identified as hydraulic breaks. The raised water levels in the drains will reduce their ability to function as a hydraulic break and the adjacent lands may become wetter. The impact of increased groundwater levels arising from the backwatering effect on drains and a reduction in their carrying capacity is likely to be minimal given these backwatering effects will dominate groundwater levels and flooding in the areas affected.

The impact of the proposed rehabilitation measures will generally be to reduce runoff from the bog but this will lead to increased groundwater levels and surface water flooding in the bog itself. During flood events no increase in flood risk is envisaged as a result of the rehabilitation measures. During normal flow regime there is a fair degree of uncertainty in relation to the post-rehabilitation water levels which will be realised, however the Drainage Management Plan seeks to identify the measures that will provide a hydrological cut off between the bog and the surrounding lands.

As indicated in previous sections there are limitations to the assessments associated with the drainage network both within the bog and outside. Factors such as flow estimations of small catchments, lack of survey data limiting drain capacity estimations and high level definition of soil porosity all contribute to these limitations. Nevertheless the measures recommended represent a pre-cautionary approach based on conservative assumptions.

The DMP measures proposed set a baseline approach however a suite of measures in any given location has been provided. This will allow a reactive approach to be taken if required. Should a measure not be operating efficiently a higher intervention measure can be implemented. This will allow Bord na Móna to identify the most appropriate measure while proceeding with drainage function uncertainties.

5.6 Climate Change Adaptability

There is high uncertainty in relation to the effects of climate change, particularly in how it may manifest in terms of small catchment runoff. Ireland is predicted to have drier summers and wetter winters. The most appropriate guidance in an Irish context can be found in the OPW's Flood Risk Management Climate Change Sectoral

Adaptation Plan[3]. For the Mid-Range Future Scenario, representing a central emissions estimate on a 100 year time horizon, it is recommended that allowances for peak flow and rainfall are increased by 20%. If such increases in runoff are realised over the timeframe of establishment of rehabilitation measures this could lead to a perception that bog rehabilitation measures at Edera are the cause of increased flood risk.

It is anticipated however that the rehabilitation measures will lead to reduced peak runoff as the water storage function of the bog is increased. This will serve to regulate peak runoff in winter and potentially smooth out the flows in drier periods, essentially acting against the anticipated effects of climate change.

It is therefore anticipated that the bog rehabilitation measures themselves will provide the mitigation of the effects of climate change on runoff and no additional measures will be needed. There is uncertainty however in the effectiveness of the rehabilitation measures in this regard and also the severity of climate change impacts. Continued monitoring of the adjacent lands is therefore also crucial to gauge the effectiveness of the BRP measures in mitigating these climate change impacts.

[3] Accessed on 10/12/2020 at https://www.gov.ie/pdf/?file=https://assets.gov.ie/46534/3575554721374f7ab6840ee11b8b066a.pdf#page=1

6 SUMMARY OF DRAINAGE MANAGEMENT PLAN

The Drainage Management Plan for Edera consists of a series measures to be implemented at different stages of the rehabilitation measures. Drains within the bog and along its border were identified as being key drainage paths or hydraulic breaks in order to mitigate against any potential impacts from the bog rehabilitation measures. The effectiveness of all drains acting as hydraulic breaks is dependent on their ability to convey flow which have been outlined in Section 5.3 and deemed appropriate subject to the measures recommended. Factors such as channel size and slope will determine this along with any downstream feature which may control water levels. The external drains which these boundary drains discharge into are also key drainage features that will affect the operation of the drainage network. Measures will range from low intervention to high and consist of monitoring, retention of existing features, upgrading features and updating the rehabilitation plan. Maintenance of measures are also proposed to the existing silt ponds within the bog. This is a legal obligation for Bord na Móna and will continue at all existing silt ponds. Monitoring of adjacent land was included in the plan. The monitoring will observe adjacent land for adverse impacts from the bog rehabilitation. Should these impacts be confirmed, higher intervention measures can be implemented to mitigate the impacts. Monitoring measures will therefore be ongoing during and after the bog rehabilitation measures. Continued retention of the key drains and maintenance of the silt ponds will also be required after the bog rehabilitation measures. Throughout the process landowner engagement is recommended to ensure both the rehabilitation plan and Drainage Management Plan are understood and to promote collaborative working to manage impacts as they arise.

Table 6.1 Drainage Management Plan

Measures required PRE bog rehabilitation measures	Measures required DURING bog rehabilitation measures	Measures required POST bog rehabilitation measures
Landowner engagement if required via community liaison	Landowner engagement if required via community liaison	Landowner engagement if required via community liaison
Retention of internal and boundary drains and Bilberry River (see section 5.1.1)	-	-
Monitoring external drains	IF REQUIRED – Consideration of need for higher intervention measures	-
-	Exclusion of designated areas from rehabilitation plan	-
-	Rehabilitation exclusion and adaptation (see section 5.1.2)	-
Maintenance of silt ponds	Maintenance of silt ponds	Maintenance of silt ponds
Monitoring of adjacent land (see section 5.1.5)	Monitoring of adjacent land (see section 5.1.5)	Monitoring of adjacent land(see section 5.1.5)
-	-	IF REQUIRED – boundary drain upgrades

-	-	Retention of key drains and pipes