National Parks & Wildlife Service

Tóchar Midlands Petland Restoration Scheme

Balnavine Fen

NFS site No. 104007

Fen Restoration Plan

September 2026

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Fen Restoration Plan

Balnavine Fen (Westmeath) (104007)

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Executive Summary

Balnavine Fen is located approximately 24 km northeast of Mullingar, Co. Westmeath. The site is not designated but is characterised by supporting wetland habitats including 7230 Alkaline fens, small areas of 91E0 Alluvial woodland and cutover bog.

The assessment primarily considers the following pressures, which may be affecting the hydrological function and favourable condition of the fen habitats:

- Drainage works that have altered natural water levels;
- Nutrient enrichment from adjacent agricultural activities;
- Encroachment by scrub; and
- Historical peat cutting.

These pressures have degraded the habitat quality and threaten the species and ecological functions supported by the site.

Actions of the Fen Restoration Plan

The restoration plan for Balnavine Fen sets out a coordinated series of measures to address the key pressures affecting the site and to support the recovery of its wetland habitats.

The key action of this plan is draining measures to be implemented within the southern-central drain and a programme of hydrological monitoring to improve understanding of groundwater and surface water interactions to determine the role of the drainage network in controlling water levels within the fen.

The results will inform the need of any future hydrological restoration measures, including the potential requirement for drain blocking or water level management at other parts of the site.

To address nutrient and pollution pressures, the plan emphasises collaboration with local landowners and farmers through established programmes and incentives. This includes efforts to reduce nutrient runoff from surrounding agricultural land. Regular water quality assessments will be conducted to monitor nutrient levels and inform adaptive management of the site.

The plan recognises the importance of stakeholder engagement and compliance. Active engagement with landowners, statutory bodies, and other local stakeholders will help ensure that restoration actions are practical, widely supported, and compliant with relevant legislation.

Benefits of the Fen Restoration Plan

The restoration plan is expected to deliver significant benefits to a range of habitats and species at Balnavine Fen. Improving the understanding of hydrological conditions will inform the most appropriate measures to restore and maintain wet conditions across the site.

Overall, these restoration actions will enhance habitat quality and resilience, supporting both biodiversity and the fen habitat condition.

Habitat and Restoration Map

The Annex I habitats recorded during the 2022 NFS are presented in Figure 1-1.

The Restoration and Monitoring Map including both hydrological and ecological measures is presented in Figure 1-2.

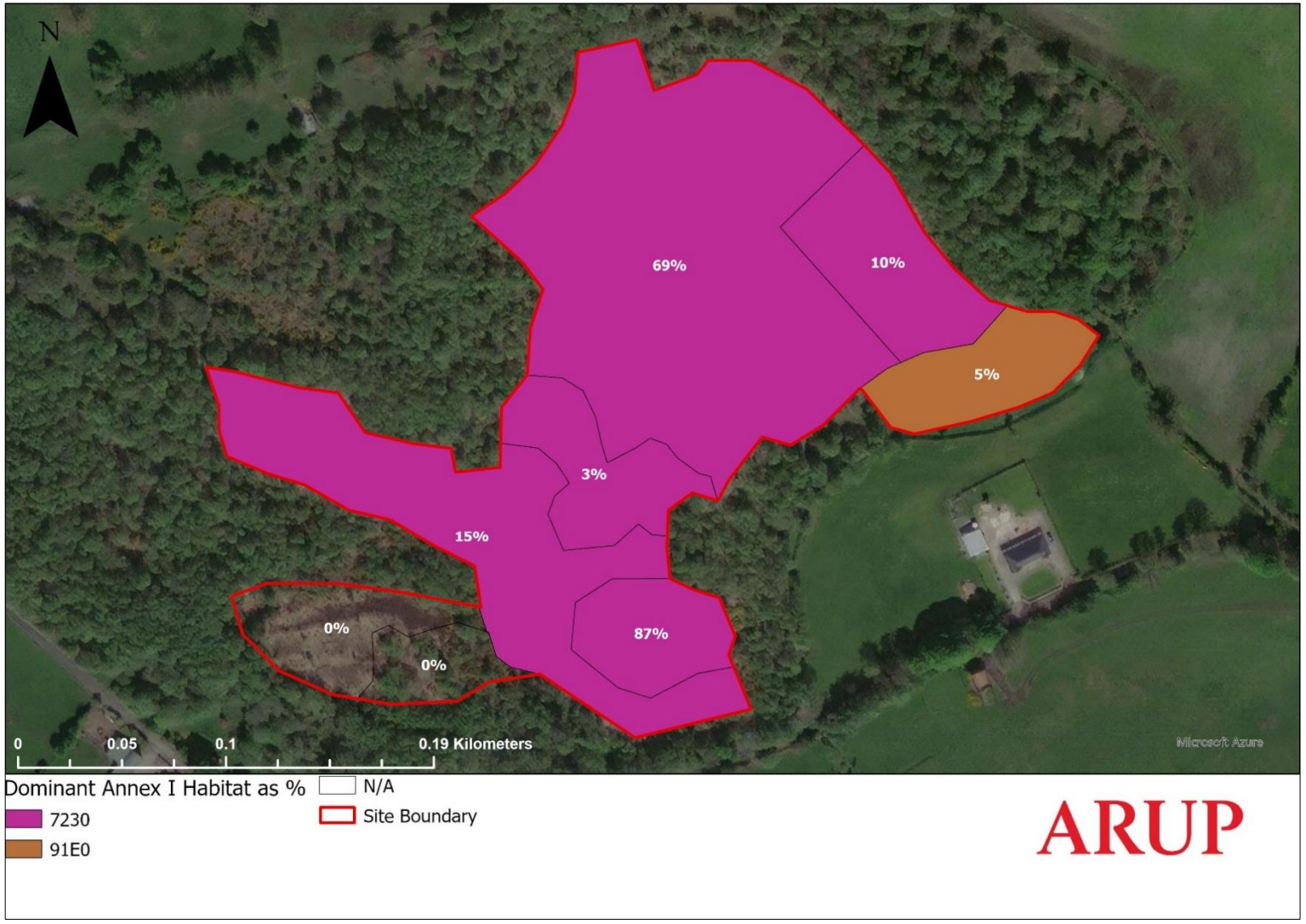


Figure 1-1: Annex I quality habitats recorded and mapped as part of the 2022 NFS. Note the % value indicates the % cover of the dominant Annex I quality habitat recorded in the polygon

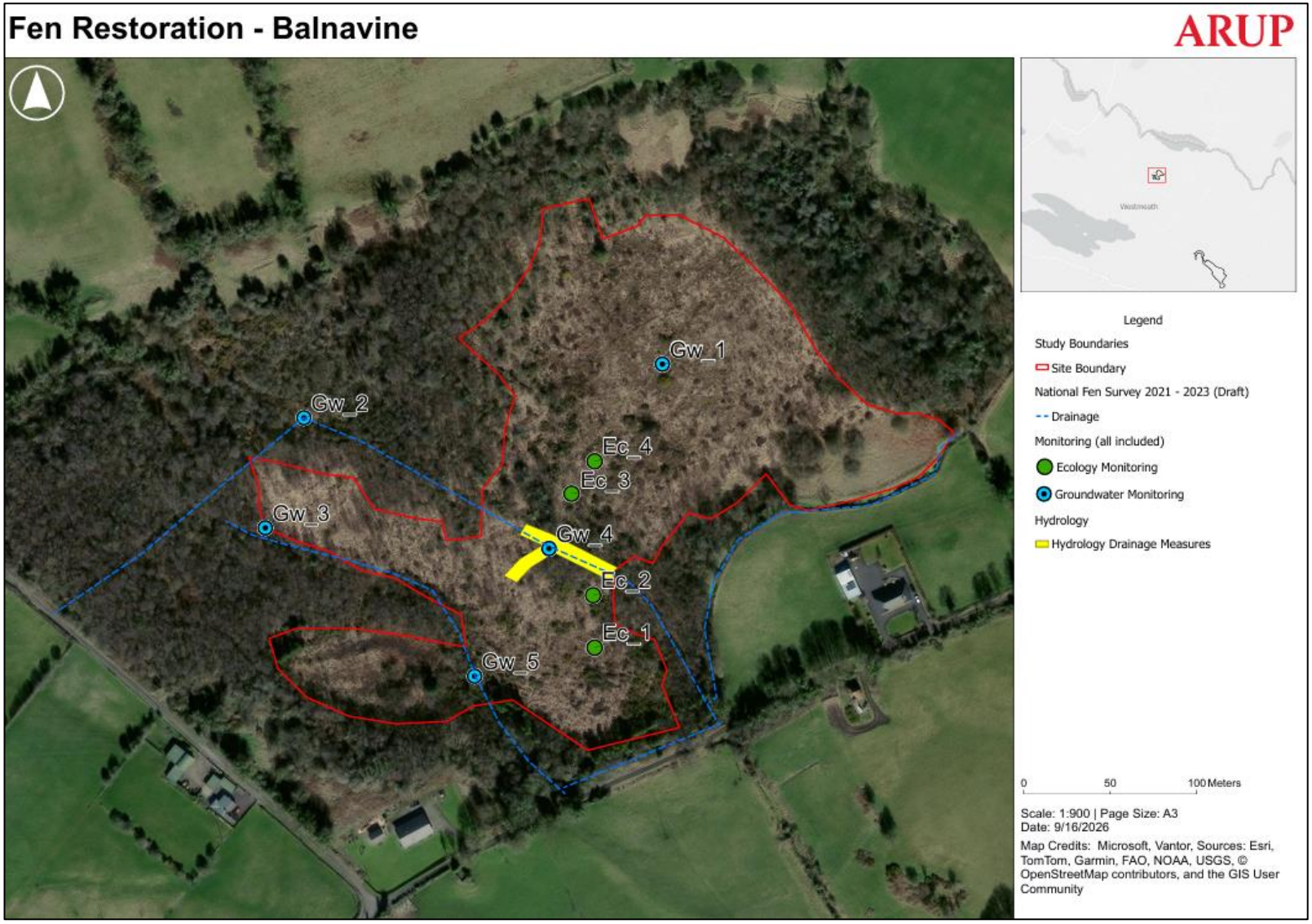


Figure 1-2: Restoration and monitoring map

Acknowledgements

This Restoration Action Plan was prepared following consultation with a broad range of groups and individuals involved in Peatland restoration, local residents and stakeholders through several workshops.

Thanks to the members of the SAR Directorate, NPWS Regional Staff, Ecological Assessment Unit (EAU), Ecological Guidance and Advisory Unit (EGAU), Wildlife Enforcement and Nature Protection Directorate, Conservations Measures Unit, Conservation Planning Unit, The FENCES Project team and the Tóchar Wetlands Project Team, including Shirley Clerkin (Project Manager), Monica Byrne (Project Administrator), Hazel Daly (Community Engagement Officer), and Emily Nolan (Community Engagement Officer).

Tóchar Wetlands is a wetlands restoration project, co-funded by the Government of Ireland and the European Union through the EU Just Transition Fund Programme. It is managed by the National Parks and Wildlife Service, of the Department of Housing, Local Government and Heritage.

1 Introduction

1.1 Purpose of this Fen Restoration Plan

This Fen Restoration Plan (FRP) report has been developed by Arup on behalf of National Parks and Wildlife Service (NPWS) to set out proposals for restoration of fen habitat. Annex I[1] habitats are those formally listed under Annex I of the EU Habitats Directive and are recognised as qualifying features of a designated site, meaning they have legal protection and must be assessed and managed to meet site-specific conservation objectives. Balnavine Fen is not a designated site, however the site supports Annex I habitat and is referred to here as Annex I quality, meaning it conforms to the Annex I habitat description, but is not a designated Special Area of Conservation (SAC).

Balnavine Fen (104007) is located approximately 24 km northeast of Mullingar in Co. Westmeath. The site covers a total area of approximately 5 ha and is dominated by fen habitat although several other associated peatland habitats are also present (Brophy et al., In prep). The following Annex I quality habitats were recorded within the site: 7230 Alkaline fens and 91E0 Alluvial woodland.

The main aim of the restoration actions proposed as part of this assessment is to maintain and improve the quality of existing areas of fen habitat, to enhance hydrological conditions that will allow an expansion of the measurable area of fen thus promoting favourable condition of wetland habitat. However, in some areas, it must be recognised that restorations to increase areas of existing fen will not be possible due to unsuitable hydrological conditions, and the objective may simply be to ensure no further deterioration.

Restoration requirements actions to raise the water table of fen will improve the hydrology of the degraded rich fen that is being encroached by dense birch bog woodland and nascent gorse scrub. Scrub removal is a recommended restoration measure for this site to reduce the pressure of encroaching scrub on the areas of fen, to allow favourable conditions to return to allow the spread of fen species.

1.2 Wider benefits of peatland restoration

Fens are vital habitats due to their rich biodiversity, supporting a wide array of flora and fauna, many of which are rare or endangered. They act as natural water filters, purifying water by trapping pollutants and sediments, thus enhancing water quality downstream. Additionally, fens store significant amounts of carbon in their peat soils, contributing to climate change mitigation by reducing atmospheric carbon dioxide levels. Their ability to absorb and gradually

[1] Each habitat and species type protected under the EU Habitats Directive (Council Directive 92/43/EEC of 21 May 1992) is given a unique numeric code so that all Member States use the same reference in legislation, reporting and monitoring. Each habitat and species code is an index in the Annex lists with codes grouped by habitat family.

release water helps regulate water flow and minimize flood risks. Beyond their ecological importance, fens hold cultural, historical, and recreational value, offering opportunities for education, research, and outdoor activities. Although some fens in Ireland are not protected as SACs or Natural Heritage Areas (NHAs), they remain crucial for biodiversity and climate resilience.

Peatland drainage and extraction transform a natural peatland which acts as a modest carbon sink into a carbon source (Waddington & McNeil, 2002; Alm *et al*. 2007; Wilson *et al*. 2015). The EPA- funded Carbon Restore Project (Wilson *et al*. 2012) found that rewetting of drained peatlands can lead to restoration of functional peatland, such as the return of typical plant and animal species, which in turn may lead to the restoration of peat-formation and the C-sink function.

The restoration of fen habitat at Balnavine fen may contribute to improve water quality in downstream waterbodies. Well-functioning fen habitat reduces the risk of dissolved organic carbon passing into water courses and has been shown to attenuate the speed at which water moves downstream thereby reducing flood risk.

1.3 Key pressures on Fens

The overarching (National) key pressures and threats to Annex I fen habitats, have been identified in the latest Status of EU Protected Habitats and Species in Ireland (Article 17 report) (NPWS 2025) in Table 1-1. The overall conservation status is assigned as Bad for 7230 Alkaline fens and 91E0 Alluvial woodland in the Article 17 report.

Table 1-1: National pressures to fen habitats

Habitat	Importance	Pressure
7230 Alkaline fens	High	PA07 Intensive grazing or overgrazing by livestock PA22 Drainage for use as agricultural land PA23 Physical alteration of water bodies (including dams, channels, etc.)
	Medium	PA01 Conversion into agricultural land (excluding drainage and burning) PA05 Abandonment of management/use of grasslands and other agricultural and agroforestry systems (e.g. cessation of grazing, mowing or traditional farming) PA08 Extensive grazing or under grazing by livestock PB24 Drainage for forestry PC06 Dumping/depositing of inert and dredged materials from terrestrial and marine extraction PF06 Deposition and treatment of waste/rubbish from built-up areas PI02 Other invasive alien species (other than species of Union concern)

Habitat	Importance	Pressure
		PL02 Drainage (mixed or unknown drivers) to surface or ground waters
	Low	PF05 Sports, tourism and leisure activities PI03 Problematic native species PE09 Land, water and air transport activities not referred to above PE01 Roads, paths, railroads and related infrastructure PC05 Peat extraction PA17 Agricultural activities generating pollution to surface or ground waters (including marine) PA20 Livestock farming generating pollution PB19 Forestry activities generating pollution to surface or ground waters (including marine) PB26 Other forestry activities, excluding those relating to forestry
91E0 Alluvial woodland	High	PB05 Logging without replanting or natural regrowth PI01 Invasive alien species of Union concern PI04 Plant and animal diseases, pathogens and pests
	Medium	PI02 Other invasive alien species (other than species of Union concern) PI03 Problematic native species PL02 Drainage (mixed or unknown drivers) PL05 Modification of hydrological flow (mixed or unknown drivers)
	Low	PA10 Livestock farming (without grazing) PB06 Logging or thinning (excluding clear cutting) PF03 Creation or development of sports, tourism and leisure infrastructure PF05 Sports, tourism and leisure activities PF06 Deposition and treatment of waste/rubbish from built-up areas

1.4 Legislative Context

There is a comprehensive system of legislation, both domestic and international, which aims to protect biodiversity at a landscape, habitat and species level in Ireland. This legislation exists within, and independently of, the planning process.

In Ireland, the most important pieces of legislation underpinning biodiversity and conservation are:

- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, hereafter referred to as the Habitats Directive.
- European Communities (Birds and Natural Habitats) Regulations, 2011 (S.I. No. 477 of 2011), as amended, hereafter referred to as the Birds and Habitats Regulations.
- Regulation (EU) 2024/1991 of the European Parliament and of the Council of June 2024 on nature restoration and amending Regulation (EU) 2022/869.
- Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds, hereafter referred to as the Birds Directive.
- Wildlife Acts 1976 to 2017, hereafter referred to as the Wildlife Acts; and
- Flora (Protection) Order, 2015 (S.I. No. 356 of 2015).

According to the EU Habitats Directive (92/43/EEC) and the EU Birds Directive (79/409/EEC), Member States are required to establish a Natura 2000 network of sites of highest biodiversity importance for rare and threatened habitats and species across the EU. In Ireland, the Natura 2000 network of European sites includes SACs and Special Protection Areas (SPAs).

The EU Nature Restoration Regulation aims to restore damaged ecosystems and improve biodiversity with particular focus on capturing and storing carbon and reducing the impact of natural disasters. Specific targets include improving and re-establishing biodiverse habitats on a large scale and bringing back species populations by improving and enlarging their habitats. EU countries are required to submit National Restoration Plans to the European Commission showing how they will deliver on the targets and monitor their progress. Member States are required to implement restoration measures for specific habitats and species, including marine ecosystems, forests, wetlands, and pollinators.

SACs are selected for the conservation of Annex I habitats (including priority types which are in danger of disappearance) and Annex II species (other than birds). SPAs are selected for the conservation of Annex I birds and all migratory birds and their habitats. The Annex habitats and species, for which each site is selected, are the qualifying interests (QI) of the SAC and special conservation interest (SCI). Conservation objectives for the site are defined for these qualifying interests.

Ireland is required to manage water resources in an integrated way under the Water Framework Directive (WFD, 2000/60/EC) and the European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003). Member States are required to submit River Basin Management Plans to the European Commission showing how they will protect and improve the water environment. Restoring surface and groundwater bodies to the equivalent of ‘good status’ or better and to protect water from any further deterioration requires collaboration at a local and national level. Implementing the WFD supports the achievement of site-specific conservation objectives for fen habitats, contributing to their favourable conservation status.

1.5 Outline of this FRP document

- Section 2 of this FRP report outlines details of Balnavine Fen site and the pressures and threats reported for 7230 Alkaline fens and 91E0 Alluvial woodland habitats.
- Section 3 outlines the findings from the land and water desktop and site monitoring surveys that were carried out to inform the development of this FRP.
- Section 4 outlines the findings from the ecological desktop and site monitoring surveys that were carried out to inform the development of this FRP.
- Section 5 provides a summary of the key pressures identified by this FRP report that are impacting on fen.
- Section 6 outlines the key restoration measures proposed by this FRP.
- Section 7 outlines additional considerations to inform the development of the FRP.
- Section 8 outlines key players in the FRP, summarises restoration actions proposed, habitats that will benefit and further steps required to prepare for implementation.

Restoration actions proposed by this FRP assessment have been mapped in GIS format and delivered to NPWS in accordance with NPWS data standards (see Appendix D for details of GIS layers provided). This includes detailed mapping of the key pressures addressed by this assessment, detailed mapping of proposed restoration actions, ecological survey results and referenced sensitivity areas. GIS Shapefiles which accompany this report include all relevant data on referenced species.

2 Site Overview

2.1 Balnavine fen

Balnavine Fen is located 24 km north-west of Mullingar, in Co. Westmeath and is not designated as a European or nationally designated site such as an SAC/SPA or an NHA/proposed NHA. Balnavine fen is a small (~5ha) cutover bog, with raised areas of acid peat interspersed with deeper cuttings extending down to calcareous/base rich ground water.

Balnavine Fen supports Annex I quality 7230 Alkaline fens, which are dominant in the northeast and present in smaller patches in the south. The site also contains minor areas of 91E0 Alluvial woodland and other habitats, including rich fen, dry meadows, wet willow-alder-ash woodland, bog woodland, and scrub. Approximately 50–60% of the site comprises 7230 Alkaline fen, surrounded by birch-dominated bog woodland, with scattered scrub encroachment. The fen supports degraded rich fen which is being encroached by downy birch (*Betula pubescens)* and gorse (*Ulex* sp.) scrub which appears to be occurring due to the hydrological changes or groundwater drawdown from the site. These drier conditions have allowed the expansion of the downy birch and gorse into areas of fen.

There are wide drains around the southern and western sections of the site. Some of these are largely unvegetated, while others are fully vegetated with species such as bogbean (*Menyanthes trifoliata*), pondweed (*Potamogeton* sp.) and beaked sedge (*Carex rostrata*). One drain along the southeast still retained water and is fully vegetated with fool's watercress (*Apium nodiflorum*).

The site lies within lands benefitting from the Arterial Drainage Scheme and forms part of the OPW Arterial Drainage Scheme (DS), at which local authorities are responsible for maintenance under the Arterial Drainage Act (1945). Surface water flow is predominantly southwards towards Lough Adeel. Historical maps (1829–1913) show no evidence of drains, while the current drainage network consists of drains around the site boundary on the side of the road and also bisecting the site.

The site is located within the Boyne Catchment and is primarily drained by tributaries of the Lough Lene-Adeel Stream_010. For the purposes of the Water Framework Directive most of the Balnavine Fen is located within the Deel [Raharney]_SC_010 sub-catchment.

Figure 2-1 outlines the location and extent of Balnavine Fen.



Figure 2-1: Site Location Map

2.1.1 Fen Condition Assessment

Balnavine Fen was surveyed as part of the NFS on the 13th of July 2022 (Brophy et al., In prep). During the NFS, the following observations were noted by the author:

- Scattered scrub encroachment (birch and willow) across approximately 50% of the area, more notably so in the southern section
- There are wide drains around the southern and western sections of the site

The structure & functions of the following Annex I quality habitat was recorded as part of the NFS:

- 7230 Alkaline fens: Unfavourable-Bad

2.1.2 Site-specific conservation objectives

As Balnavine Fen is not an SAC, it does not have Site-Specific Conservation Objectives (SSCO). Attributes and targets for Annex I habitats vary and are specific to each site, therefore while they cannot be directly applied to Balnavine Fen, general conservation objectives can be applied as a basis to inform favourable conservation status of the fen habitats. This includes measures such as maintaining appropriate hydrological levels and quality or abundance of vegetation communities and appropriate physical structure relevant to Annex I habitats.

3 Land and Water

3.1 Desktop Study

3.1.1 Meteorological Conditions

Understanding long-term meteorological patterns is key for informing effective fen restoration planning, particularly with respect to hydrological dynamics. To support this, historical precipitation data over the past 18 years from the closest Met Éireann weather station, (COLLINSTOWN (Lough Bawn)), which was opened in 2007, has been reviewed to assess seasonal variability in rainfall at the site and surrounding areas (Met Eireann, 2025).

Two datasets have been visualised: (1) average monthly precipitation (mm), incorporating an 18-year period to show seasonal distribution patterns (Figure 3-1) and (2) total annual precipitation (mm) for each year within the 18-year record (Figure 3-2), to identify longitudinal trends. This information is important to assess water availability and evaluate the feasibility and sustainability of restoration actions aimed at restoring or maintaining suitable hydrological conditions.

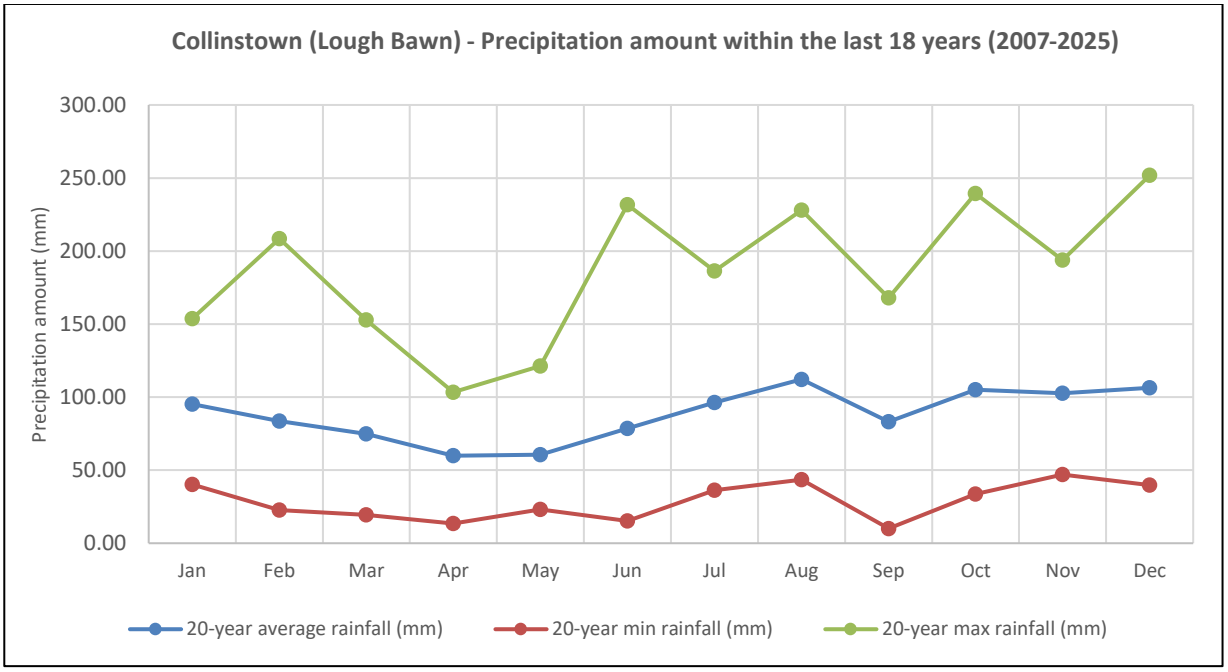


Figure 3-1: Collinstown (Lough Bawn) – Average, minimum and maximum precipitation within the last 18 years (2007-2025)

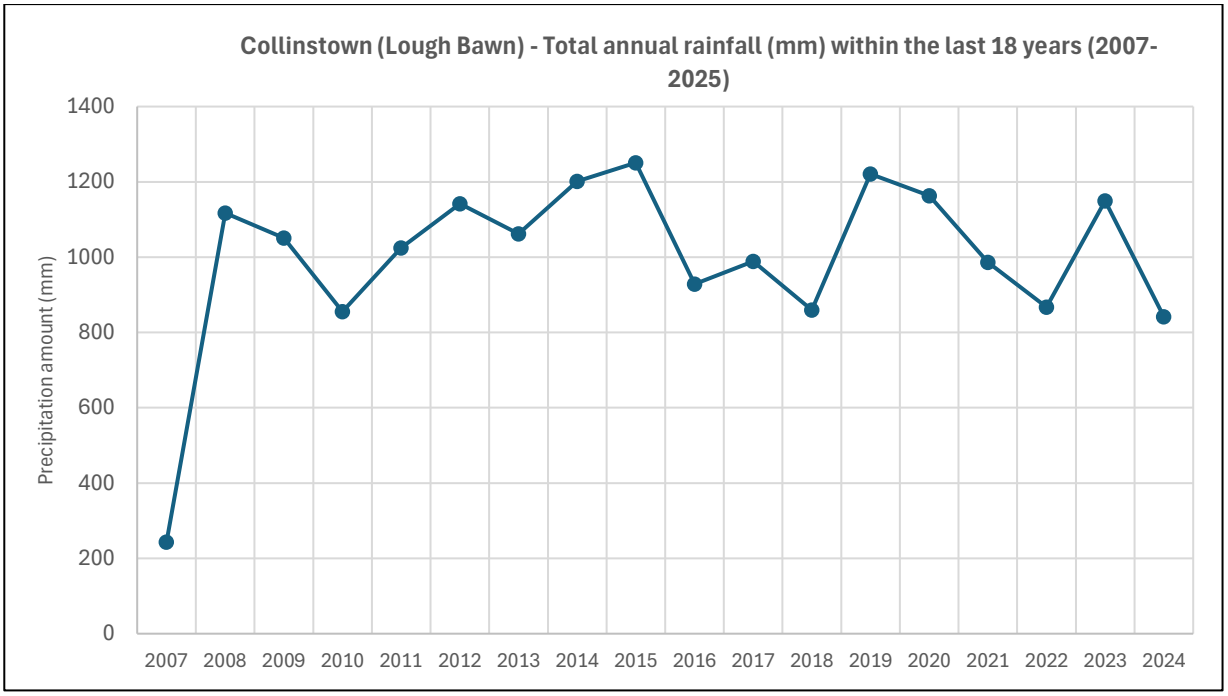


Figure 3-2: Collinstown (Lough Bawn) – Total annual precipitation within the last 18 years (2007-2025)

The 18-year monthly rainfall data show clear seasonal variation, indicating that the rainfall is typically highest in late autumn and winter, and lowest in spring (notably in April and May). The maximum monthly precipitation is higher during the winter, which relates to the wettest periods of the year.

Total annual precipitation also varies between years, indicating inter-annual variability that is relevant when considering baseline hydrological conditions and the application of the restoration measures under both wetter and drier climate conditions.

3.1.2 Hydrogeological Setting

The site is underlain by the Derravaragh Cherts comprised of chert limestone and minor shales. The bedrock geology is presented in Figure 3-3. Additionally, there are some outcrops located to the north of the site.

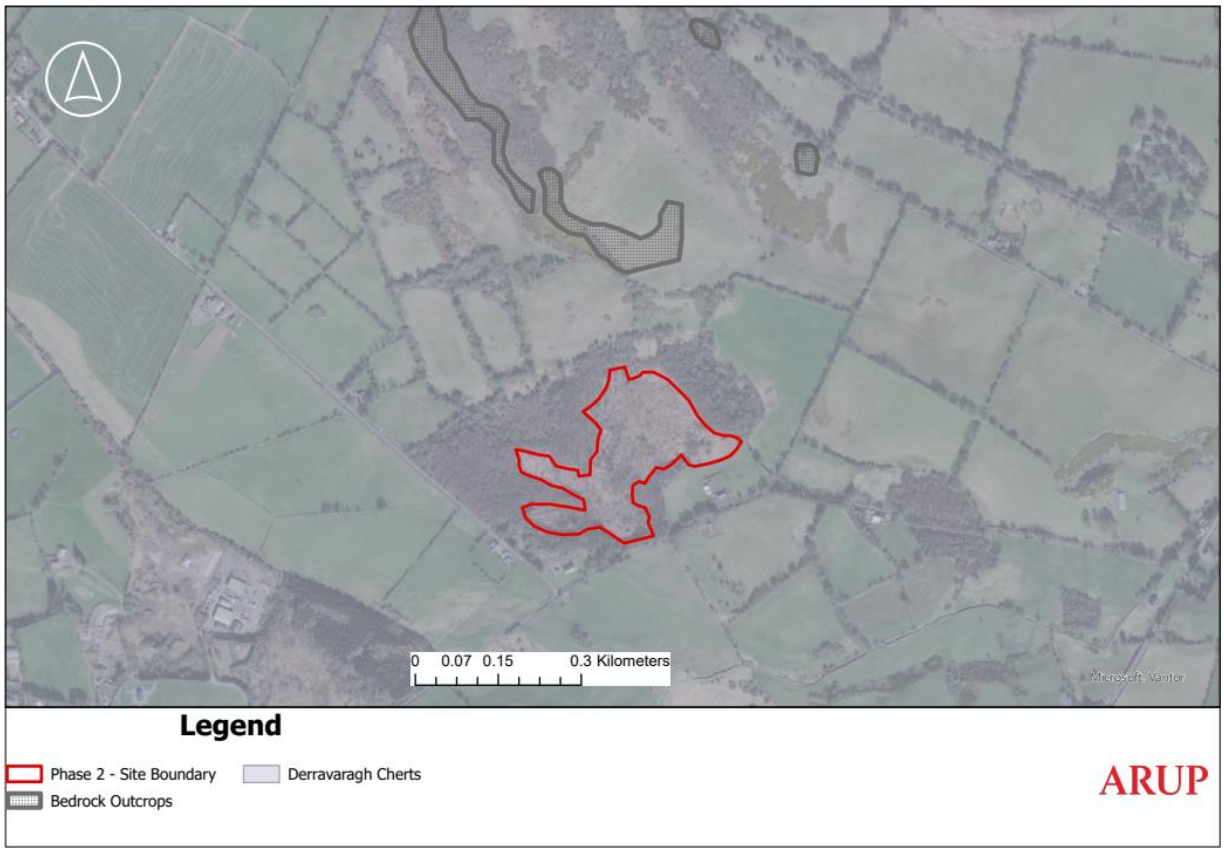


Figure 3-3: Bedrock Geology of Balnavine Fen (Source: GSI)

3.1.3 Hydrogeological Characteristics

The site is underlain by a Locally Important Karstified Bedrock Aquifer (Lk), which falls within the Dinantian Upper Impure Limestone (DUIL) hydrostratigraphic rock unit. These aquifers are characterised by Karstified limestone, typically too small to be classified as 'Regionally Important'. They are not subdivided into karst sub-types such as diffuse or conduit systems. The presence of karstification suggests the possibility of deeper groundwater flow paths within the bedrock beneath the site. The aquifer classification underlying the site is illustrated in Figure 3-4.

Additionally, according to the GSI karst landforms mapping, there are some enclosed depressions located to the north and northeast of the site. These features, along with the bedrock outcrops mentioned in the previous section, suggests the presence of a groundwater recharge zone in this area. The enclosed depressions are indicative of karst processes, which therefore facilitate the movement and infiltration of water into the subsurface. The combination of these karst features and exposed bedrock suggests that the northern and northeastern portions of the site are significant for groundwater recharge.

The Athboy groundwater body, which underlies the site, currently is classified with a 'good' status and is assessed as 'not at risk' of failing to meet its Water Framework Directive (WFD) objectives.

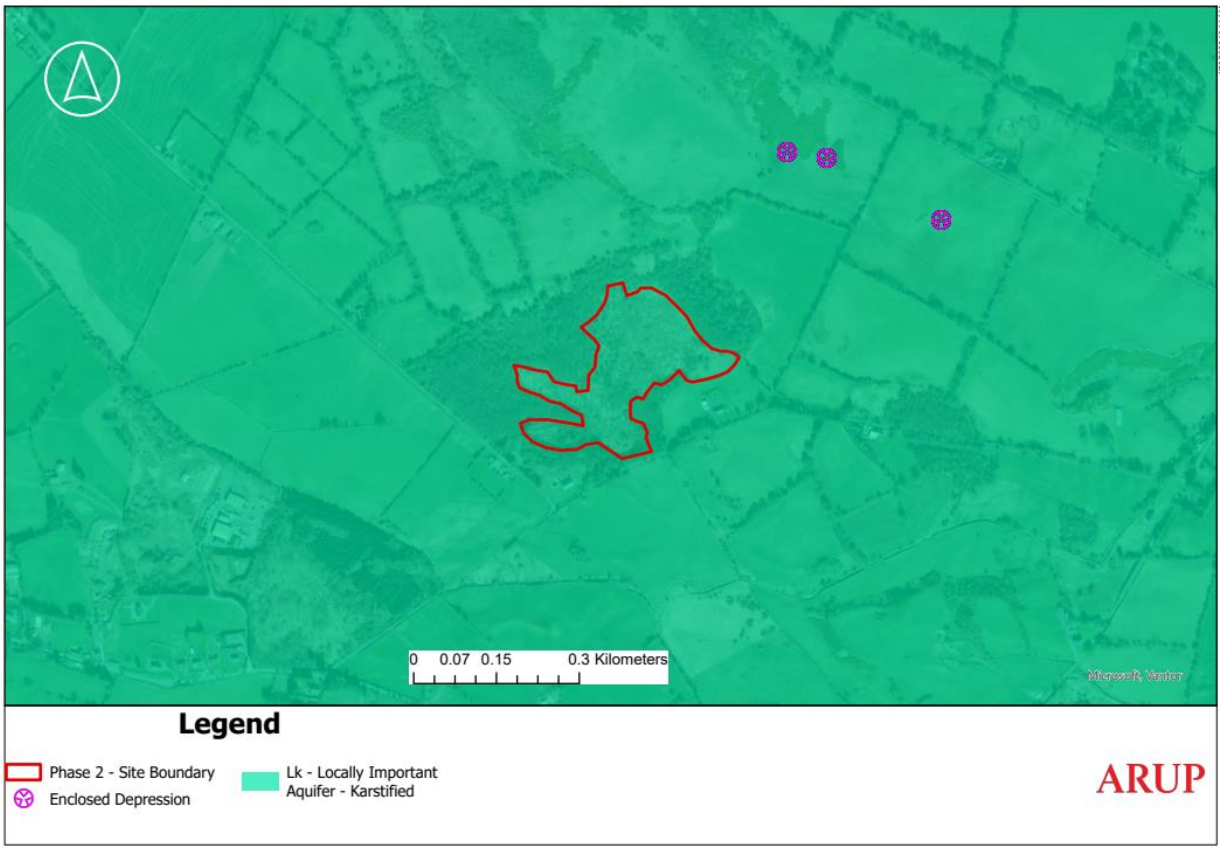


Figure 3-4: Aquifer classification and karst underlying Balnavine Fen (Source: GSI)

Quaternary sediments within the site boundary comprise Fen peat (FenPt), with areas of cut-over raised peat occurring both within and adjacent to the fen. To the south, the subsoils transition to limestone-derived gravels, while to the north, the site is characterised by till derived from cherts. Localised areas of higher elevation in the northern area also expose bedrock at the surface. The subsoil map is shown in Figure 3-5.

Peat depth recorded during previous National Fen Surveys (Brophy et al., In prep), reached up to a depth of 3.1 m, confirming the presence of deep, intact peat layers in parts of the site. Teagasc soil mapping identifies the dominant soil type as cut-over peat, consistent with historical peat extraction activities.

Groundwater vulnerability is not uniform across the site and varies according to the underlying subsoil and bedrock conditions. In areas where fen peat overlies the bedrock, the vulnerability is moderate. In contrast, it becomes higher in regions where tills and gravels are present. There is a zone of extreme groundwater vulnerability in the northern part of the site, where bedrock is exposed at the surface. The groundwater vulnerability map is presented in Figure 3-6.

Recharge rates follow a similar spatial pattern, reflecting the influence of subsoil type on the water infiltration. In areas dominated by gravel and till deposits, recharge rates are relatively high, estimated to range from approximately 350 to 500 mm per year. Where the site is

covered by peat, recharge rates are significantly lower, typically between 1 and 50 mm per year.

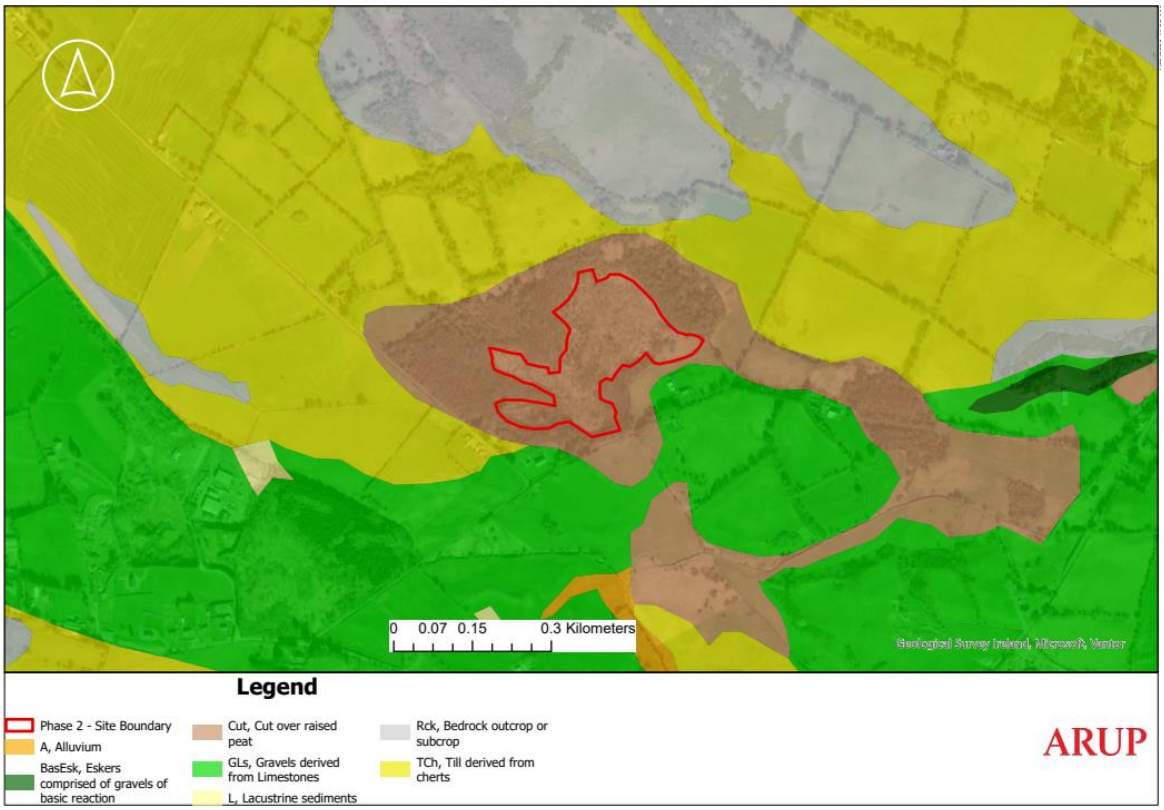


Figure 3-5: Sub-soil type underlying Balnavine Fen (Source: GSI)

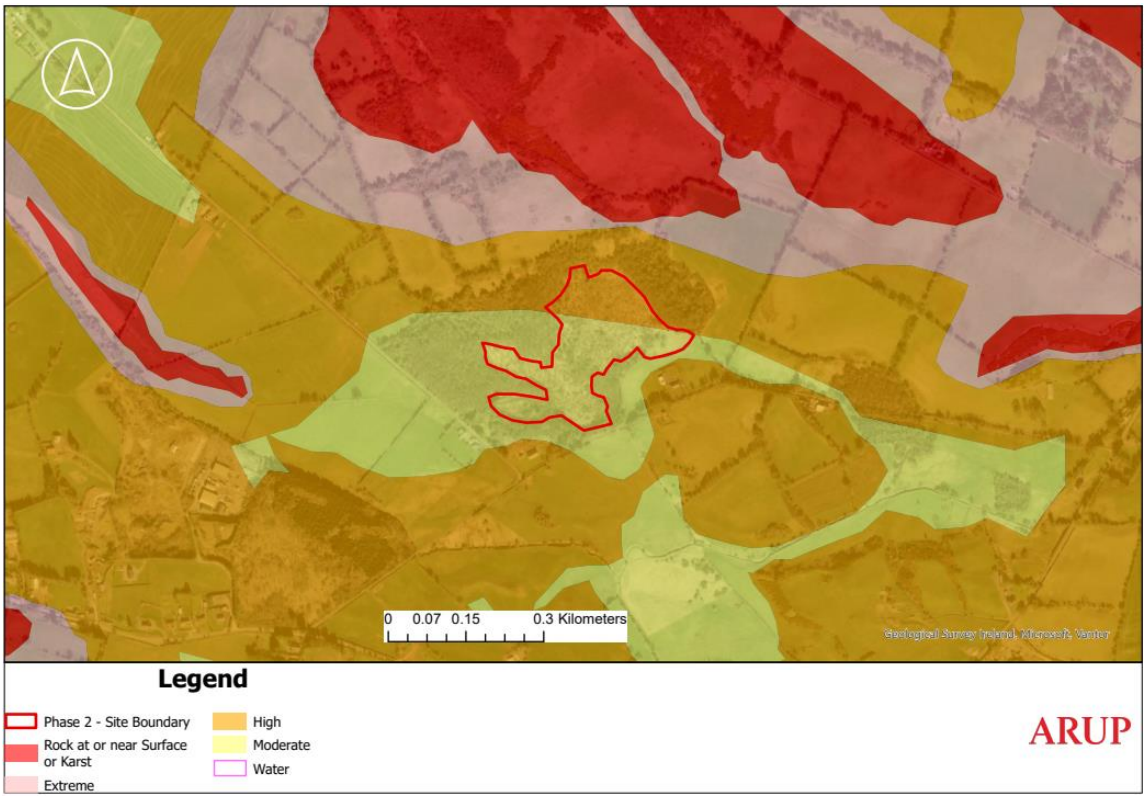


Figure 3-6: Groundwater vulnerability map for Balnavine Fen (Source: GSI)

3.1.4 Topographic and Surface Water Drainage

The site is situated within the Boyne Water Framework Directive (WFD) Catchment and specifically falls under the Deel [Raharney]_SC_010 WFD sub-catchment, as illustrated in Figure 3-7. The WFD River waterbody associated with the site is currently assessed as having 'good status,' and it is considered 'not at risk' of failing to achieve its WFD objectives.

The topography of the site is mainly flat (around 102 mOD) and gradually rises towards the north and northwest, reaching approximately 110 mOD in these areas. Beyond the site boundary, the landscape becomes notably elevated in the northern and northeastern. This area shows bedrock outcrops and karst features (dolines), rising to around 150 mOD. To the south of the site, the elevation drops to below 90 mOD, near Lough Adeel.

Balnavine Fen has been identified as an area for restoration under the River Basin Management Plan for Ireland 2018-2021 (2nd cycle). This area comprises five waterbodies, including the Lough Lene-Adeel Stream. Prior to the implementation of the management plan, the Lough Lene-Adeel waterbody was classified as being 'at risk'. However, following completion of the plan, the waterbody's status has improved, and it is no longer considered at risk.

An assessment of both historical and current hydrological records has indicated that, according to mapping from 1829 to 1913, no drainage channels were present within the site during this period. Currently, there is a drainage channel situated in the central part of the site and directs its flow towards the southeast. In addition to this drain, drainage channels are located along the southern and western boundaries.

According to the National Fen Survey carried out in 2022 (Brophy et al., In prep) there are drains around the site boundary on the side of the road and also bisecting the site. Although some were dry at the time of survey, most of them are wide and deep. Some drains remain stagnant, while others are hydraulically connected to neighbouring land parcels, facilitating water movement beyond the site boundary. The main drain is the one bisecting the site, which is flowing to the southeast. The drain along the western boundary is characterised by an absence of visible flow, suggesting stagnant water or minimal movement. In contrast, the drain found along the southern boundary is actively flowing towards the southwest. Overall, the predominant direction of surface water flow across the site is towards the south, which discharge ultimately entering Lough Adeel. These details are represented in Figure 3-8.

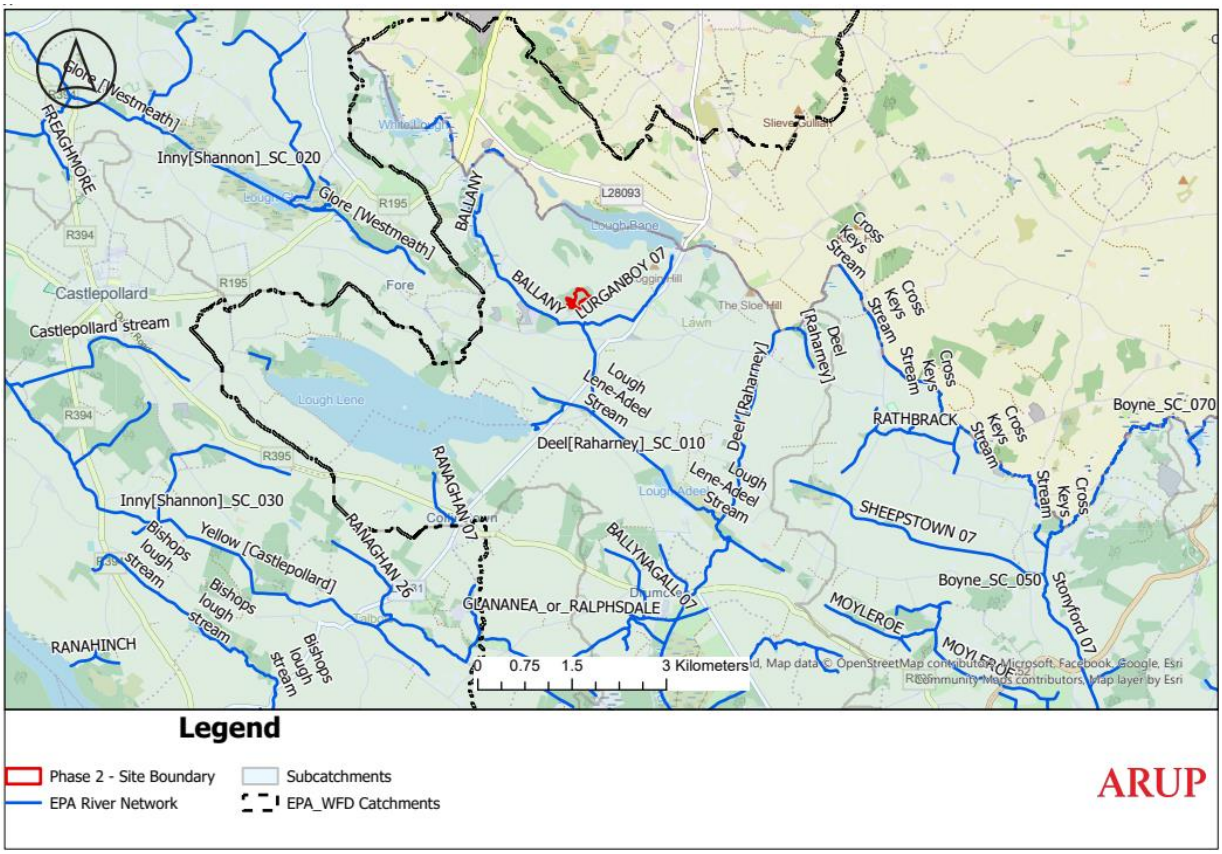


Figure 3-7: WFD Catchment and River sub-basin (EPA, 2025)

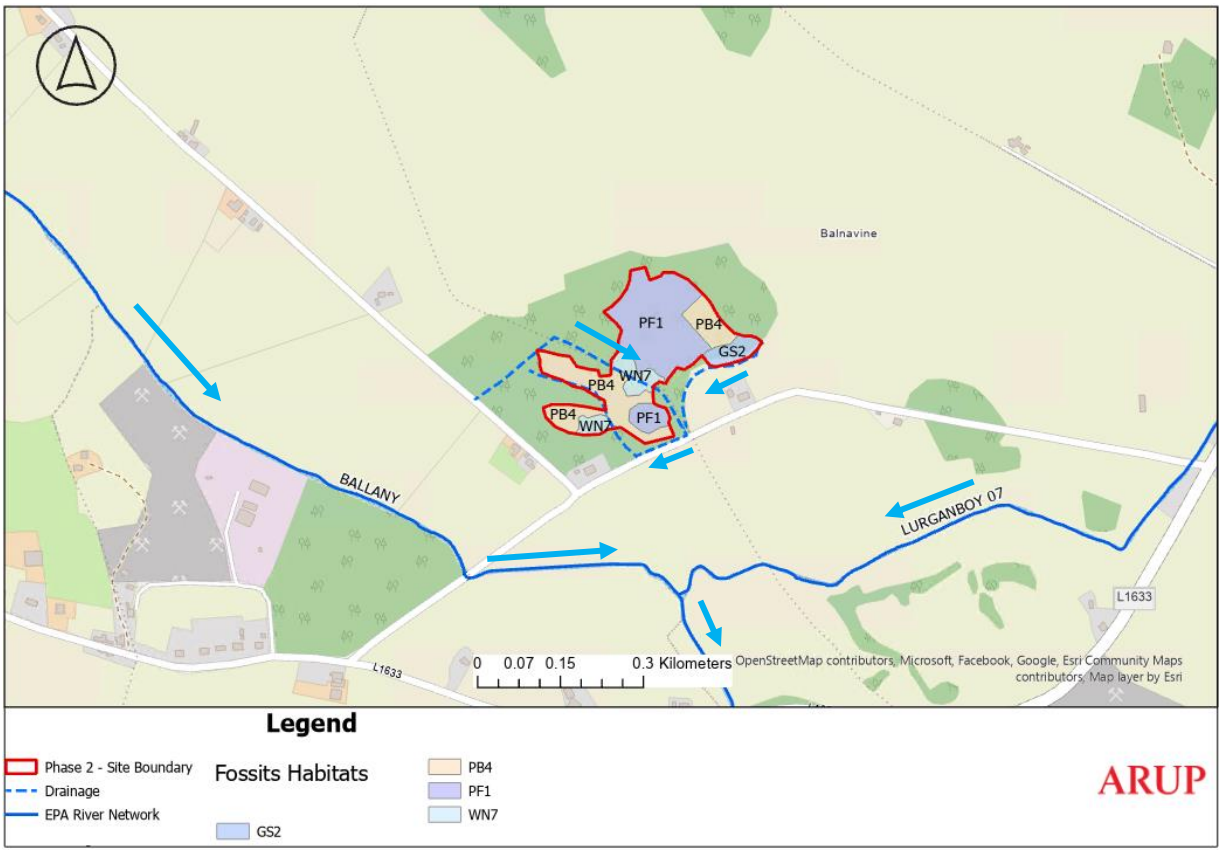


Figure 3-8: Mapped drainage network at Balnavine Fen

The mapped Wetness Index for the site indicates that it is classified as temporarily wet. This classification reflects alternating periods of saturation and dryness between 2012 and 2018. Such variability in soil moisture conditions creates a mosaic across the landscape, which supports intermittent wetland characteristics throughout the site Figure 3-9.

An analysis of total productivity from 2017 to the present indicates that Balnavine Fen shows moderate productivity levels (Figure 3-10). This status is commonly associated with semi-degraded peatland habitats that have been affected by drainage and increasing vegetation encroachment. These patterns are further reflected in aerial imagery.

Aerial photographs from 2009, 2017, 2021, and 2025 (Figure 3-11) display a clear progression of vegetation growth across the site. The imagery shows changes over this period, with increased vegetation coverage indicating an ongoing habitat transformation.

Figure 3-12 and Figure 3-13 show the Digital Terrain Model (DTM) map and the site photogrammetry, both generated from LiDAR images of Balnavine Fen. These images show that the most expressive drain is located within the southern boundary of the site, followed by another drain located in the western section of the site, running perpendicular to the central drain, as well as a second western drain oriented in a northeast–southwest direction.

The central drain appears to be most pronounced in the southeast part of the site, becoming progressively less distinct towards the northwest. From the central area northwards, the drain becomes increasingly difficult to identify in the LiDAR images and, in places, is almost no longer visible.

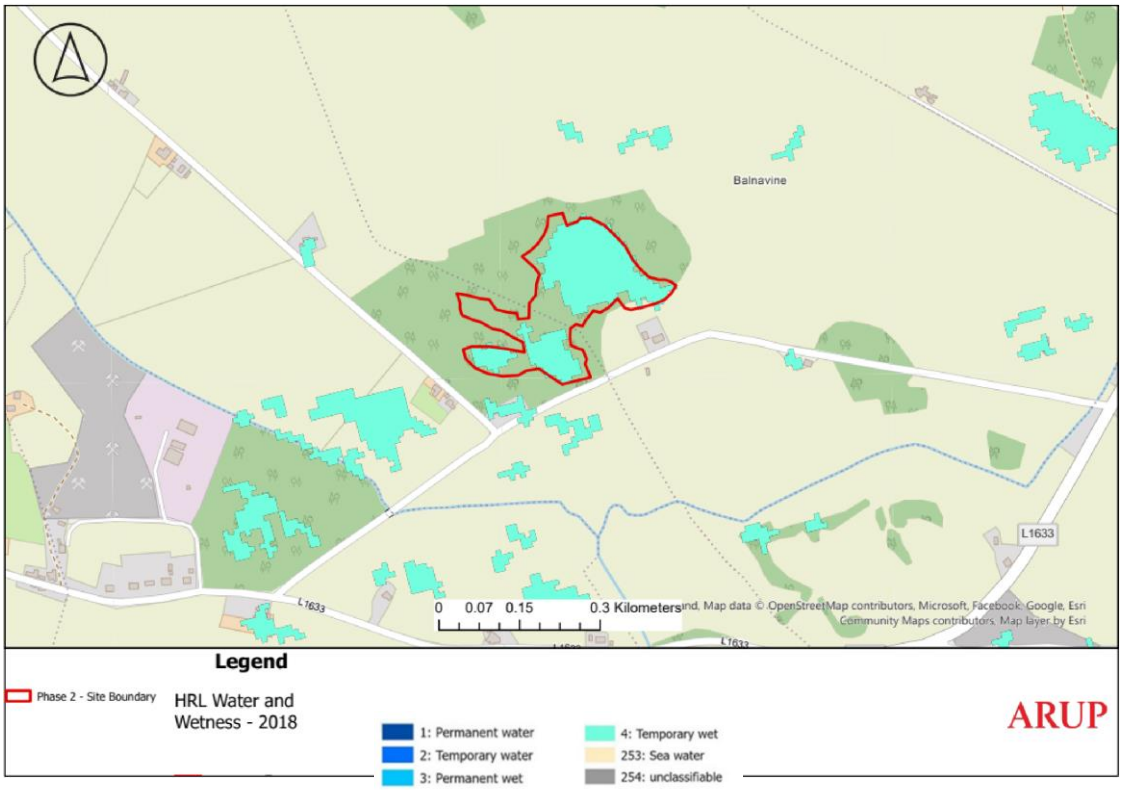


Figure 3-9: HRL Water and Wetness – 2018 Balnavine Fen (Copernicus, 2025)

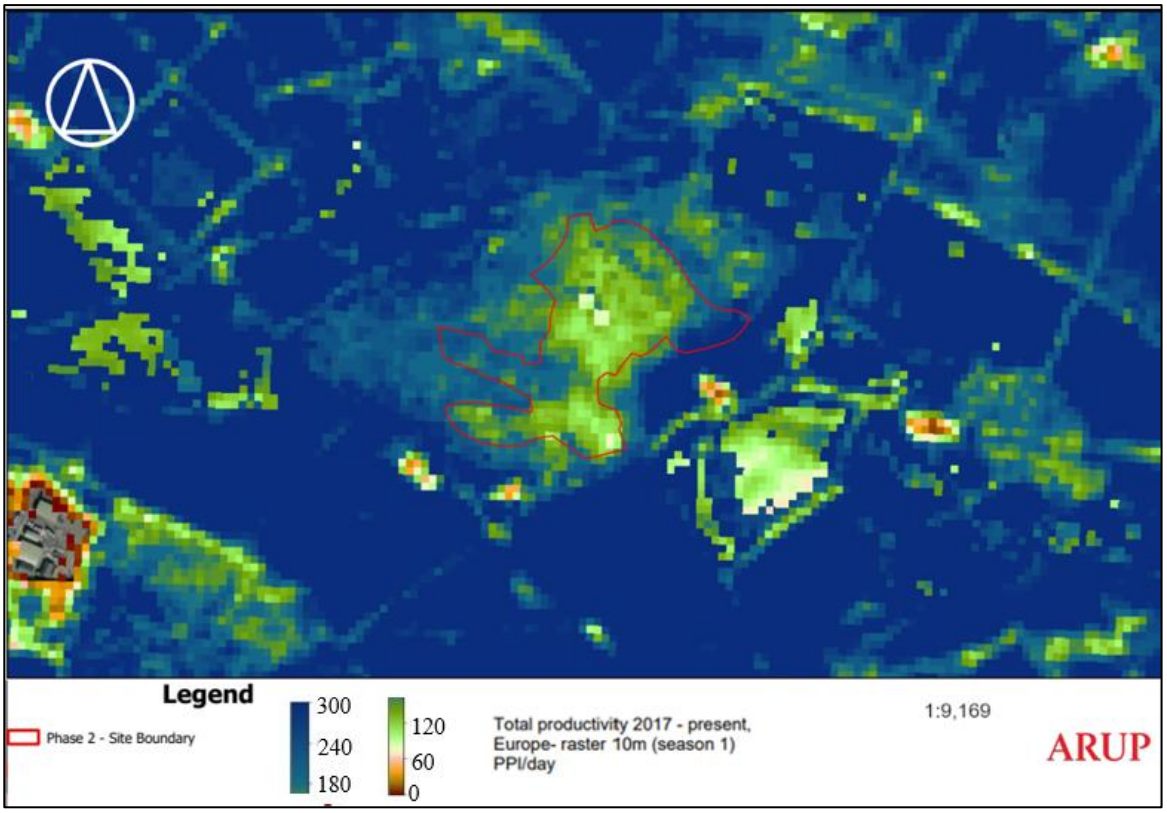


Figure 3-10: Total Productivity 2017 -present, Europe – raster 10m (season 1) Balnavine Fen (Copernicus, 2025)

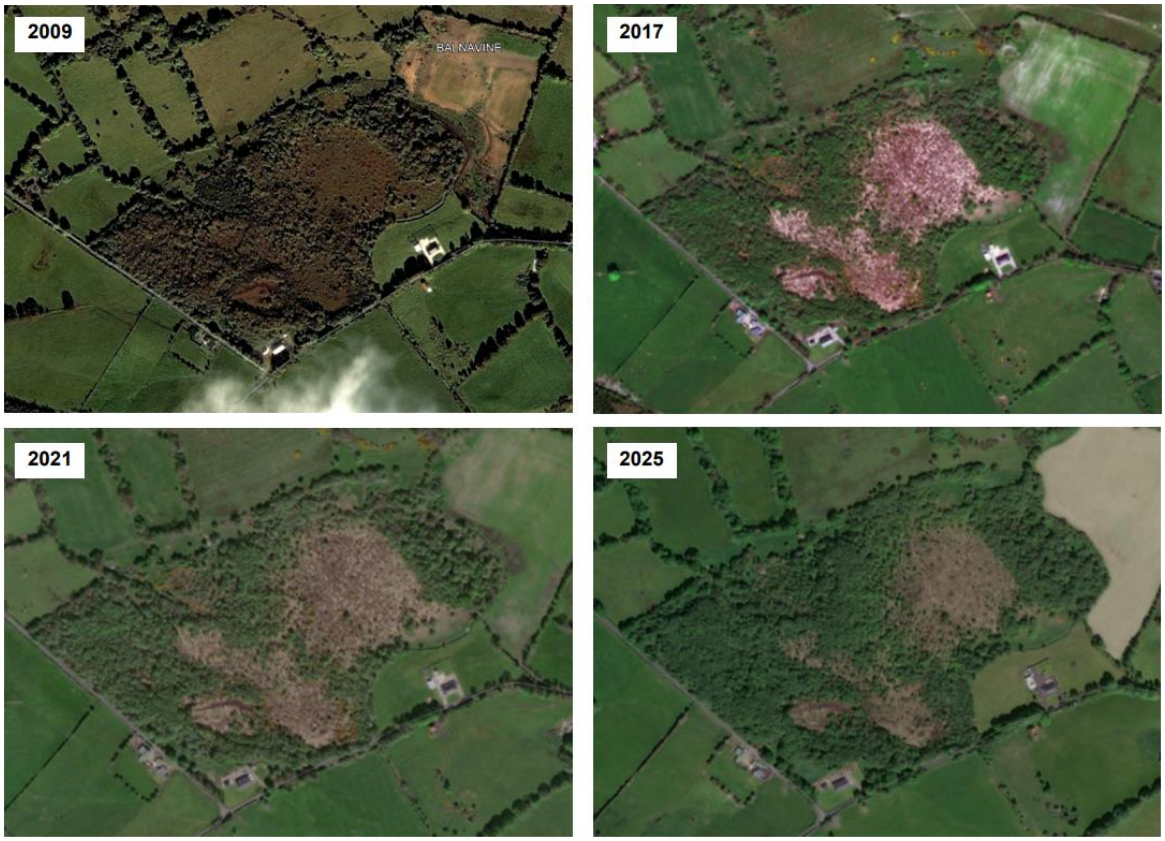


Figure 3-11: Aerial imagery from the years 2009, 2017, 2021 and 2025

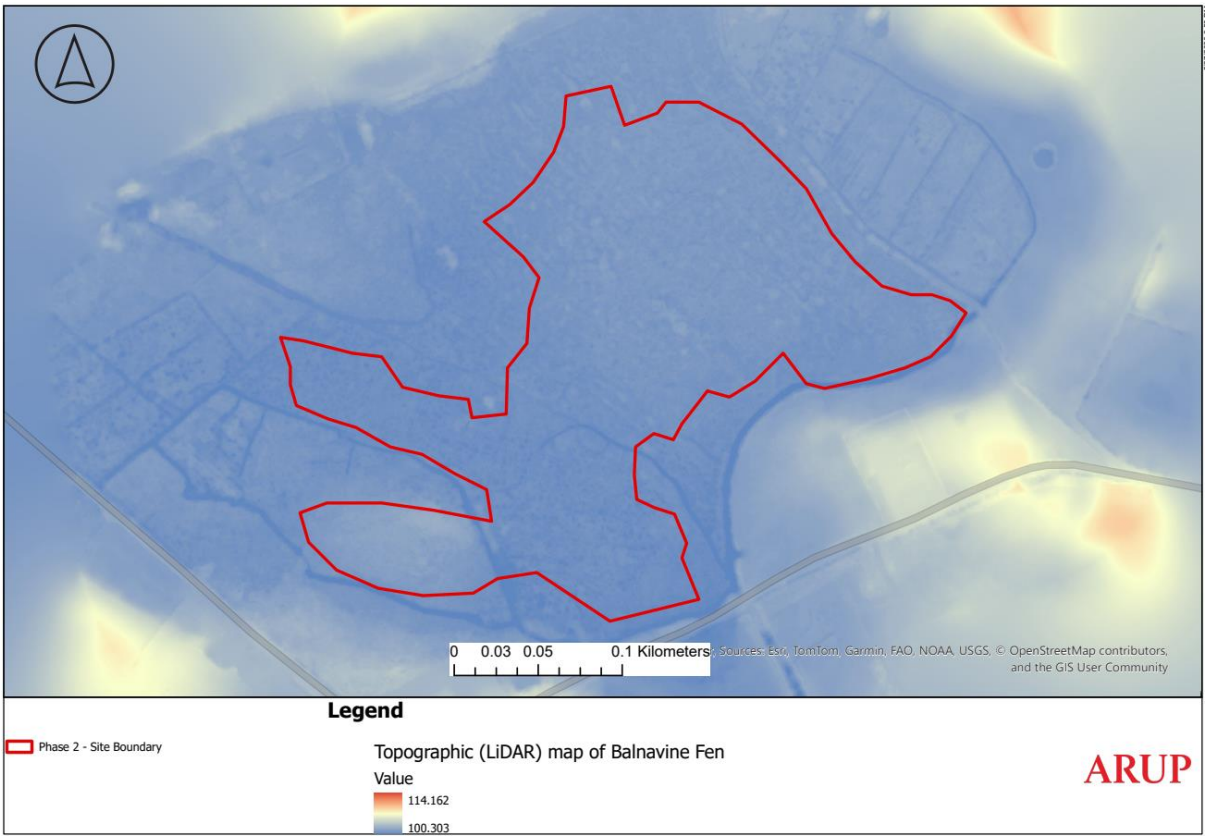


Figure 3-12: DTM Topographic (LiDAR) map of Balnavine Fen

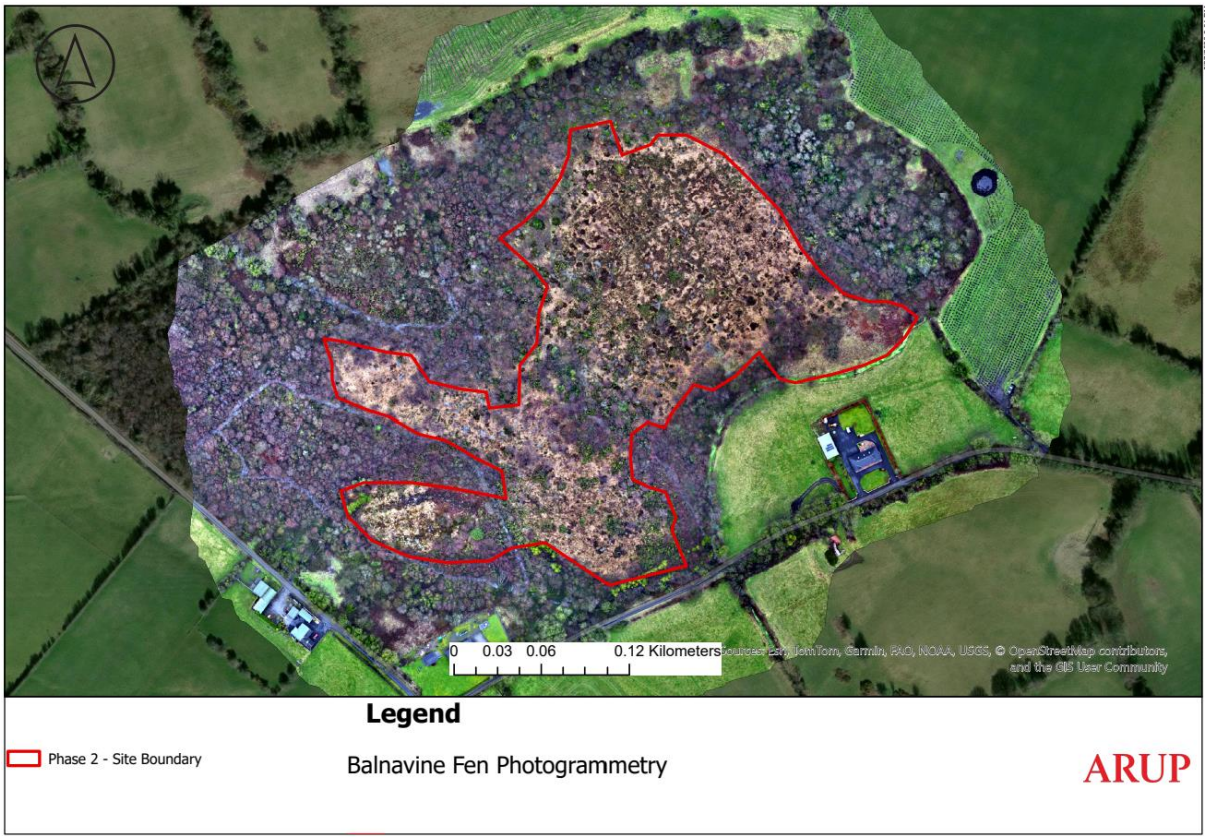


Figure 3-13: Site Photogrammetry map of Balnavine Fen

3.1.5 Land use Pressures and Water Quality

Pollution Impact Potential (PIP) maps (EPA 2025) show the highest risk areas in the landscape for losses of nitrate and phosphorus to waterbodies. The PIP models estimate the annual nutrient losses from agricultural land using spatial data on farm management, soil and hydrogeology.

Areas identified as high risk for phosphorus loss are typically characterised by poorly draining soils and dominant overland flow pathways. Such conditions facilitate the movement of phosphorus from the land surface into nearby waterbodies. PIP phosphorus mapping across the site shows that the majority are of medium risk, with areas of higher risk situated on the eastern side. Additionally, according to the flow delivery path map, potential preferential pathways have been identified in the eastern portion of the site. These pathways may provide direct routes for phosphorus movement towards the fen, highlighting specific locations that could be targeted for measures. Flow delivery paths and points for phosphorus across the site is presented in Figure 3-14.

Areas characterised by freely draining soils and significant groundwater pathways are recognised as high-risk zones for nitrate losses. Within the context of Balnavine Fen and its surroundings, the overall risk of nitrate loss is generally assessed as low to medium. However, the northern portion of the site exhibits a notably higher risk, classified as Rank 3. According to the Targeting Agricultural Measures map, Balnavine Fen is designated as an Orange Flag area, which indicates that the site is at risk for nitrate losses.

PIP maps for phosphorus and nitrate are presented in Figure 3-15 and Figure 3-16, respectively. The Targeting Agricultural Measures Map is presented in Figure 3-17.



Figure 3-14: PIP- P Flow delivery paths and points for Phosphorus (EPA, 2021)

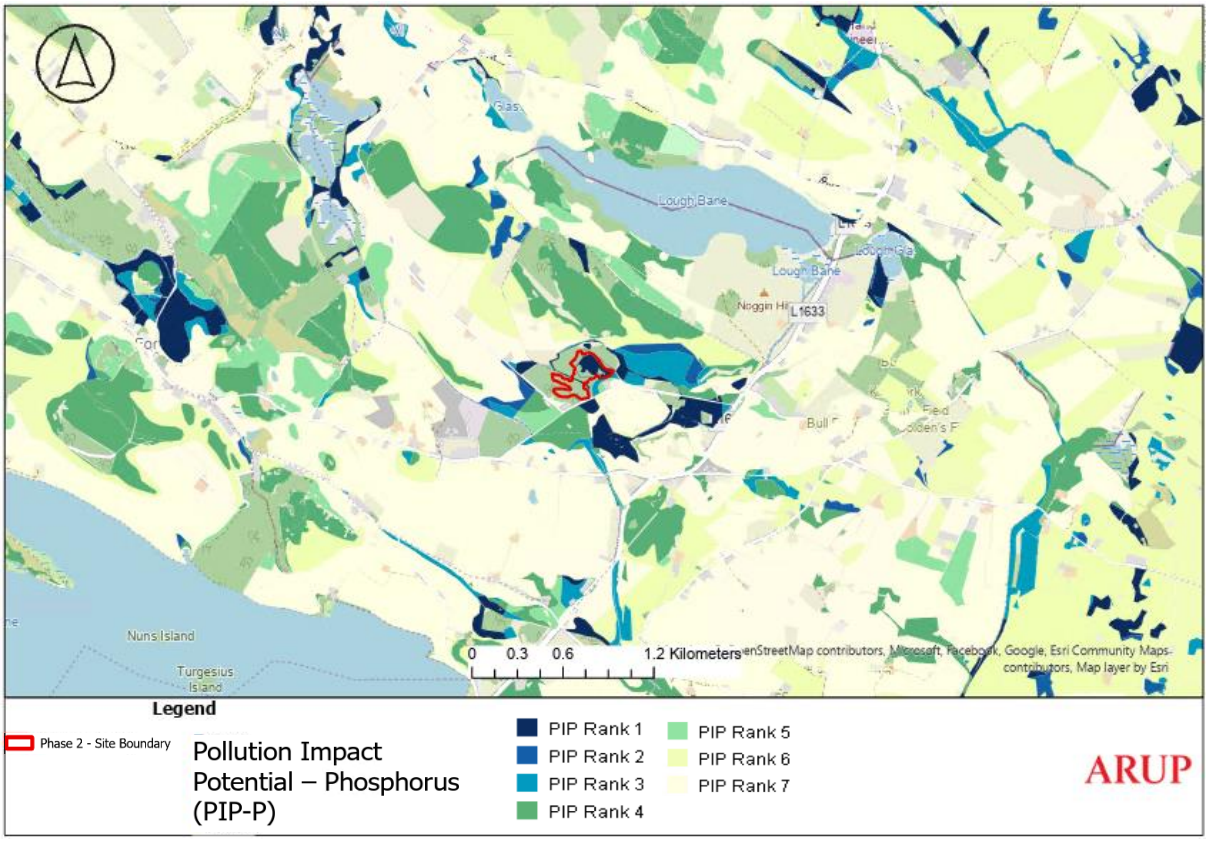


Figure 3-15: PIP maps (Phosphorus) of Balnavine Fen

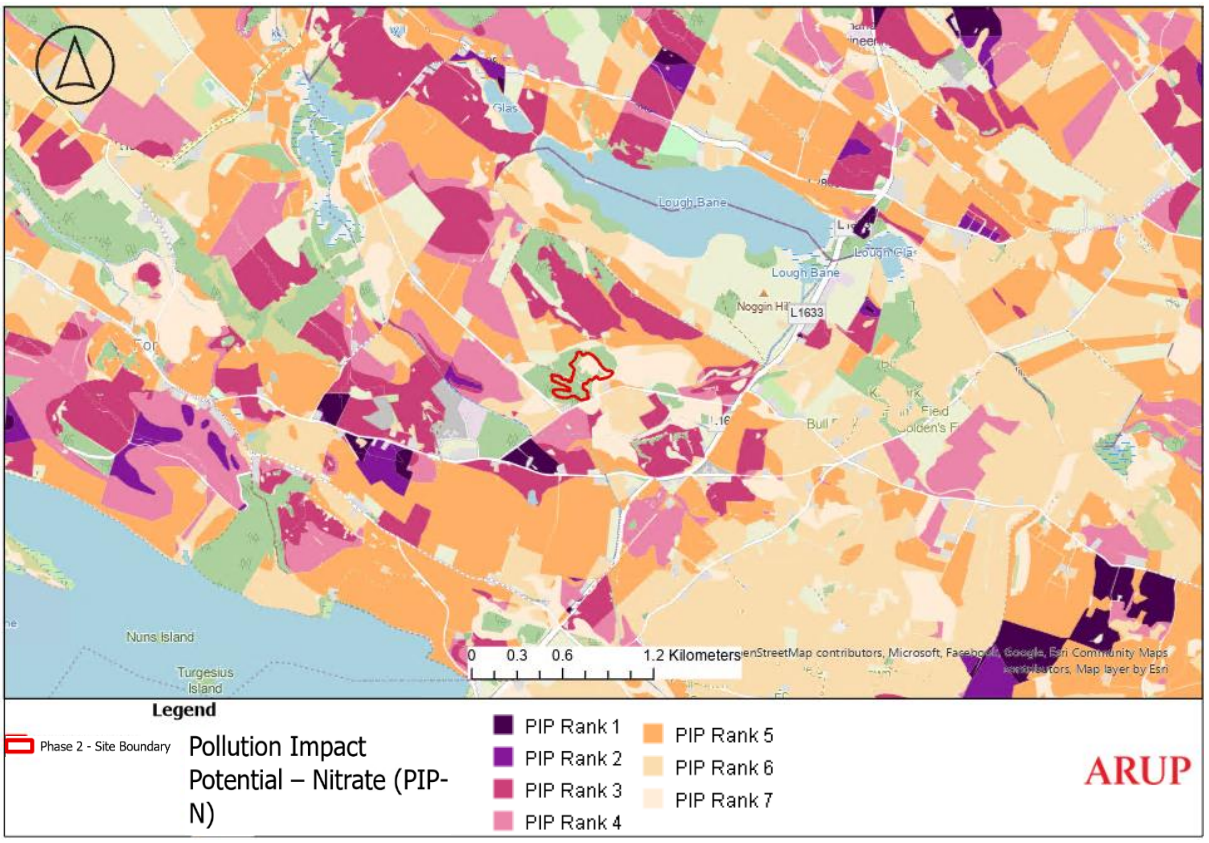


Figure 3-16: PIP maps (Nitrate) of Balnavine Fen

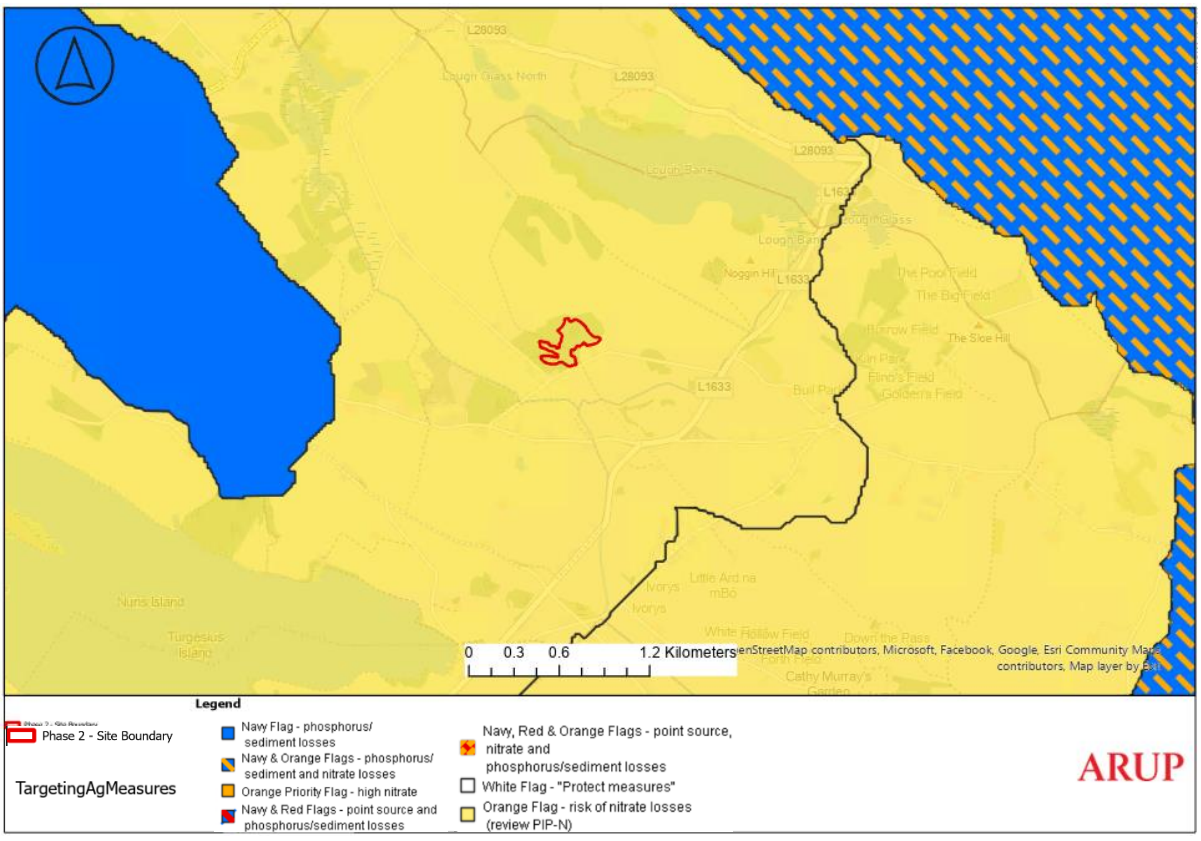


Figure 3-17: Targeting Agricultural Measures map of Balnavine Fen

3.2 Field Survey: Monitoring Activities

Electrical Conductivity (EC), pH, and peat depth data were recorded as part of the National Fen Survey (Brophy et al., In prep). EC was recorded at 600 µS/cm and pH at 6.03 in one location. Peat depth was also recorded at one location with a depth of 310 cm. However, the spatial location of these measurements was not provided.

Site monitoring was undertaken in February and April 2026, focusing on developing the understanding of the water regime, pressures and implementation of restoration measures within the site. The monitoring included peat depth probing, water quality monitoring, and observations of water flow in the drainage network.

Water quality data were collected from several areas within the site and its surroundings. Samples were obtained from the drain located in the central area, as well as from drains situated along the southern and western boundaries. pH, EC, temperature, dissolved oxygen (DO), nitrate, and phosphate were recorded during the monitoring. Observations of water flow were made throughout the site's drainage network to further understand hydrological dynamics. Peat depths were measured at various locations across the site to assess substrate characteristics.

3.2.1 Peat Depth Probing and Ground Investigations

Peat depth probing was conducted throughout the site to assess substrate characteristics (Figure 3-18). The first site visit, held in February 2026, involved peat depth measurements at two locations in the northern area. Both locations showed deep peat, with recorded depths of 3.5 m at each location. These findings are consistent with those from previous National Fen Surveys (Brophy et al., In prep), which documented a peat depth of 310 centimetres based on a single measurement across the site, however no spatial location was reported for this measurement.

During the subsequent site visit in April 2026, peat depth was measured in the central portion of the site, near the central drain. The observed peat depth at this location was 1.5 m. Peat depth was also measured at two locations in the southern portion of the site, which recorded depths of approximately 3.1 m at each location.

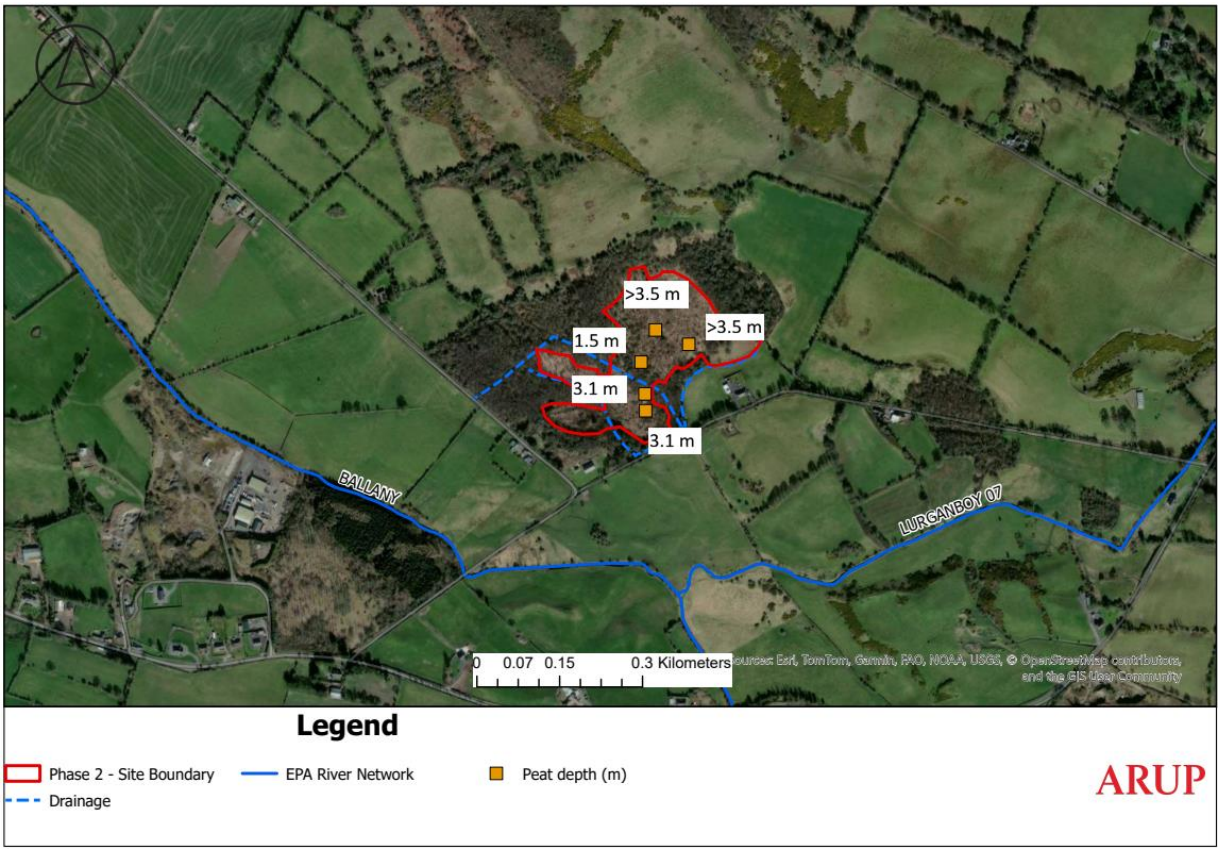


Figure 3-18: Peat depth (m) at Balnavine Fen

3.2.2 Surface Water Drainage

Drainage Network Description

Surface water conditions across the site showed variation during the site visits, particularly in relation to flow regimes and types of drainage features observed. Water monitoring locations are presented in Figure 3-19.

A central drain traverses the site, measuring approximately 1.5 m in width and 0.2 m in depth, and flows in a southeasterly direction. During the site visit, this central drain was found with only a limited amount of water, and was heavily overgrown with grasses, fallen branches, and trees, which littered the channel.

The southern portion of the site is characterised by a drain approximately 3 m wide and 0.75 m deep. This drain showed active water flow moving towards the southwest. Its banks were densely vegetated, with bracken, grasses, mosses, and woody plants providing substantial shading and coverage.

Along the western boundary, a drain-oriented northeast to southwest was observed. This drain exceeds 2 m in width and is about 1 m deep. Unlike the southern drain, the western boundary drain did not show visible water flow. The banks are fully vegetated, and the bed of the drain supports established vegetation. A second drain, located in the western part of the

site, was also noted during the visit; it was completely dry, with vegetation present in the channel bed indicating a persistent lack of surface water.

To the south of the site, beneath the Balnavine road, a stream of approximately 5 m in width and around 2 m in depth was observed. The stream flows out of the fen in a southeasterly direction. The channel is deep, with abundant vegetation along its banks, and the water appeared clear.

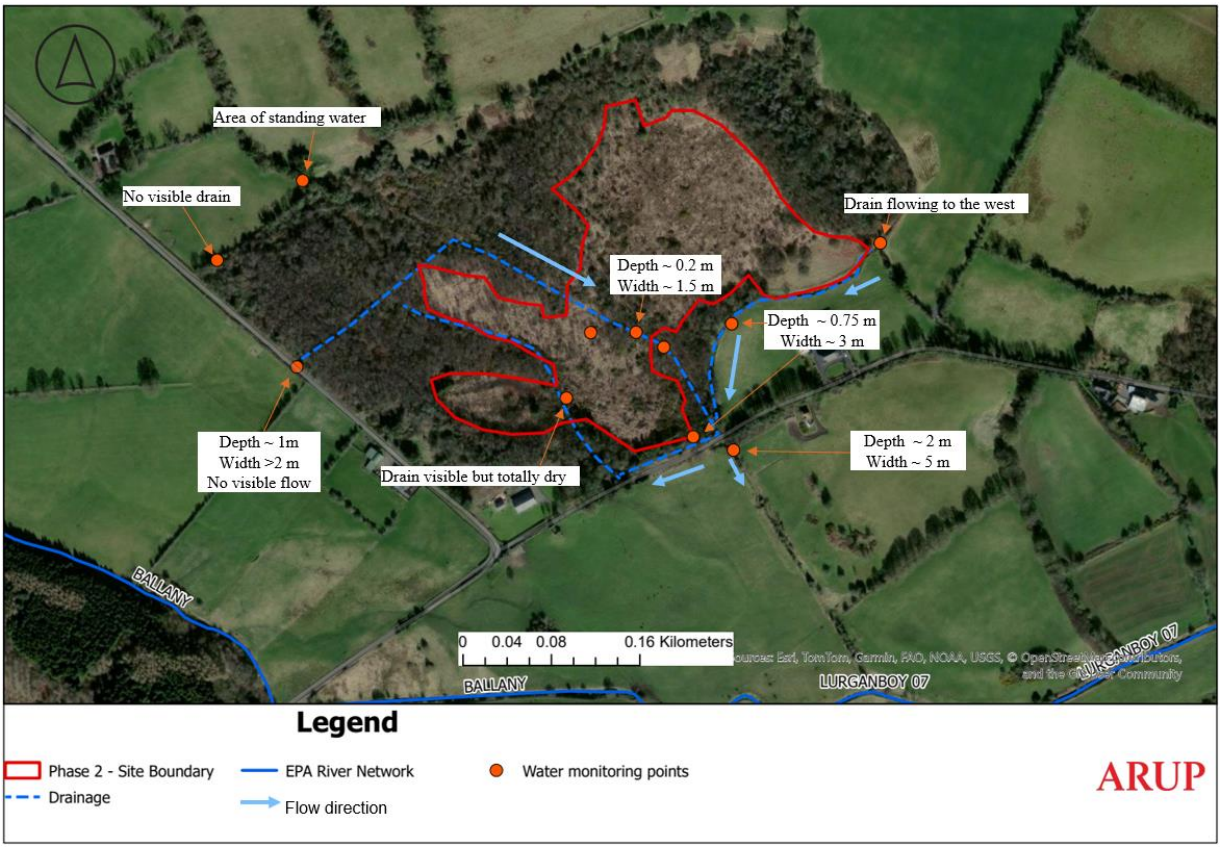


Figure 3-19: Drainage Network of Balnavine Fen

3.2.3 Water Quality

Water quality monitoring indicates clear spatial variation in nutrient concentrations across the site, with evidence of localised enrichment, particularly in the south-east and central drainage network.

Phosphate (PO_4) concentrations recorded across the site are consistently elevated and exceed the Water Framework Directive (WFD) good status environmental quality standard of 0.107 mg/l PO_4 (0.035 mg/l PO_4-P[2]). The highest phosphate concentration (2.5 mg/l) was recorded within the central drain, indicating a potential point or pathway of nutrient input. Two sampling points along the southern drain show notable variation, with 0.23 mg/l recorded

[2] Government of Ireland, 2015. European Union Environmental Objectives (Surface Waters) Regulations 2009–2015. S.I. No. 272 of 2009, as amended.

north of the central drain and a substantially higher concentration of 2.23 mg/l recorded to the south of it. Elsewhere, phosphate concentrations remain elevated, including 0.85 mg/l in the drain south of the Balnavine road and 0.36 mg/l along the western boundary drain. These values are indicative of widespread phosphorus enrichment across the site (Figure 3-20).

Nitrate (NO_3-N) concentrations also vary considerably, with all recorded values exceeding the indicative ecological threshold of 1.8 mg/l NO_3-N (8 mg/l (NO_3^-) (EPA, 2025b), above which impacts on health of rivers may occur. Several locations also exceed the European groundwater threshold of 50mg/l $N0_3$-N (Directive 2006/118/EC)). The highest concentration (36.6 mg/l) was recorded within the southern drain. Other elevated concentrations included 10.5 mg/l in the central drain and 8.5 mg/l in the western drain. The lowest nitrate concentration recorded was 4.7 mg/l at the southern channel, south of the central drain, which nevertheless remains above ecologically acceptable levels. These results indicate nitrogen enrichment throughout the site (Figure 3-21).

Fens are generally characterised by low nutrient levels, particularly with respect to nitrogen and phosphorus, as most nutrients are retained within the developing peat layers. However, changes in the fen environment can lead to release of nutrients from these stores. The release of additional nutrients via processes within a fen is often termed ‘internal nutrient enrichment’. Factors driving these changes might include increased nitrogen and phosphorus from atmospheric inputs, and falling or fluctuating water levels due to drainage, abstraction or changes in precipitation. This process is commonly associated with the later successional phases of fen development when the drier conditions and lower soil water levels can result in the release of the nutrients which have accumulated within the soil.

The observed concentrations indicate potential nutrient enrichment within the site. Furthermore, some phosphate and nitrate values are above those associated with WFD good or high ecological status, suggesting possible impacts on the ecological integrity of the fen environment.

Measurements of pH and EC provide further insight into site conditions. Recorded pH values range from 6.63 to 7.47, indicating neutral to slightly alkaline conditions consistent with a groundwater-fed (base-rich) fen system (Figure 3-22). Electrical conductivity values range from 449 to 678 µS/cm. The highest EC values correspond with areas of elevated nutrient concentrations, suggesting a potential linkage between nutrient enrichment and groundwater inflow pathways (Figure 3-23).

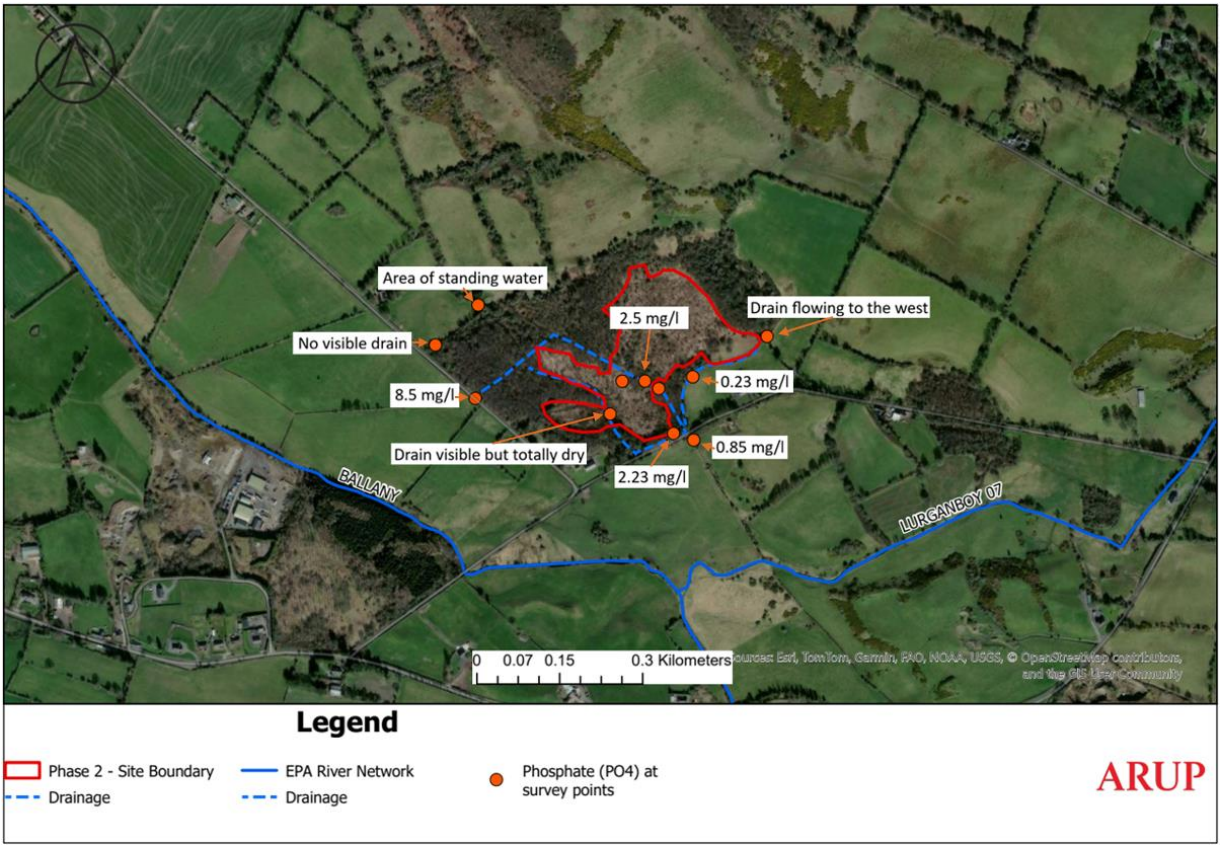


Figure 3-20: Phosphate (PO4) at survey points in Balnavine Fen

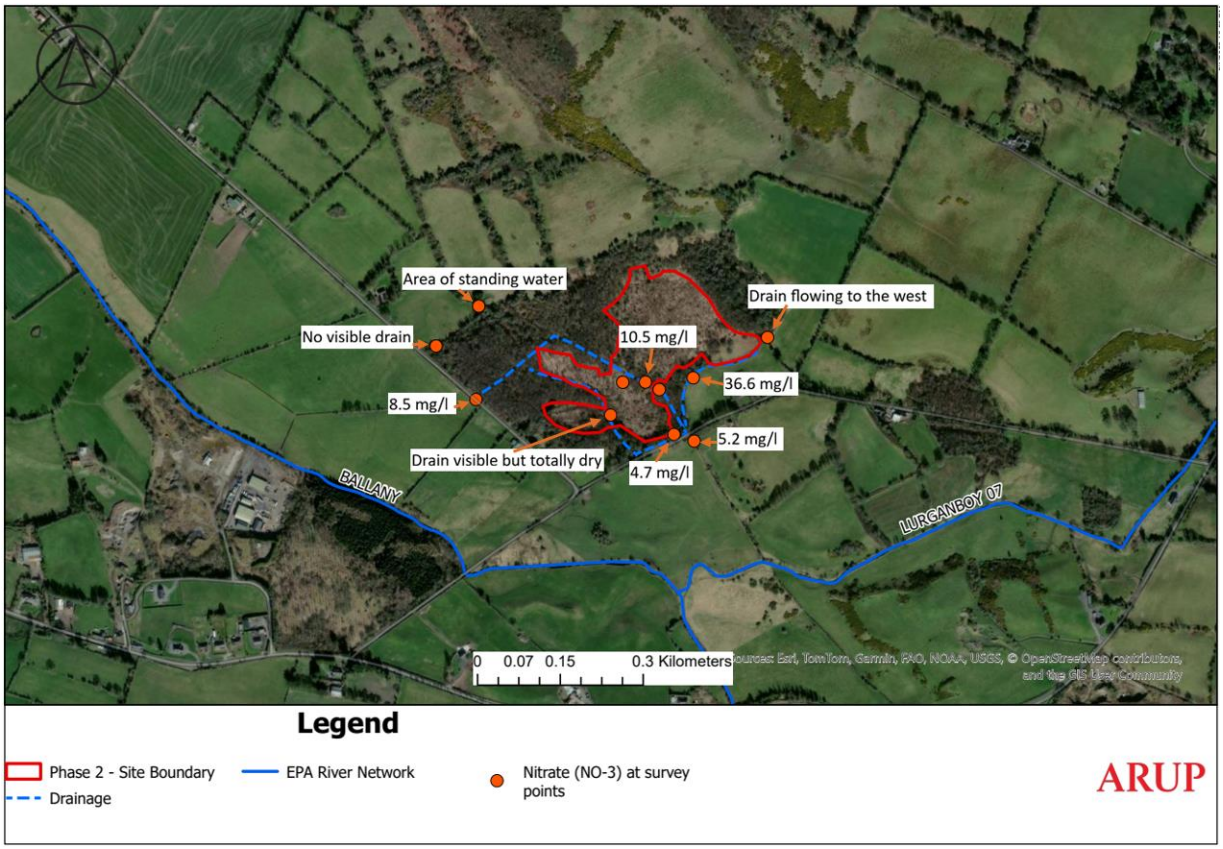


Figure 3-21: Nitrate (mg/l NO_3) at survey points in Balnavine Fen

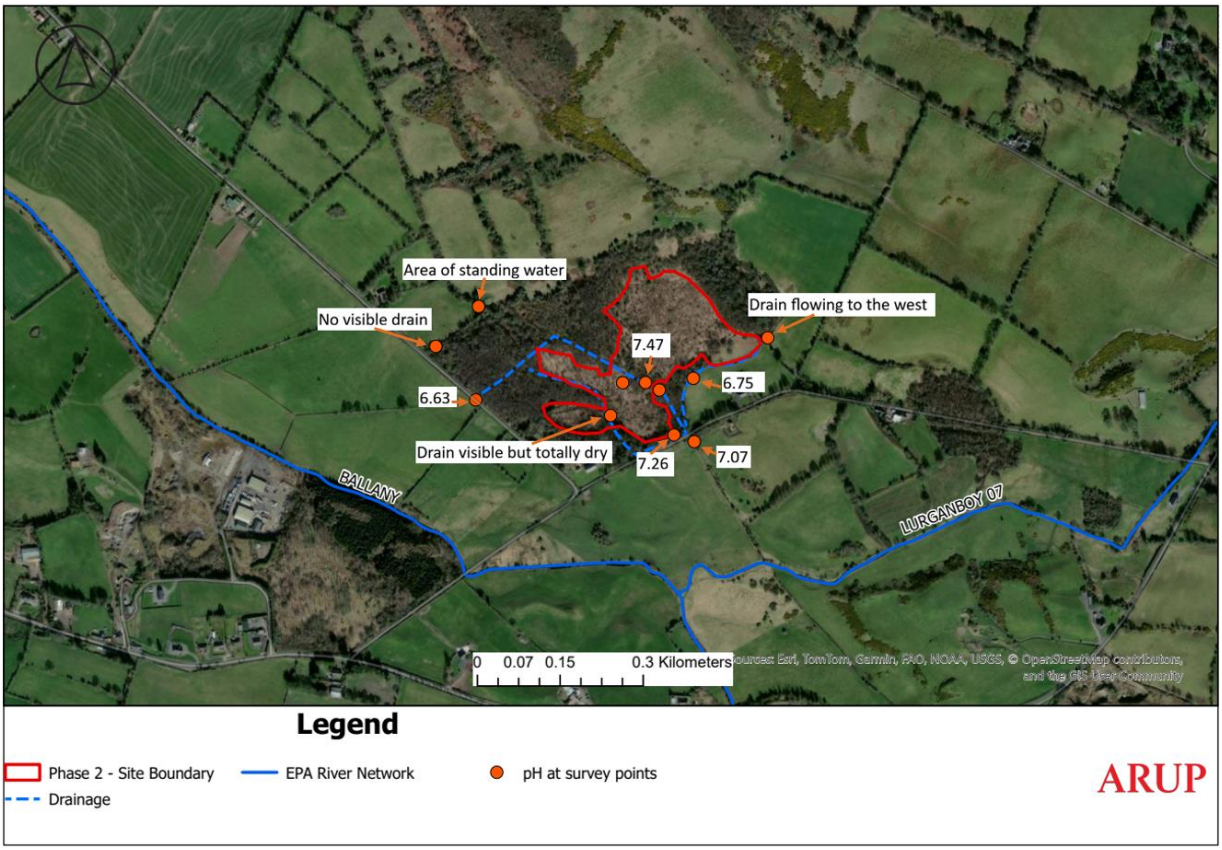


Figure 3-22: pH at survey points in Balnavine Fen

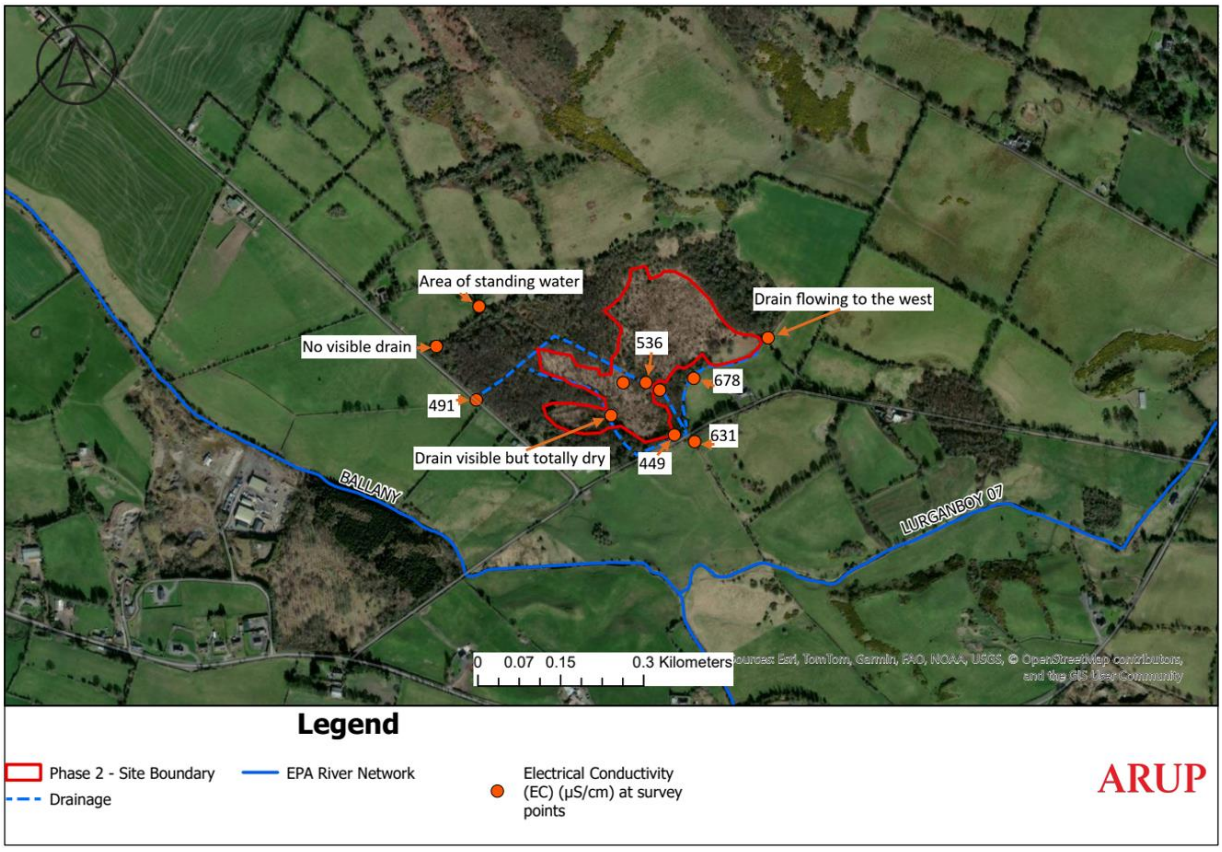


Figure 3-23: Electrical Conductivity (EC) (µS/cm) at survey points in Balnavine Fen

3.3 Conceptual Site Model

Under the WETMEC framework defined by Wheeler, Shaw & Tanner (2009), Balnavine Fen is classified as a groundwater-fed valley-bottom fen, where hydrological inputs are dominated by groundwater emerging from adjacent elevated terrain and moving through the site that represents a discharge zone. Due to historical drainage impacts, the fen currently aligns more closely with WETMEC type 9b, representing a partially drained groundwater-bottom system. There are a few old peat tips through the area which are better described as WETMEC 13a. The karst features located northeast of Balnavine potentially represent WETMEC 16.

Figure 3-24 illustrates the site Conceptual Site Model.

- The site's topography is characterised by elevated ground in the north and northwest, reaching approximately 110 mOD in these areas, which gradually transitions to lower and flatter terrain towards the south, where the elevation drops to below 90 mOD, leading to Lough Adeel. These gradient influences local drainage and water movement within the fen, with higher areas positioned away from the lake and flatter land creating pathways for water flow towards the southern boundary. The change in elevation is a key factor in the site's hydrological functioning, impacting both groundwater discharge and surface water runoff.
- The site represents a groundwater discharge zone, while the areas to the north, northwest and northeast being characterised by bedrock outcrops and karst landforms (dolines), reaching approximately 150mOD and which likely function as groundwater recharge zones. Rainfall and surface water drain into these depressions, infiltrating the underlying karst system. The presence of these karst features indicates a subterranean drainage network, through which water is collected, transported and subsequently discharged within the site area.
- The site is underlying by the Derravaragh Cherts comprising cherty limestone interspersed with occasional shale layers. Quaternary sediments are dominated by Fen Peat (FenPt) are located in the boundary and cut-over raised peat is located within the site. Deposits of gravels derived from limestones and till originating from cherts are located to the southern of Balnavine Fen site boundary.
- Beneath the site lies a Locally Important Karstified Aquifer (Lk), which allows for deeper and preferential flow paths due the karstification.
- Water flow across the site predominantly moving southwards and discharging to Lough Adeel. Historical mapping indicates that no drains were originally present. However, following NPWS surveys and site visits, there is a central drain flowing to the south that currently bisects the site, with additional drains located along the western and southern boundaries. According to the LiDAR images, both southern and western drains are more expressive than the central drain. The southern drain shows active flow towards the southwest, whereas the western drain has no visible flow, and the

southern drain, parallel to the central drain was found completely dry. To the south, beneath Balnavine road, a stream was observed flowing out of the fen in a southeasterly direction.

- The base-rich hydrochemistry (pH 6.6 to 7.4EC 450 to 680 µS/cm) confirms substantial groundwater contribution to the water balance. High nitrates levels (36.6) were registered at the northern side of the central drain, within the southern drain, which might be associated with enrichment from adjacent agricultural lands.
- The Annex I 7230 Alkaline fen vegetation, dominated by Schoenus nigricans and other species, is the expected ecological expression of a functioning WETMEC 9.
- The hydrological characteristics of the site result from the combined influence of groundwater discharge, rainwater, and catchment runoff. Modifications to site drainage and groundwater drawdown have altered these dynamics, leading to drier conditions within the fen. Evidence of drainage works and peat hags are attributed to historical peat cutting activity, though no recent cut-over extraction has occurred. These impacts have contributed to the semi-degraded state of the fen, facilitating the encroachment of woodland and scrub species particularly birch, willow and gorse.

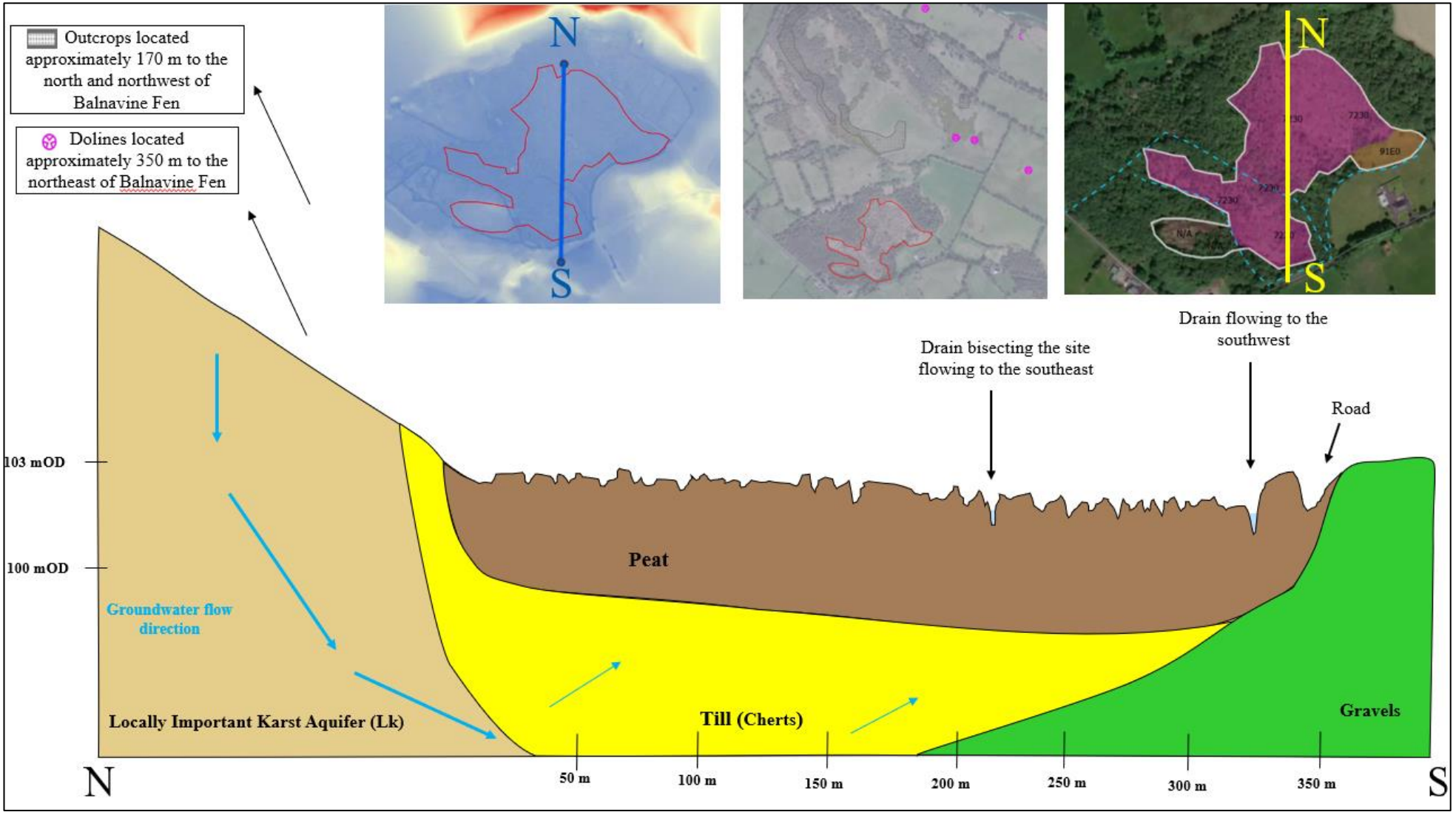


Figure 3-24: Balnavine Conceptual Site Model

4 Ecology

4.1 Desk Study

A review of available desktop information on the ecological baseline for Balnavine Fen was reviewed from the below information sources:

- Biodiversity Maps - National Biodiversity Data Centre (NBDC).
- Plant Atlas 2020 website - Botanical Society of Britain & Ireland (BSBI).
- NFS (Brophy et al., In prep).

The NFS was commissioned to develop and test a standardised methodology for assessing the conservation status of fen habitats across Ireland. As part of this study Balnavine Fen was selected as one of the sites for field survey. The site was surveyed in August 2022, with a focus on Annex I wetland and fen habitats. The survey methodology included:

- Detailed vegetation assessments using quadrats to record species composition and structure.
- Hydrological observations such as water levels and flow.
- Documentation of disturbance indicators including drainage, grazing, and invasive species.

GPS mapping and photographic records were also used to support habitat boundary delineation and condition assessment. While the primary emphasis was on habitat quality, vascular plants and bryophytes were recorded as part of the vegetation surveys, contributing to an understanding of species diversity and habitat integrity at the site.

4.1.1 Habitats

The NFS at Balnavine Fen revealed that the site comprises a former cutover bog with raised areas of acid peat interspersed with deeper cuttings. Surrounding the site on nearly all sides is birch dominated bog woodland with some rowan (*Sorbus aucuparia*) and grey willow (*Salix cinerea*) also present. Approximately 50-60% of the site supports 7230 Alkaline fen with some patches of Great fen-sedge (*Cladium mariscus)* but these were below minimum mapping areas.

4.1.1.1 Annex I Habitats

The following Annex I quality habitats were identified and mapped:

- 7230 Alkaline fen - covering 2.12ha of the site predominantly located within the centre of the site. There is noted scrub encroachment by downy birch, grey willow and gorse on higher peat within the 7230 Alkaline fen.
- 7210 Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* - a small patch of *Cladium mariscus* approximately 8m in diameter was observed in the

southern section of the site which then opens out to an area predominantly fen. Within this southern section there is also scrub containing gorse.

- 91E0 Alluvial forests woodland – located along the eastern section of the site adjacent to the 7230 Alkaline fen.

It should be noted that the resulting mapping of Annex I and Annex I quality habitats from the NFS survey requires suitable interrogation and interpretation as to the extent of these habitats within each polygon i.e. Annex I habitat mapping is represented by the habitat that has the highest percentage attributed to the polygon. Therefore, polygons could be a mosaic or only support a small percentage of Annex I habitat within the overall polygon area and thus must be interpreted appropriately.

4.1.1.2 Non-Annex/Fossitt habitats

Non-Annex I fen and other habitats were also recorded, with mapping based on Fossitt (2000) classification (Table 4-1 and Figure B-9-1, Appendix B).

Table 4-1: Fossitt habitats within Balnavine Fen

Habitat Type	Location	Notes
PF1 - Rich Fen and Flush	Two sections in the north and south	Impacted by scrub encroachment in the north with section in the south predominantly fen with small clump of *Cladium*
PB4 – Cutover bog	Two sections in the southwest and northeast	Section in the southwest has some fen and scrub – small patches of *Schoenus nigricans*
WN7 - Bog woodland	Two small sections in the south – one south west and one slightly further north	Predominantly young *Betula* spp. in the south. Dry shallow (nonfunctional) drain located in the north section of the woodland
WS1 - Scrub	West of the site	Small clump of WS1 in the west with scrub encroachment also noted in the northern section of fen.
GS2 – Dry meadows and grassy verges	East of the site	On border of site with agricultural grassland, dominated by *Arrhenatherum elatius*
HD1 – Dense bracken	Southwest of the site	Noted being in cutover bog on border with WN7

4.1.2 Species

The following subsections outline the presence of species recorded at or within the zone of influence of Balnavine Fen. This includes protected species listed under relevant legislation and conservation frameworks such as the EU Habitats and Birds Directives (Annex I, II, IV, and V), the Irish Red Lists, and the Wildlife Acts (including species protected under the Flora Protection Order. Where available, maps of recorded sightings will be provided to support spatial understanding of species distribution. Records are limited to those from the past ten years, reflecting the most plausible timeframe for continued presence and ecological relevance to the site - excepting where invasive species have been historically recorded and there has been no indication since of their elimination.

4.1.2.1 Species Within the Site

The species within Table 4-2 were identified using the NBDC interactive maps service and reviewing the NFS documentation. Only records from the last 15 years have been included.

Predominant species in the fen habitat are black bog rush (*Schoenus nigricans*), common cottongrass (*Eriophorum angustifolium*), yellow starry Feathermoss (*Campylium stellatum*), intermediate hook-moss (*Drepanocladus cossonii*), and hooked scorpion moss (*Scorpidium scorpioides*), pondweed (*Potamogeton* sp.) and beaked sedge (*Carex rostrata*).

Table 4-2: Species records within Balnavine Fen

Common Name	Latin name	Description	Most recent record
Round leaved wintergreen	*Pyrola rotundifolia*	Rare, Near Threatened; occurs in alkaline fens and transition mires with stable hydrology.	2022
Bog bean	*Menyanthes trifoliata*	Found in shallow water, fens, bogs and slow flowing water such as canals.	2022
Fool's-water-cress	*Apium nodiflorum*	Found on riversides, ditches and streams; Fool's water-cress tolerates and thrives in nutrient-rich water, especially water with elevated nitrogen and phosphorus.	2022
Shining Pondweed	*Potamogeton lucens*	Found in clear, base-rich (calcareous) freshwater, often in relatively deep water, and can tolerate both mesotrophic and moderately eutrophic conditions. Locally frequent in calcareous waters of central Ireland, but sensitive to eutrophication and water quality decline.	2016
Small Pondweed	*Potamogeton berchtoldii*	Prefers oligotrophic to eutrophic waters, including mildly enriched systems, and is a	2013

		good colonist of new or disturbed habitats.	

4.1.2.2 Species within the Zone of Influence

Table 4-3 outlines the functionally linked species recorded within the 2km distribution zone of influence around Balnavine Fen within the last ten years from NBDC. The records are from within the following Irish grid references: N57K, N57F, N56P and N56J.

Table 4-3: Species records within the Zone of Influence of Balnavine Fen

Legislative Protection	Common name	Latin name
Irish Wildlife Act	Buzzard	*Buteo buteo*
Irish Wildlife Act	Chaffinch	*Fringilla coelebs*
Irish Wildlife Act	Jay	*Garrulus glandarius*
Irish Wildlife Act	Long-eared owl	*Asio otus*
Irish Wildlife Act	Great Crested Grebe	*Podiceps cristatus*
Irish Wildlife Act	Magpie	*Pica pica*
Irish Wildlife Act	Sparrowhawk	*Accipiter nisus*
Irish Wildlife Act	Blackbird	*Turdus merula*
Irish Wildlife Act	Blackcap	*Sylvia atricapilla*
Irish Wildlife Act	Black-headed gull	*Chroicocephalus ridibundus*
Irish Wildlife Act	Blue tit	*Cyanistes caeruleus*
Irish Wildlife Act	Bullfinch	*Pyrrhula pyrrhula*
Irish Wildlife Act	Coal tit	*Periparus ater*
Irish Wildlife Act	Common redpoll	*Acanthis flammea*
Irish Wildlife Act	Cormorant	*Phalacrocorax carbo*
Irish Wildlife Act	Dunnock	*Prunella modularis*
Irish Wildlife Act	Goldcrest	*Regulus regulus*
Irish Wildlife Act	Goldeneye	*Bucephala clangula*
Irish Wildlife Act	Goldfinch	*Carduelis carduelis*
Irish Wildlife Act	Great, crested Grebe	*Podiceps cristatus*
Irish Wildlife Act	Great Tit	*Parus major*
Irish Wildlife Act	Greenfinch	*Chloris chloris*
Irish Wildlife Act	Little Grebe	*Tachybaptus ruficollis*

Legislative Protection	Common name	Latin name
Irish Wildlife Act	Wood pigeon	*Columba palumbus*
Irish Wildlife Act	Yellowhammer	*Emberiza citrinella*
Irish Wildlife Act	Mistle Thrush	*Turdus viscivorus*
Irish Wildlife Act	Mute Swan	*Cybgus olor*
Irish Wildlife Act	Pheasant	*Phasianus colchicus*
Irish Wildlife Act	Pied Wagtail	*Motacilla alba*
Irish Wildlife Act	Redwing	*Turdus iliacus*
Irish Wildlife Act	Rook	*Corvus frugilegus*
Irish Wildlife Act	Shag	*Gulosus aristotelis*
Irish Wildlife Act	Song Thrush	*Turdus philomelos*
Irish Wildlife Act	Starling	*Sturnus vulgaris*
Irish Wildlife Act	Tufted Duck	*Aythya fuligula*
Irish Wildlife Act	Mallard	*Anas platyrhynchos*
Irish Wildlife Act	Robin	*Erithacus rubecula*
Irish Wildlife Act	Grey Heron	*Ardea cinerea*
Irish Wildlife Act	Hooded Crow	*Corvus cornix*
Irish Wildlife Act	Jackdaw	*Coloeus monedula*
Irish Wildlife Act	Pied wagtail	*Motacilla alba*
Irish Wildlife Act	Rook	*Corvus frugilegus*
Irish Wildlife Act	Swallow	*Hirundo rustica*
Irish Wildlife Act	Woodpigeon	*Columba palumbus*
Irish Wildlife Act	Wren	*Troglodytes troglodytes*
Irish Wildlife Act	Hedgehog	*Erinaceus europaeus*
No legislative protection	Blue-tailed Damselfly	*Ischnura elegans*
No legislative protection	Brown Hawker	*Aeshna grandis*
No legislative protection	Common Blue Damselfly	*Enallagma cyathigerum*
No legislative protection	Common Darter	*Sympetrum striolatum*
No legislative protection	Ruddy Darter	*Sympetrum sanguineum*
EU Birds Directive	Kingfisher	*Alcedo atthis*
EU Habitats Directive	Otter	*Lutra lutra*
Eu Habitats Directive	Marsh Fritillary	*Euphydryas aurinia*

Legislative Protection	Common name	Latin name
EU Habitats Directive	White-clawed Crayfish	*Austropotamobius pallipes*
EU Habitats Directive	Pine Marten	*Martes martes*
EU Habitats Directive	Soprano Pipistrelle	*Pipistrellus pygmaeus*
Eu Habitats Directive	Common Frog	*Rana temporaria*

4.2 Field Survey

Following a comprehensive review of available desktop data, a targeted ecological survey was undertaken in April 2026. The field surveys concentrated on key areas highlighted during the desk-based assessment, specifically those with potential for restoration activities. These locations were investigated in detail to verify and further assess ecological conditions and parameters, ensuring that any recommended restoration measures would be both appropriate and effective in the identified zones.

Two survey forms were created to collect data relevant to:

- Monitoring data; and
- Pressures and threats

4.2.1 Monitoring Points

To inform the FRP, a targeted walkover survey was undertaken. This was a focused assessment designed to gather site-specific data at pre-identified locations. The walkover was designed to assess ecological condition at four pre-identified monitoring points (Monitoring Points 1-4), selected based on hydrological features, habitat potential, and restoration feasibility. The locations were determined through expert discussion and review of baseline data and will serve as fixed monitoring stations post-restoration. A map of survey points is provided in Appendix B.

These monitoring points now serve a dual purpose:

- Baseline characterisation of current site conditions.
- Long-term monitoring stations to assess ecological change following restoration.

The survey focused on these key components:

- Monitoring points: Presence and absence of positive and negative indicators of fen habitat.
- Target notes: Any qualitative observations capturing for example site condition, vegetation structure, hydrological features, and legacy management.
- Pressures and Threats Identification: Systematic recording of anthropogenic and natural pressures affecting each location.

The survey confirmed the presence of several fen habitat types, notably the Annex I habitat 7230 Alkaline fen and Fossitt habitat PF1 Rich Fen and Flush.

Monitoring point 1

7230 Alkaline fen and PF1 Rich Fen and Flush habitats were present with the following positive indicator species for fen habitat: devil's bit scabious (*Succisa pratensis)*, glaucous sedge (*Carex flacca)*, yellow starry feathermoss (*Campylium stellatum)*, comb moss (*Ctenidium molluscum)*, purple moor-grass (*Molinia caerulea)*, black bog-rush (*Schoenus nigricans)*, maidenhair pocketmoss (*Fissidens adianthoides)* as well as some negative indicator species for fen habitat including bramble (*Rubus fruticosus* agg.) and ling heath (*Calluna vulgaris).*

Monitoring Point 2

7230 Alkaline fen and PF1 Rich Fen and Flush habitats were present with the same positive and negative indicator species as monitoring point 1, plus the following negative indicator species: grey willow and downy birch.

Monitoring stop 3

7230 Alkaline fen and PF1 Rich Fen and Flush habitats were present with the same positive and negative indicator species as monitoring point 1, plus the following positive indicator species: stonewort (*Chara* spp.), angelica (*Angelica sylvestris)*, common cottongrass (*Eriophorum angustifolium)*, water mint (*Mentha aquatica)*, valerian (*Valeriana officinalis)*, meadowsweet (*Filipendula ulmaria)*, small fruited yellow sedge *(Carex viridula)*, carnation sedge (*Carex panicea)*, marsh bryum (*Bryum pseudotriquetrum)* and the negative indicator species: creeping bent (*Agrostis stolonifera).*

Monitoring point 4

7230 Alkaline Fen and PF1 Rich Fen and Flush habitats were present with similar positive and negative indicator species as monitoring point 1 and 3.

4.2.2 Pressure & Threats

This section outlines the historical and current pressures and threats affecting Balnavine Fen, with emphasis on the Annex I quality habitats.

Historical Pressures

The NFS determined the Structure & functions of the 7230 Alkaline fens to be Unfavourable-Bad, with negative pressure being:

- **Drainage -** wide drains located around the southern and western sections of the site
- **Scrub Encroachment -** there is scattered scrub encroachment (birch and willow) in drier parts, across approximately 50% of the area, and notably so in the southern section.

- **Peat Extraction –** the site is a former cutover bog with previous peat extraction with no recent activity, long abandoned.

Current Observations

The 2026 walkover surveys confirmed that the previous pressures on the site, notably drainage and scrub encroachment, were still affecting the condition of the fen habitat.

4.2.3 Additional Observations

A target note taken at Monitoring Stop 1 highlights that there are abundant algae within the plot on dying vegetation which could indicate ammonia deposition. There were also several quaking hollows located to the south of Monitoring Stop 1.

4.3 Site Conservation Priority Matrix for Balnavine Fen Site

The proposed restoration actions require initial monitoring to suitably inform what actions would be most beneficial and practical for fen habitat within Balnavine Fen (Table 4-4). Should monitoring result in recommendation of restoration actions these are expected to deliver broader ecological benefits beyond their target habitat types. If these measures are successfully implemented and sustained, they may positively influence associated features such as priority species, nationally important species, and locally significant habitats and species. To validate and understand the extent of these mutual benefits, ongoing post-restoration monitoring will be essential. This will ensure that improvements are not limited to fen habitats alone but extend to the wider ecological network within and around the site.

Table 4-4: Site Conservation Priority Matrix for Balnavine Fen

Level	Feature Type	Feature Name	Extent/ Population	Pressure/Threat affecting it	Restoration Measure On-Site	Restoration Measure Off- Site
1	NHA Habitat - Annex I quality	7230 Alkaline fens	2.12	Drainage Scrub encroachment	Hydrological monitoring to inform the suitability of drain blocking or other hydrological measures to raise the water table. Should these measures be implemented, scrub clearance is recommended ahead of any hydrological restoration measures.	N/A
		91E0 Alluvial woodland	Not specified in NFS	This polygon area of woodland, whilst recorded as 91E0 Alluvial woodland, only 5% of the polygon is deemed to qualify as this habitat type. NFS notes that the area is dominated by false oat-grass (*Arrhenatherum elatius*) with dense bracken (*Pteridium aquilinum*) and bramble. No measures proposed for this area.		
2	European Priority Species	See Table 4 –2, Table 4-3	See Table 4 –2, Table 4-3	Scrub encroachment	As per 7230 Alkaline fen	N/A
3	Nationally important species	See Table 4 –2, Table 4-3	See Table 4 –2, Table 4-3	Scrub Encroachment	As per 7230 Alkaline fen	N/A
4	Habitats and species of local interest	See Table 4 –2, Table 4-3	See Table 4 –2, Table 4-3	Scrub Encroachment	As per 7230 Alkaline fen	N/A

4.4 Impact Assessment Notes

Following hydrological monitoring, should restoration actions be recommended, these aim to improve the ecological condition of the fen and wetland habitats, particularly the Annex I habitats 7230 Alkaline fens. These actions are designed to support favourable condition of these habitats and enhance habitat resilience. However, potential impacts, both direct and indirect, must be carefully considered to ensure no detrimental impacts to habitats.

Potential impacts:

- **Habitat loss** – low risk – restoration actions e.g. drain blocking and scrub removal are designed to enhance and expand habitats rather than remove them.
- **Habitat degradation** – moderate risk – potential degradation could occur if restoration measures are poorly implemented or monitored. This could occur through poor management of herbicides as part of scrub management, poor biosecurity and spread of invasive species or drain blocking alters hydrology in unintended ways if not based on robust baseline data. Should restoration measures be actioned, monitoring protocols will be embedded into the site plan to monitor change following implementation of the restoration measures.
- **Species disturbance** – low risk – potential for species disturbance if works are undertaken during breeding bird season. Should works be required, these will be undertaken outside the breeding bird season (March to August inclusive). Should works be required during the breeding season, confirmation from an Ecological Clerk of Works that no nesting birds are present in the working area will be undertaken ahead of any works proceeding.
- **Introduction and/or spread of invasive non-native species** – moderate risk - restoration activities (e.g., soil disturbance, water movement) could facilitate dispersal of invasive species. Monitoring and biosecurity protocols will be embedded into the site plan to avoid such risks.

Ecological Impact Assessment Considerations

- Vegetation Measures
    - Monitoring of vegetation - fixed-point quadrat monitoring to assess effectiveness and inform adaptive management.
- Scrub removal
    - Recommended across sections of the site as scrub encroachment is evident. However, this should be considered following hydrological monitoring and if measures are recommended that would raise the water table of the site. This is to ensure that any scrub removal would be effective in the long term rather than requiring consistent management.

- Hydrology Measures
    - Hydrology monitoring - installation of piezometers to assess ground water levels within the site.
- Nutrient Measures
    - Hydrochemistry monitoring - testing of nutrients in surface and groundwater.

4.5 Good Practice Recommendations

Several good practice measures are recommended based on the requirement for compliance with legislation but also the occurrence of sensitive receptors and possible pathways for negative effects during preparation for or implementation of restoration actions. These are summarised in Table 4-4 below and should be taken as generally applicable in the planning of FRP.

Consultation with relevant NPWS staff should be undertaken prior to implementation to obtain more recent or up to date information on the locations of sensitive receptors, and buffers revised accordingly. Any further requirements outlined by NPWS at pre implementation stage should also be adhered to.

Table 4-4: Good Practice Recommendations

Receptor	Measure
Ground nesting birds	No vegetation clearance or activity which might contravene Section 40 of the wildlife act (consolidated) should be undertaken.
Invasive Alien Species (IAS)	Where applicable, all vehicles, tools and equipment should undergo steam cleaning before site entry. Should IAS be identified within the working areas, suitable buffers should be implemented to ensure they are not spread off site.
Protection of Sensitive Habitats	High sensitivity habitats should be protected from long term damage. Extensive repeated tracking over fen habitat or any other identified priority habitat should be avoided. The storage locations of any materials should avoid high & medium sensitivity habitats. This applies also to brash management following scrub management if undertaken.

5 Key Pressures – Field Validation and Evaluation

The FRP considers pressures on Balnavine Fen through an initial desktop assessment of existing information on the site (including previous NPWS commissioned surveys), assessment of land, water and topographic data and aerial imagery, followed by field surveys to characterise and confirm key pressures mapped through desktop assessment. Consultation with NPWS Regional Staff was also undertaken, including a visit with the Conservation Ranger for the area to inform identification of pressures.

The NFS (Brophy et al., In prep) undertook a site evaluation and ranking which determined the conservation value of the site. This evaluation considered 15 criteria as outlined which included naturalness, non-recreatability, potential value, typicality, educational value, size, diversity, fen value, rarity of species, rarity of habitats, viability, recorded history, management needs, intrinsic appeal and expert opinion. These criteria then informed the conservation status assessment (structure & functions) which are detailed in Section 2.1.1.

5.1 Field surveys of key pressures

Follow completion of desktop mapping of key pressure, field surveys were carried out by personnel to verify the findings of the desktop assessment and characterise conditions of the pressures to inform selection of appropriate restoration actions required. The site surveys are discussed in Sections 3.2 and 4.2. These surveys aimed to capture information on the land and water environment such as drainage features, peat depth and water quality and the ecology.

As part of the ecology monitoring surveys, pressures and threats associated with the monitoring point were recorded. A summary is provided within Section 5.2.

5.2 Key Pressures

An overview of the key pressures identified on site, following desktop review and site visits are summarised in this section.

5.2.1 Flora and Fauna Pressures

The pressures outlined below are ranked according to their intensity and their influence on the ecological receptors of Balnavine Fen. Their identification is based on an evaluation of historical data (NFS), together with observations made at Monitoring Points during fieldwork for this project (Figure 5-1).

- **Drainage** – drains around the perimeter of the site may still be influencing the hydrology of the site.
- **Scrub encroachment** – birch and willow scrub encroachment on the drier parts of the site.

5.2.2 Fen Hydrology Pressures

The following hydrological pressures were identified within Balnavine Fen:

- Drainage has been identified as a pressure affecting fen hydrology across the site. Preliminary assessment of site topography indicates a gradient from the north towards the southern boundary. This gradient, in combination with the existing drainage network, facilitates water loss from the fen system. Where drains occur within the habitat and show localised effects, they have been flagged as a pressure requiring further assessment. Key features include:
    - The central drain, which bisects the site and flows towards the southern boundary, currently exhibits limited flow. However, it remains a potential pathway for drainage and may influence water levels within the fen. Further assessment is required to determine its role in controlling the water system.
    - The southern drain, which shows active flow may contribute to continued lowering of water levels, particularly in the southern sector where degradation is most evident.
    - The western boundary drain and parallel dry channel may act as flow pathways during wetter periods.
- Lowering and fluctuations of water levels:
    - Evidence from vegetation structure, together with observations of drains exhibiting limited or no flow, indicates that the site is experiencing reduced and/or fluctuating water levels. This is particularly evident in the southern section, where fen habitat is heavily degraded and dry.
- Modification of natural groundwater – surface water interactions:
    - Balnavine Fen is a cutover bog system with hydrological dependence on base-rich groundwater inputs. Historical peat cutting and associated drainage features (including hags and cuttings) have altered the natural hydrogeological regime.

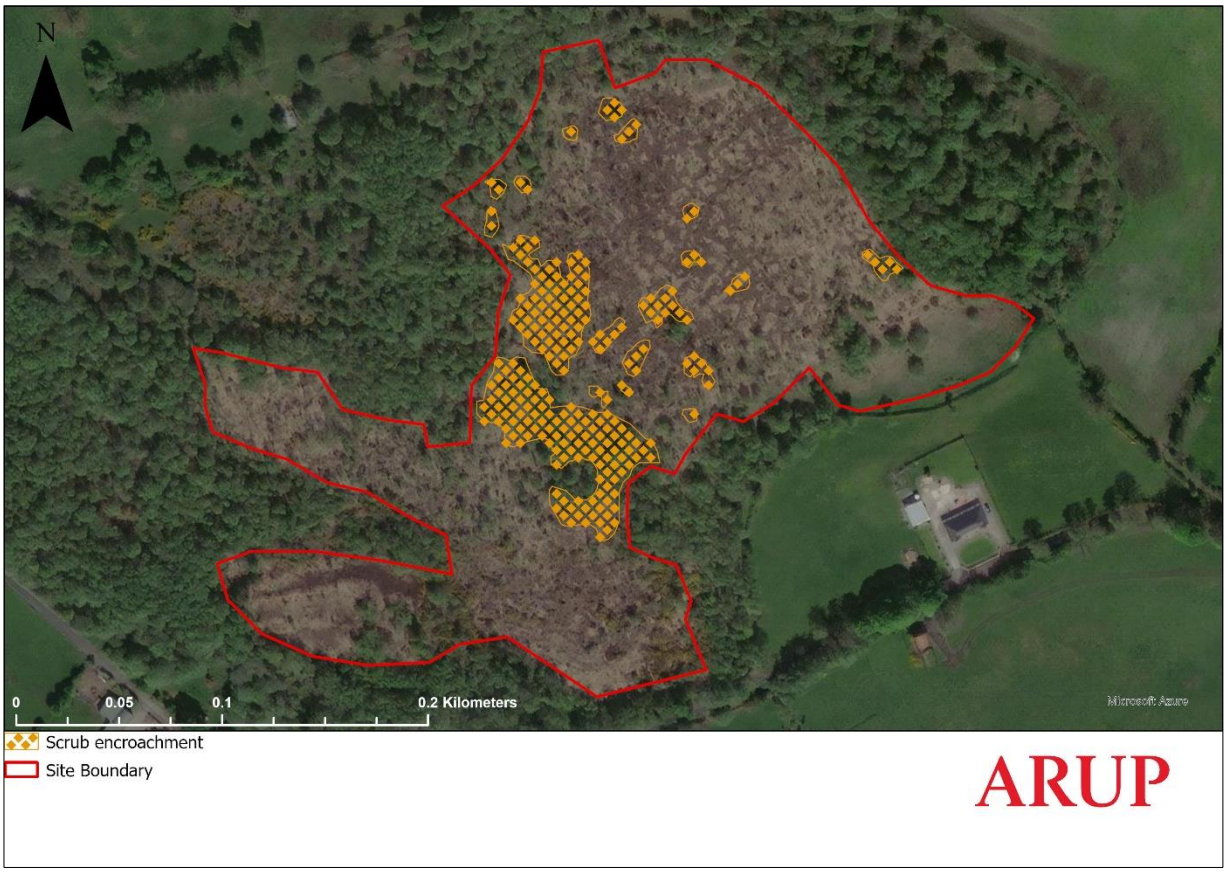


Figure 5-1: Pressures and threats recorded as present at Balnavine Fen. Pressures and threats were compiled from the desktop review and 2026 ecological walkover.

5.2.3 Fen Nutrient Pressures

The following nutrient pressures were identified within Balnavine Fen:

- Diffuse and/or localised nutrient input from agricultural activities: according to the National Fen Survey (Brophy et al., In prep), no nutrient pressures were identified for the site. However, during the site visits, evidence of nutrient enrichment was registered. The site exhibits elevated nutrient concentrations, with the highest nitrate levels recorded in the southern drain and phosphate levels in the central drain and southern drainage network.
- Internal nutrient enrichment linked to hydrological change:
    - Lowered and fluctuating water levels are potentially contributing to the release of nutrients previously stored within peat soils. This internal nutrient enrichment process is consistent with drying fen conditions and is supported by the observed combination of elevated nutrient concentrations and degraded vegetation structure.
- Link between groundwater inputs and nutrients:

- Higher conductivity values are associated with areas of elevated nutrients, suggesting that groundwater pathways may be potentially contributing to nutrient enrichment in some parts of the site.

6 Restoration Measures

6.1 Introduction

The restoration actions proposed by the Fen Restoration Plan will help to maintain or improve the quality of existing areas of fens and improve the conditions that will allow an expansion of the fen area. In some areas it must be recognised that restoration to fen habitat will not be possible, and the objective may simply be to improve the habitat condition.

Selection of the most appropriate restoration action depends on a range of factors including peat depth, hydrological conditions (flow rates, existing and expected flow paths after restoration), substrate type, existing ecological conditions, potential ecological constraints and practicality of access for machinery.

Each of the factors was considered based on a combination of desktop analysis combined with site-specific field surveys to select the most appropriate restoration technique to address each pressure considered by the FRP.

The restoration measures proposed are outlined in Section 6.2 to Section 6.4, with detailed mapping of proposed measures illustrated in the maps provided in Appendix B.

6.2 Hydrology Measures

6.2.1 On-site Fen Hydrology Measures

Drain blocking is proposed within the main southern-central drain, where fen conditions are drier than the rest of the site.

A hydrological monitoring network will be established to assess site conditions. Monitoring will include the installation of piezometers and standpipes at selected locations.

Monitoring parameters will include depth to water table, hydraulic gradients across the site, and water levels within drains and at the outflow.

Supporting datasets will include rainfall and evapotranspiration data obtained from nearby monitoring stations.

The monitoring results will be used to inform any future hydrological restoration measures, including the potential requirement for drain blocking or water level management at other parts of the site.

6.2.1.1 Groundwater Monitoring Installations

Monitoring installations will be installed in five different locations:

- South: two monitoring locations are proposed within the southern drain area, which is currently in a highly degraded condition with extensive encroachment of gorse and downy birch. During the site visit undertaken in May 2026, the drain was identified as

dry. However, LiDAR images indicate an expressive drain within this area. The two piezometers should identify water levels fluctuations and potential seasonal variations.

- Central: two monitoring locations are proposed: one on the eastern side, where hydrological conditions are influenced by an existing drain, and another on the western side, where a ponded water area has been identified. The two should identify water level fluctuations and possible connection between the eastern and western side, and if this drain is contributing to water loss across the site.
- North: wetter fen with less scrub encroachment; to provide a baseline for wetter fen conditions and allow comparison across the site.

Proposed on-site hydrological measures are presented in Figure 6-1.

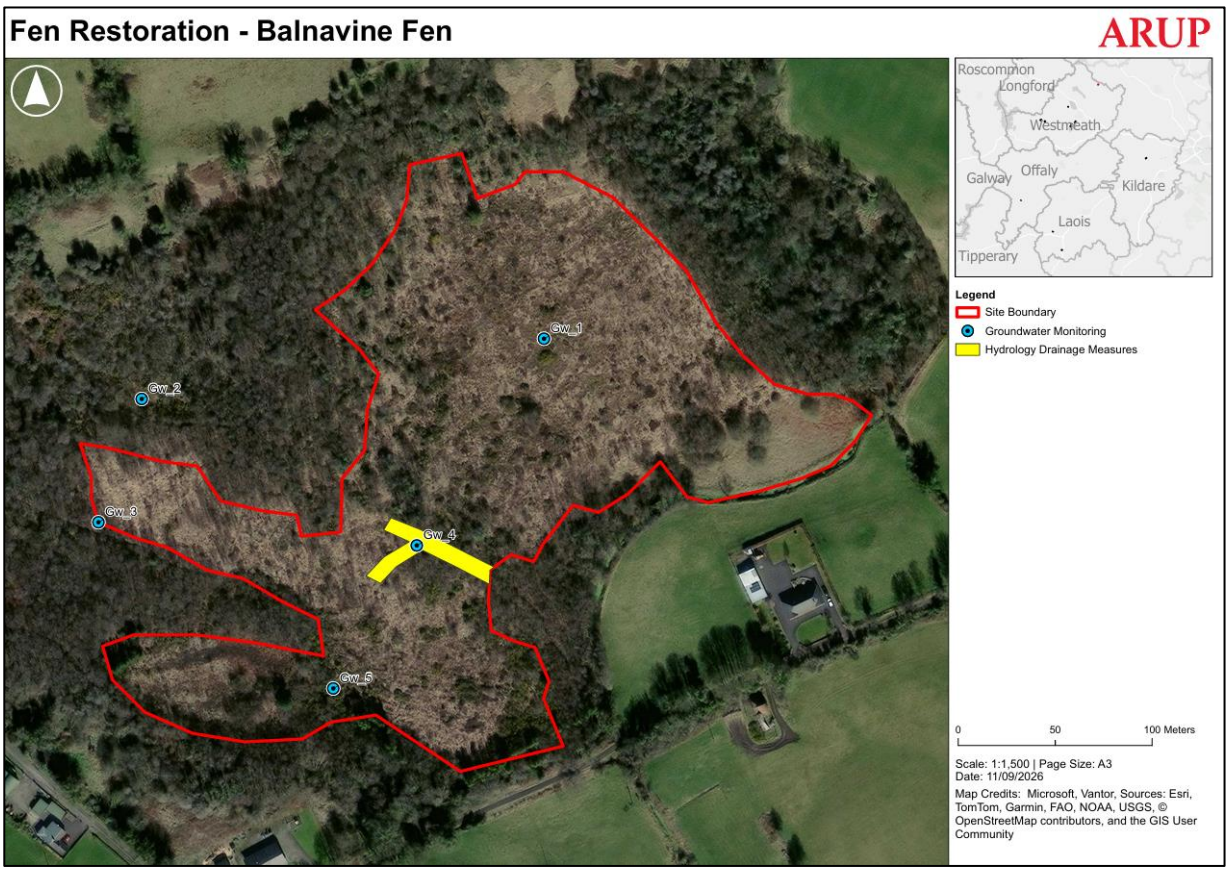


Figure 6-1: Proposed hydrological measures for Balnavine Fen

6.2.2 Off-site Hydrology Measures

6.2.2.1 Avoid creating new drainage channels adjacent to fen

The hydrology of Balnavine Fen is influenced by groundwater recharge and subsurface flow, particularly from the north and northeast where karst features are present. No new drainage channels should be excavated within those lands that are hydrologically connected to Balnavine Fen. Engagement with adjacent landowners will be required to maintain natural infiltration processes and to prevent drainage works that could alter recharge or flow pathways.

6.2.2.2 Monitoring Progress

Progress will be assessed through groundwater level trends within the fen, stability of water levels, and the absence of new drainage features within the contributing catchment.

6.3 Nutrient Measures

The primary aim of the nutrient measures is to maintain appropriate water quality, particularly nutrient levels, to support the natural structure and functioning of the habitats.

6.3.1 On-site Nutrient Measures

6.3.1.1 Water Quality Monitoring

On-site nutrient measures will focus on the monitoring of water quality to improve understanding of nutrient dynamics within the site and to assess the effectiveness of any future off-site measures.

Water quality monitoring will include nitrate, phosphate, electrical conductivity (EC), pH and temperature.

Monitoring locations will include the central drain, southern drain, western boundary drain, the outflow channel south of the site, and groundwater monitoring points.

Monitoring objectives are to:

- Assess nutrient concentrations across the site
- Identify spatial and temporal trends in nutrient concentrations
- Improve understanding of nutrient sources and pathways (surface water vs groundwater)
- Assess the relationship between hydrology and nutrient enrichment

The results of monitoring will be used to determine whether further intervention is required and to guide the selection of appropriate nutrient management measures.

6.3.2 Off-site Nutrient Measures

6.3.2.1 Agricultural Nutrient Management

Elevated nutrient concentrations indicate inputs from the surrounding catchment, likely via both surface and groundwater pathways. There is no clear impact of this on the site vegetation. Improvement in river would quality along the boundary of the fen would require engagement with landowners to consider current nutrient loading and potential sources.

6.3.2.2 Catchment Nutrient Management

Catchment-scale measures should target both phosphorus and nitrogen pathways based on observed spatial patterns. Measures should include source control through nutrient

management planning, pathway interception to reduce nutrient transport, and groundwater protection through management of land use in recharge areas, particularly in freely draining and karst-influenced zones.

6.4 Vegetation Measures

6.4.1 On-site Vegetation Measures

On-site vegetation measures are detailed in Table 6-1 and Figure 6-6-2. The site was not deemed to be suitable for grazing due to the nature of the site being a former cutover bog which has resulted in uneven ground across the site.

Table 6-1: On-site vegetation measures

Priority	Measure	Description	Responsibility
1	Vegetation monitoring	Monitoring points have been proposed which overlap with (where suitable) the existing NFS points. The purpose of these points is to monitor species composition within the habitat. This serves to monitor any vegetation change and inform future restoration measures.	NPWS (post-Tóchar)
2	Scrub removal [informed by hydrological monitoring]	Following hydrological monitoring, an assessment of what hydrological interventions (if any) will be made. Should measures be identified that raise the existing water table, it is recommended that scrub removal is undertaken concurrently. This will ensure that scrub removal is effective in the long term.	NPWS (post-Tóchar)

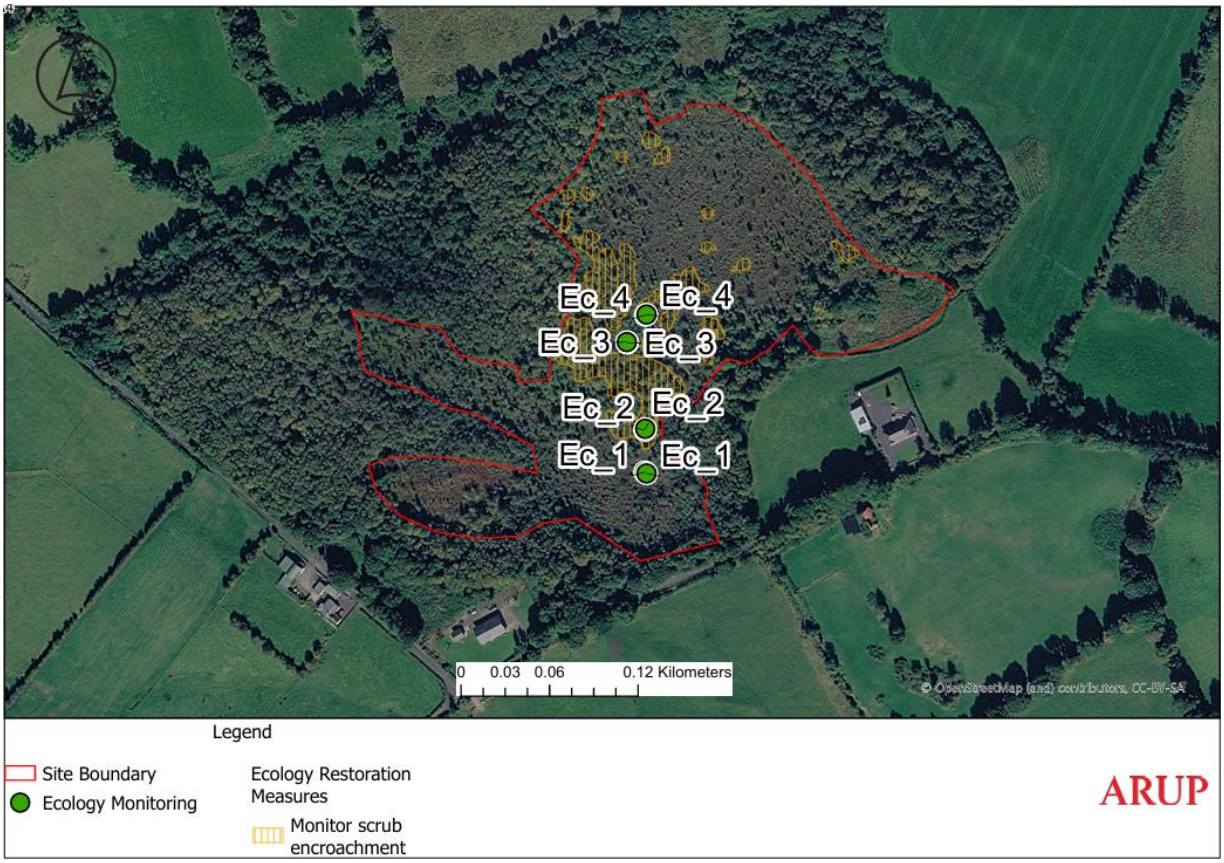


Figure 6-6-2: Proposed vegetation monitoring for Balnavine Fen

6.4.2 Off-site Vegetation Measures

No off-site vegetation measures were identified at the time of writing.

7 Additional Considerations

7.1 Drainage Management Plan

Arterial Drainage Schemes were carried out under the Arterial Drainage Act, 1945 to improve land for agriculture and to mitigate flooding. Rivers, lakes weirs and bridges were modified to enhance conveyance, embankments were built to control the movement of flood water and various other work was carried out under Part II of the Arterial Drainage Act, 1945. The purpose of the schemes was to improve land for agriculture, to ensure that the 3 – year flood was retained in bank this was achieved by lowering water levels during the growing season to reduce waterlogging on the land beside watercourses known as callows. Flood protection in the benefiting lands was increased because of the Arterial Drainage Schemes.

The Brosna (Westmeath, Offaly and Laois) was the first scheme, which commenced in 1947. The last schemes were completed in the 1990s. Arterial Drainage schemes cover approximately 20% of the country, typically the flattest areas. The OPW is required to maintain Arterial Drainage schemes under sections 37 and 38 of the Arterial Drainage Act, 1945. The Act was amended on a number of occasions, e.g. to transpose EU Regulations and Directives such as the EIA, SEA, and Habitats Directives and the Aarhus Convention.

Drainage Districts were designated by the Commissioners of Public Works to improve land for agriculture and to mitigate flooding. Channels and lakes were deepened and widened, weirs removed, embankments constructed, bridges replaced or modified and various other work was carried out. Local authorities are charged with responsibility to maintain Drainage Districts. The Arterial Drainage Act, 1945 contains a number of provisions for the management of Drainage Districts in Part III and Part VIII of the act.

The preliminary drainage management plan for Balnavine Fen is presented in Appendix D.

7.2 Peat Stability Assessment

Restoration activities have the potential to introduce additional risk of peat stability issues. The combination of additional loading (e.g. when excavators are used) and a higher water table has the potential to increase risk. At present, no specific guidance is available in Ireland detailing how peat stability risks should be managed in restoration projects.

Undertaking detailed geotechnical assessments is beyond the scope of the FRP. However, preliminary peat stability analysis was undertaken to inform the level of assessment required prior to the implementation of restoration actions. This includes a review of the landslide susceptibility map and historic landslide events produced by the Geological Survey of Ireland (GSI). The GSI landslide susceptibility map provides a preliminary indication of the susceptibility of a landslide based on several contributing factors, including where previous

landslides have occurred and what caused them (slope, soil type and the impact of the flow of water in an area).

The proposed approach to peat stability is a tiered approach that aims to filter out low risk sites that can proceed with limited ground investigation, followed by more complex sites that require a more detailed quantitative assessment. Where risks cannot be excluded following these steps it may be necessary to progress to more detailed geotechnical studies.

The GSI landslide susceptibility map for Balnavine Fen is presented in Figure 7-1.

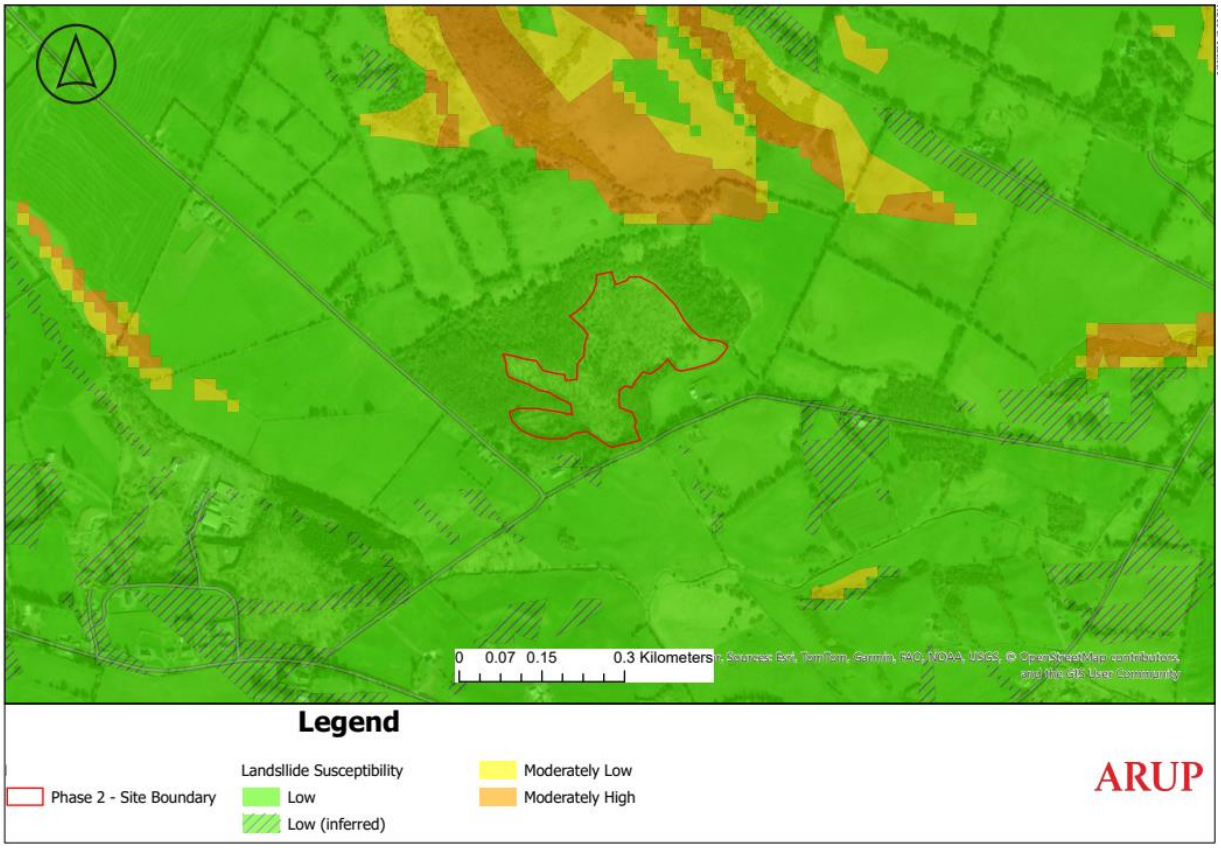


Figure 7-1: Geological Survey of Ireland Landslide Susceptibility mapping for Balnavine Fen.

7.3 Archaeology

A desktop constraint assessment was conducted using the National Monuments Service (NMS) Historic Environment Viewer to evaluate the site boundary and immediate surrounding buffer zones against the statutory Record of Monuments and Places (RMP) and the Sites and Monuments Record (SMR).

The assessment confirmed that there are no recorded archaeological monuments, protected heritage features, or statutory "zones of notification" overlapping with or situated within a relevant proximity to the proposed restoration footprint.

Consequently, statutory requirements under the National Monuments Acts are determined to be not applicable to this project as follows:

- Section 12 Notification: Not required, as no works will take place at, or in the immediate vicinity of, an RMP-listed site.

- Section 14 Consent / Licensing: Not required, as the project does not impact any designated National Monument or site subject to a Preservation Order.

Proactive Risk Mitigation (Chance Finds Protocol)

While no recorded features exist, the waterlogged and anaerobic conditions of fen environments possess a high potential for preserving previously unrecorded organic archaeological materials (e.g., wooden trackways, ancient implements, or environmental deposits).

To ensure complete compliance with the spirit of the National Monuments Acts, a standard "Chance Finds" Protocol will be maintained throughout the duration of the restoration works. In the highly unlikely event that any sub-surface archaeological features or artefacts are exposed during ground disturbance or rewetting activities, works in the immediate area will cease immediately, and the National Monuments Service and the National Museum of Ireland will be notified within the statutory 72-hour window.

8 Summary of Fen Restoration Plan Actions

Prior to proceeding with the implementation of the restoration measures outlined in the FRP, consultation with landowners and key stakeholders with an interest in the site is essential (Table 8-1). While this FRP identifies the key pressures and actions to be implemented, consultation with landowners and stakeholders may identify the need to amend or alter restoration actions. There may also be opportunities to provide additional benefits to the wider community. Consultation with local NPWS staff will be crucial to informing implementation planning.

Table 8-1: Role players in fen restoration plan

Measures	Stakeholder	Description
On-site	Landowners	Engaging landowners to manage surrounding sites more sensitively to protect fen habitats
Off-site	Landowners & farmers	Engagement for uptake of catchment measures.
Capacity building	NPWS	NPWS engaging in community education and events

This section provides the summary of the Fen Restoration Plan Actions for Balnavine Fen (Table 8-2). The immediate actions for this site involve installation of hydrological monitoring equipment to gather appropriate data to inform whether further restoration measures are suitable for the site. If more intrusive works such as drain blocking or scrub removal were required, enabling works may include a site walkover with an Ecological Clerk of Works and any necessary mitigation measures to ensure potential adverse impacts are controlled. For the purpose of this FRP, these are included for future reference, however relevant notes are made in the table as to their relevance to the immediate actions.

Table 8-2: Implementation plan for Balnavine Fen Restoration

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
1	**Required preliminary actions**							
1.1	Drainage management plan							
	Consultation with Westmeath County Council on the drainage management plan is required to ensure compliance with legislation and local authority objectives.	Sitewide	Drainage management plan	Pre-restoration	NPWS	Westmeath Co. Co	Arup	Within Tóchar project scope
1.2	Archaeological assessment							
	Consultation with NMS on the archaeology is required to ensure compliance with legislation and local authority objectives.	Sitewide	Archaeological assessment report	Pre-restoration	NPWS	Westmeath Co. Co	Arup	Within Tóchar project scope
2	**Enabling Works – [Included here for reference but these would only be applicable to more intrusive works such as scrub removal, which is not the immediate action recommended]**							
2.1	Pre-restoration Works Surveys							
	Pre-site walkover with Ecologist/Ecological Clerk of Works (ECoW) to ensure proposed measures are appropriate and whether alterations are required.	Sitewide	ECoW report	Pre-restoration	NPWS	Westmeath Co. Co		NPWS
2.2	Implementation of Mitigation Measures							

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
	Ecological Impact Assessment Considerations – identification of necessary mitigation measures. Such measures may include, but are not limited to, the utilisation of hand machinery to avoid impact on sensitive habitats	Sitewide	ECoW report	Pre-restoration	NPWS	Westmeath Co. Co		NPWS
2.3	Breeding Bird Considerations							
	Prior to restoration works, where any restoration measures are identified to have the potential to interfere with breeding birds e.g. scrub removal, these works shall occur outside the breeding bird season (1 March – 31 August inclusive).	Sitewide	ECoW report	Pre-restoration	NPWS	Westmeath Co. Co		NPWS
2.4	Good Practice Recommendations and CEMP							
	Good Practice Recommendations – Includes, but not limited to, avoidance of sensitive ecological receptors, pollution prevention procedures, biosecurity measures etc. The preparation and provision of a Construction Environmental Management Plan (CEMP).	Sitewide	ECoW report	Pre-restoration	NPWS	Westmeath Co. Co		NPWS
3	**On-Site Restoration measures**							
3.1	Hydrology measures							

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
	Drain blocking is proposed within the main southern-central drain, where fen conditions are drier than the rest of the site. Installation of Piezometers Piezometers will be used to monitor groundwater levels and support the interpretation of groundwater flow pathways. The data collected will help determine whether blocking one of the two drains, located to the southern and central, has the potential to deliver positive habitat benefits.	Northern, Central and Southern areas	Site installations Records	Restoration in 2027	NPWS to facilitate		Arup/ Contractor	Within Tóchar project scope
3.2	Vegetation measures							
	Scrub Removal - This should be undertaken following the results of the hydrological monitoring as scrub removal and drain blocking would be the most effective measure to prevent encroachment.	Dependent on the proposed hydrological measures. Scrub removal should be in areas of the site where the water table will rise	Updated monitoring and a pre-start check with an ecologist to identify the optimal area and extent of scrub removal required	Seasonal removal of vegetation to avoid bird nesting season	NPWS working with landowner	Westmeath Co. Co		NPWS

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
4 Off-Site Restoration measures								
4.1	Hydrology measures							
	Landowners should be made aware about excavation and livestock access impacts to prevent drainage on nearby land that could disrupt the fen's water balance.	Surrounding farms	Landowner awareness	Long-term		Westmeath Co. Co.		Westmeath Co. Co.
4.2	Nutrient measures							
	Catchment nutrient management. Targeted nutrient management strategies should be implemented throughout the catchment to address both phosphate and nitrogen pathways. Recommended measures include source controls such as Farmer Training Courses within the fen catchment, Nutrient Management Plans, and Nitrogen Surplus monitoring; pathway interception initiatives like Linear Riparian Buffer Zones in grassland areas; and receptor interventions such as installation of vegetated bunded drains.	Surrounding landowners	Uptake of measures by landowners/ farmers	Long-term	NPWS, LAWPRO, Farming for Water EIP		Landowners	Catchment measures to be funded through Farming for Water EIP / other similar
5	**Monitoring progress**							
5.1	Hydrology monitoring							

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
	Monitoring groundwater and surface water at key site locations using piezometers and standpipes.	Northern, Central and Southern areas	Water level	Long term	NPWS to facilitate access			NPWS
5.2	Nutrient monitoring							
	Water quality in fen habitats and drainage channels will be monitored regularly.	Allocated locations across Balnavine Fen	Nitrate, phosphorous, EC, Temperature, pH	Long term	NPWS to facilitate site access			NPWS
5.3	Vegetation monitoring							
	Vegetation monitoring will be undertaken using detailed relevés to document habitat composition, cover, and structural characteristics within representative plots. The surveys will also record any pressures or threats, including scrub encroachment, invasive species, or changes to hydrological conditions. These surveys will guide any restoration actions if changes are detected.	Sitewide	Site records/habitat surveys	Long term	NPWS to facilitate site access	Westmeath Co. Co		NPWS
6	**Capacity building and training**							
	Public meeting: To engage stakeholders on developments and results from the restoration measures.			Long-term	NPWS			NPWS

	Activity	Location	Monitoring/ implementation indicator	Timeframe	Key role player			Possible funding source
					National	Regional/ Local	Other	
	Farmer training: Training such as that provided by the Farming for Water EIP will provide farmers with knowledge of alternative and habitat sensitive measures			Long-term	NPWS/ Farming for Water EIP / LAWPRO / Teagasc			Farming for Water EIP / other similar

8.1 Habitats Benefiting from Implementation of Restoration Actions

7230 Alkaline fen

Following the hydrological monitoring proposed across three sections of the site; this will identify suitable areas to propose interventions such as drain blocking to raise the water table onsite and improve conditions for 7230 Alkaline fen. Scrub removal should also be undertaken concurrently with drain blocking as there is extensive scrub encroachment across the site, particularly in the southern section. This combination of raising the water table and removing scrub such as birch, willow and gorse will further improve the condition of the fen.

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Appendix A – Non-Technical Summary

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan Non-Technical Summary			
Site Name	Balnavine Fen	**NFS site no.**	104007
County	Westmeath	**Designation**	None
Fen habitats present (area)	7230 Alkaline Fen (2.12 ha)	**Species of note**	*[Pyrola rotundifolia], [Philonotis calcarea], [Listera ovata], [Dactylorhiza transteineroides]*

Site Description

Balnavine Fen is a small (approximately 5 ha) cutover bog located 24 km north-west of Mullingar, Co. Westmeath. Although the site is not designated as an SAC, SPA or NHA, it supports Annex I quality 7230 Alkaline fen, which covers approximately 50–60% of the site. Other habitats include alluvial woodland, rich fen, dry meadow, wet woodland, bog woodland and scrub. The site is being affected by the encroachment of downy birch and gorse scrub, likely due to hydrological changes or groundwater drawdown that have created drier conditions and allowed woody vegetation to expand into areas of fen.

Conceptual Site Model (CSM)

Balnavine Fen is a groundwater-fed valley-bottom fen that functions as a groundwater discharge zone, receiving water from surrounding higher ground and karst recharge areas to the north, northwest and northeast. Groundwater moves through the underlying karstified limestone aquifer and discharges within the fen before flowing southwards towards Lough Adeel. The site is underlain by Derravaragh Cherts and peat deposits, which influence groundwater storage and flow. Base-rich groundwater conditions support alkaline fen vegetation, including Annex I 7230 habitats. Historical drainage and peat-cutting activities have altered the site's natural hydrology, with drains contributing to drier conditions in parts of the fen. These changes have led to habitat degradation, peat erosion, and the encroachment of scrub and woodland species such as birch, willow and gorse. Elevated nitrate concentrations recorded in some areas may reflect agricultural influences within the wider catchment.

Key Pressures

Hydrology Pressures	Drainage, Lowering and fluctuations of water levels, Modification of natural groundwater-surface interactions.
Nutrient Pressures	Diffuse and/or localised nutrient input from agricultural activities; Internal nutrient enrichment linked to hydrological change; Link between groundwater inputs and nutrients.

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan Non-Technical Summary	
Ecology Pressures	Drainage; Scrub encroachment
Objective of Restoration Plan	
The main aim of the restoration actions proposed as part of this assessment is to maintain and improve the quality of existing areas of fen habitat, to enhance hydrological conditions that will allow an expansion of the measurable area of fen thus promoting favourable condition of wetland habitat. However, in some areas, it must be recognised that restorations to increase areas of existing fen will not be possible due to unsuitable hydrological conditions, and the objective may simply be to ensure no further deterioration.	
Restoration Measures	
Hydrology Measures	**On-site Measures:** Drain blocking and Hydrological monitoring **Off-Site Measures**: Avoid creating new drainage channels.
Nutrient Measures	**On-Site Measures:** Water quality monitoring **Off-Site Measures:** Agricultural Nutrient Management; Catchment Nutrient Management
Ecology Measures	**On-Site Measures:** Vegetation monitoring; Scrub removal
Monitoring	
Hydrology Monitoring	A hydrological monitoring programme will be implemented to assess site water conditions and understand the influence of the drainage network on water levels. The programme will use piezometers, to collect groundwater and surface water data, supported by rainfall and evapotranspiration records. Monitoring will focus on water table depth, hydraulic gradients, and drain and outflow water levels. The results will inform future restoration and water management measures, including potential drain blocking. Drain blocking in the southern area is currently considered a likely option but will be confirmed through the monitoring programme.
Nutrient Monitoring	Monitoring of water quality to improve understanding of nutrient dynamics within the site and to assess the effectiveness of any future off-site measures.
Ecology Monitoring	Monitoring points have been proposed which overlap with (where suitable) the existing NFS points. The purpose of these points is to monitor species composition within the habitat. This serves to monitor any vegetation change and inform future restoration measures.

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan Non-Technical Summary
More information
Fen Restoration Plan Report Tóchar website: https://www.tocharwetlands.ie/fen-restoration/

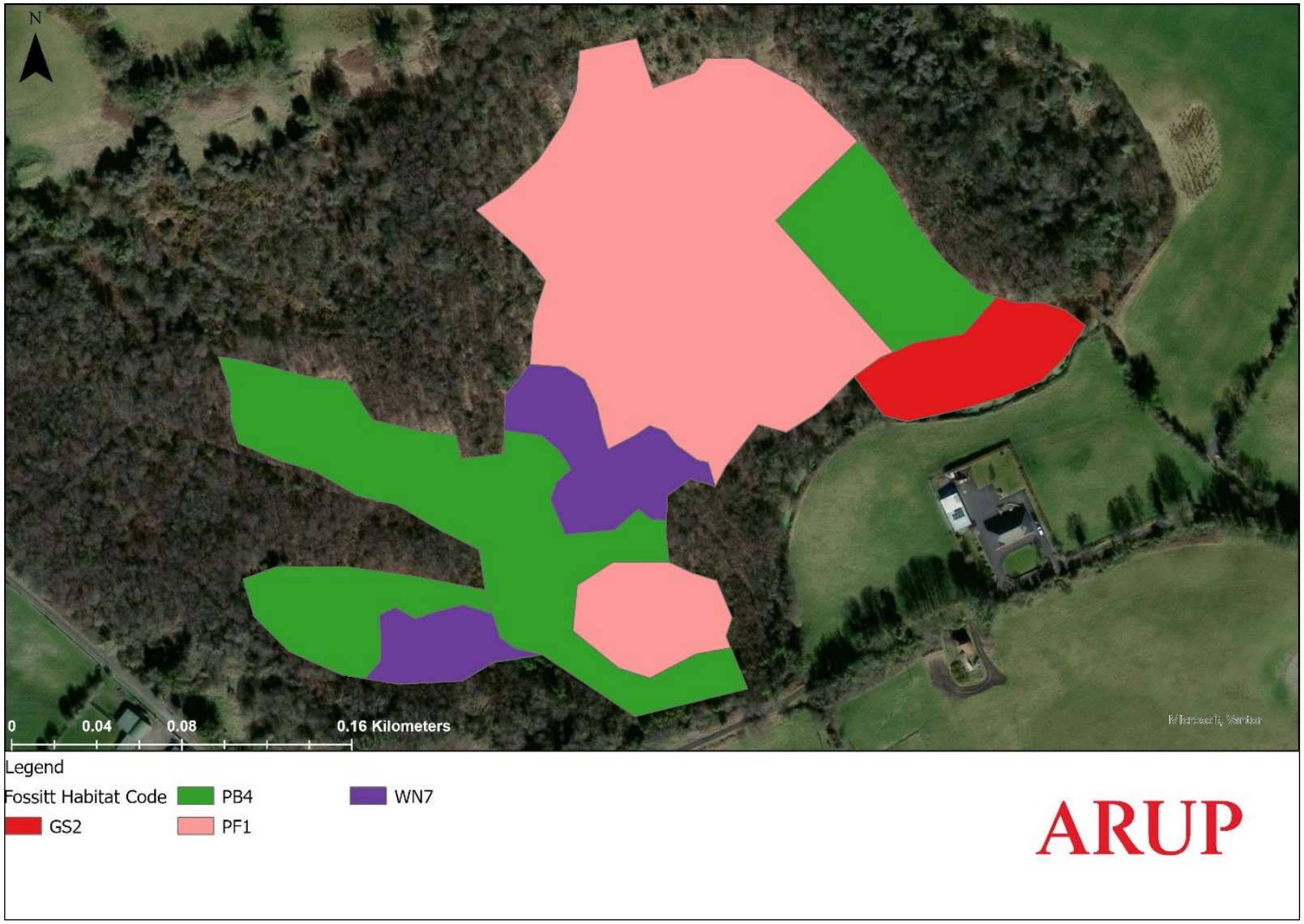


Figure 1: Site Habitat Map

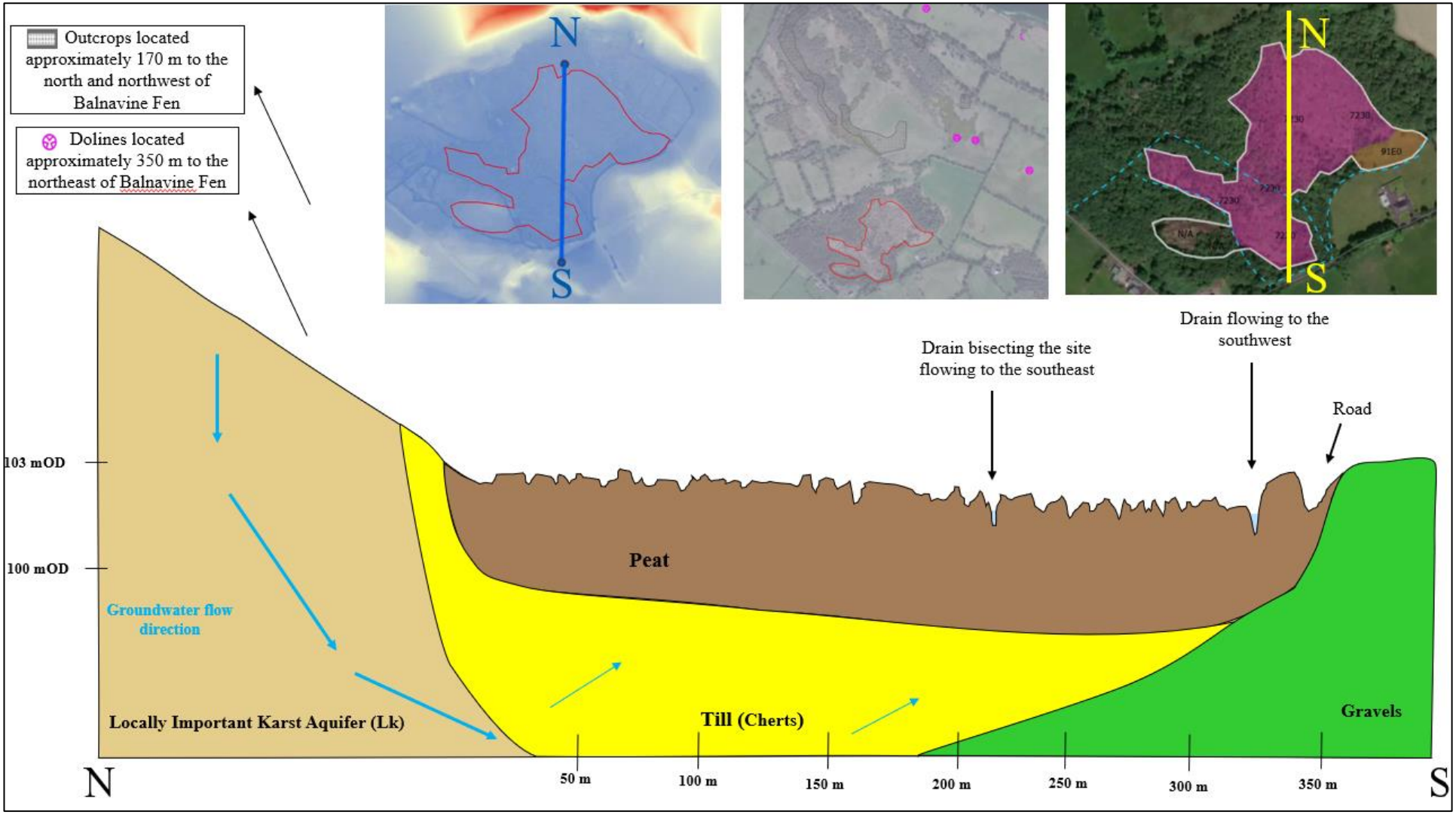


Figure 2: Conceptual Site Model

Appendix B – Ecological Survey Maps

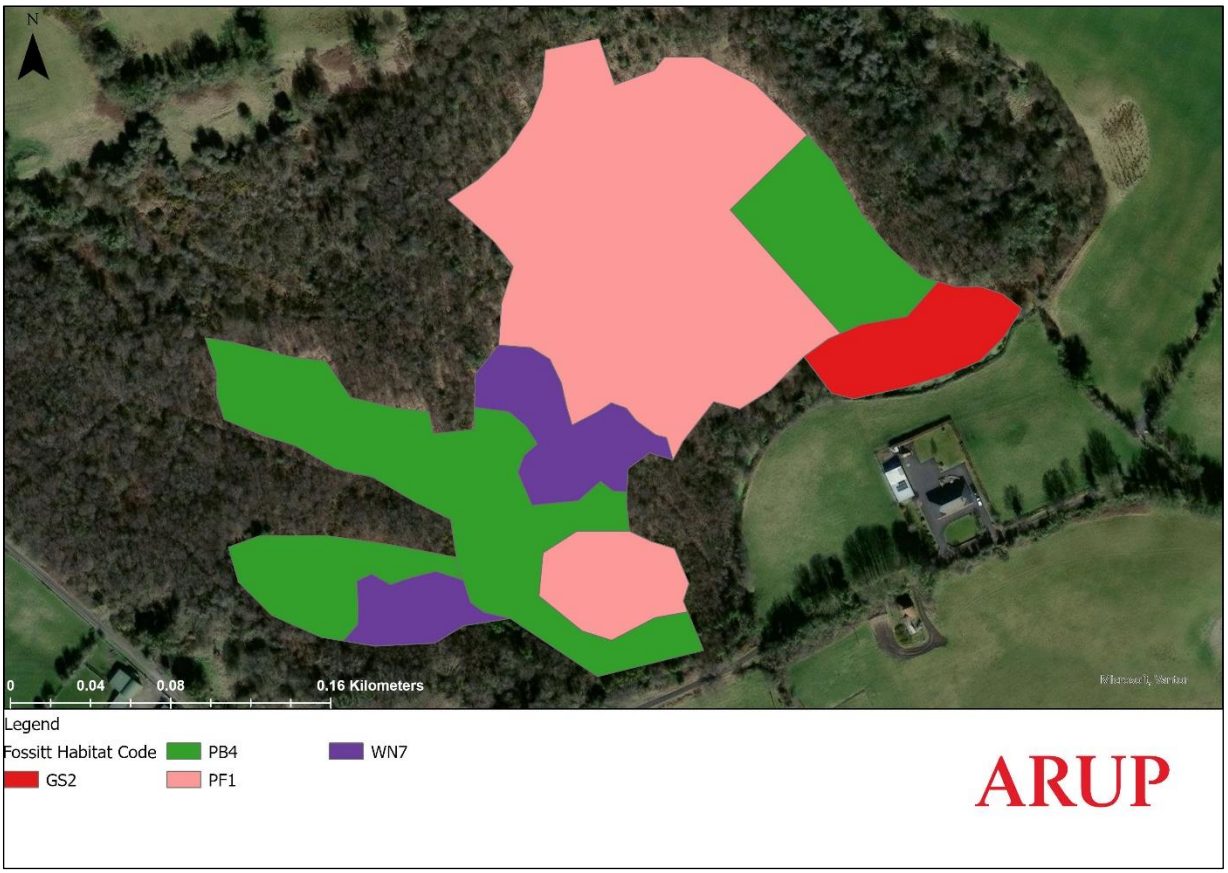


Figure B-9-1: Habitats recorded during the 2022 NFS and classified according to the Fossitt Habitat Classification System. Please refer to Appendix B for the full directory of habitat codes and names.

Table 9-1 Annex I habitat codes and Fossitt habitat code directory

Annex I habitat code	Annex I habitat name	Fossitt Habitat Code	Fossitt Habitat Name
3110	Oligotrophic Isoetid lake habitat	FL1	Dystrophic lakes
3130	Slender Naiad-type lakes	FL2	Acid oligotrophic lakes
3140	Hard-water lakes	FL3	Limestone/marl lakes
3150	Rich pondweed lake habitat	FL4	Mesotrophic lakes
3160	Acid oligotrophic lakes	FL5	Eutrophic lakes
3180	Turloughs	FL6	Turloughs
3260	Vegetation of flowing waters	FL7	Reservoirs
3270	Chenopodion rubri	FL8	Other artificial lakes and ponds
4010	Wet heaths	FW1	Eroding/upland rivers
4030	Dry heaths	FW2	Depositing/lowland rivers
4060	Alpine and subalpine heath	FW3	Canals
5130	Juniper scrub	FW4	Drainage ditches
6130	Calaminarian grasslands	FP1	Calcareous springs
6210	Orchid-rich calcareous grassland	FP2	Non-calcareous springs
6230	Species-rich Nardus grassland	FS1	Reed and large sedge swamps
6410	Molinia meadows	FS2	Tall-herb swamps
6430	Hydrophilous tall-herb swamp	GA1	Improved agricultural grassland
6510	Hay meadows	GA2	Amenity grassland (improved)
7110	Raised bog (active)	GS1	Dry calcareous and neutral grassland
7120	Degraded raised bogs	GS2	Dry meadows and grassy verges
7130	Blanket bog (active)	GS3	Dry-humid acid grassland
7140	Transition mires	GS4	Wet grassland
7150	Rhynchosporion depressions	GM1	Marsh
7210	Cladium fens	HH1	Dry siliceous heath
7220	Petrifying springs	HH2	Dry calcareous heath
7230	Alkaline fen	HH3	Wet heath
8110	Siliceous scree	HH4	Montane heath
8120	Calcareous scree	HD1	Dense bracken
8210	Calcareous rocky slopes	PB1	Raised bog
8220	Siliceous rocky slopes	PB2	Upland blanket bog
8240	Limestone pavement	PB3	Lowland blanket bog

Annex I habitat code	Annex I habitat name	Fossitt Habitat Code	Fossitt Habitat Name
8310	Caves	PB4	Cutover bog
8330	Sea caves	PB5	Eroding blanket bog
91A0	Old oak woodland	PF1	Rich fen and flush
91D0	Bog woodland	PF2	Poor fen and flush
91E0	Alluvial woodland	PF3	Transition mire and quaking bog
91J0	Yew woodland	WN1	Oak-birch-holly woodland
		WN2	Oak-ash-hazel woodland
		WN3	Yew woodland
		WN4	Wet pedunculate oak-ash woodland
		WN5	Riparian woodland
		WN6	Wet willow-alder-ash woodland
		WN7	Bog woodland
		WD1	(Mixed) broadleaved woodland
		WD2	Mixed broadleaved/conifer woodland
		WD3	(Mixed) conifer woodland
		WD4	Conifer plantation
		WD5	Scattered trees and parkland
		WS1	Scrub
		WS2	Immature woodland
		WS3	Ornamental/non-native shrub
		WS4	Short rotation coppice
		WS5	Recently-felled woodland
		WL1	Hedgerows
		WL2	Treelines
		ER1	Exposed siliceous rock
		ER2	Exposed calcareous rock
		ER3	Siliceous scree and loose rock
		ER4	Calcareous scree and loose rock
		EU1	Non-marine caves
		EU2	Artificial underground habitats
		ED1	Exposed sand, gravel or till
		ED2	Spoil and bare ground

Annex I habitat code	Annex I habitat name	Fossitt Habitat Code	Fossitt Habitat Name
		ED3	Recolonising bare ground
		ED4	Active quarries and mines
		ED5	Refuse and other waste
		BC1	Arable crops
		BC2	Horticultural land
		BC3	Tilled land
		BC4	Flower beds and borders
		BL1	Stone walls and other stonework
		BL2	Earth banks
		BL3	Buildings and artificial surfaces

Appendix C – Restoration measures and monitoring

Point	Measure	Objective	Timeframe	Frequency of monitoring
Gw_1	Hydrological	Groundwater levels and quality monitoring	Long-term	Quarterly for year 1 Annual for year 2-5
Gw_2				
Gw_3				
GW_4				
GW_5				
Ec_1	Ecological	Monitoring within areas of 7230 Alkaline fens	Long-term	Seasonal for year 1 Every 3 years for year 2-5
Ec_2				
Ec_3				
Ec_4				

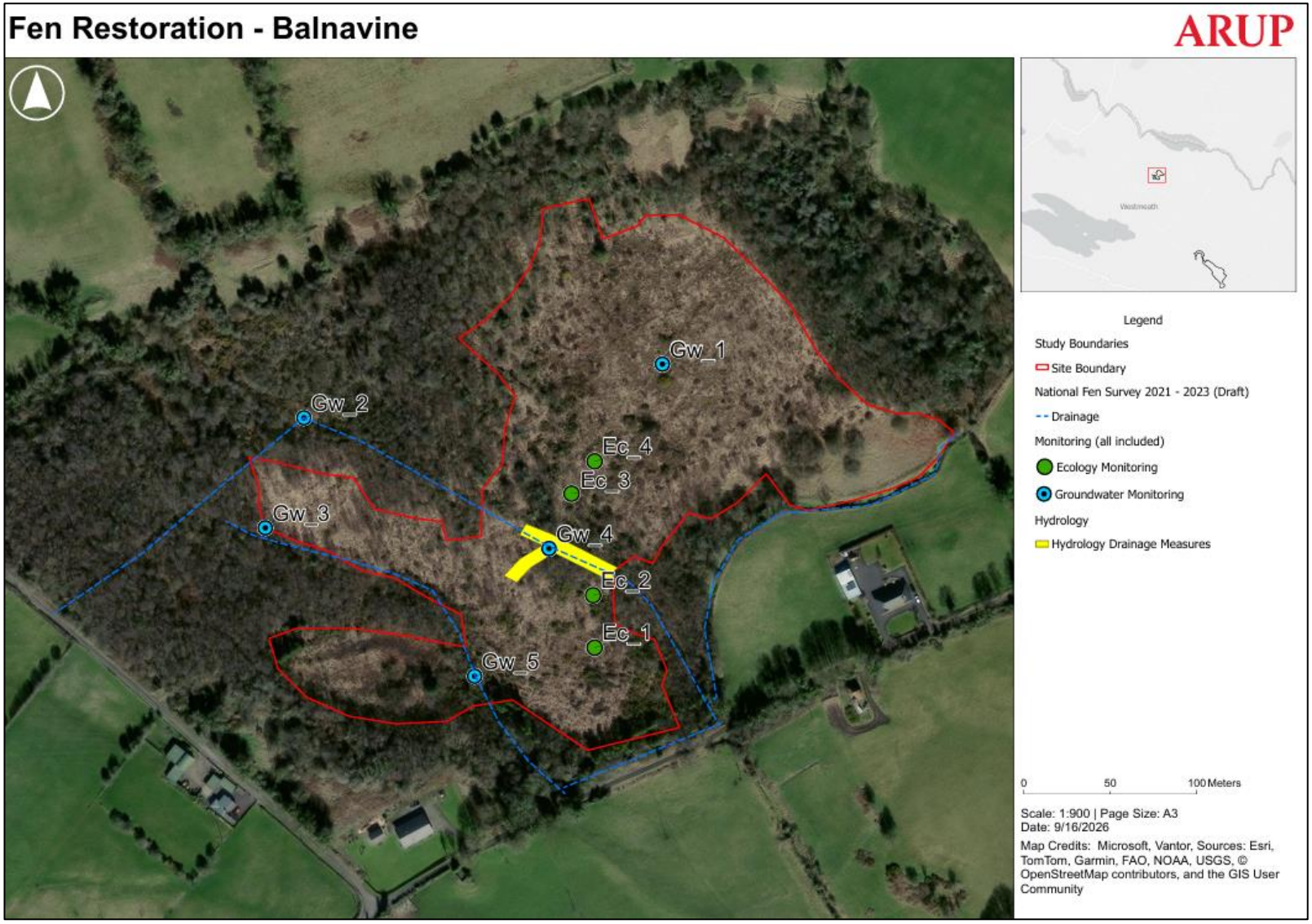


Figure 9-2: Restoration and monitoring map

Appendix D – Drainage Management Plan

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan: Drainage Management Plan			
Site name	Balnavine Fen		
County	Westmeath	NFS site No.	104007
Catchment overview:			
The site is generally flat, with ground elevations of approximately 102 mOD, gradually increasing towards the north and northwest where levels reach around 110 mOD. Beyond the site boundary, the terrain rises more significantly to the north and northeast, attaining elevations of approximately 150 mOD and featuring exposed bedrock and karst landforms, including dolines. To the south, the landscape slopes down towards Lough Adeel, where elevations fall below 90 mOD. The area contains five waterbodies, including the Lough Lene–Adeel Stream.			
WFD catchment	Boyne	WFD Sub-catchment	Deel [Raharney]_SC_010
Drainage Area	Yes	Drainage District	None
Responsible authority	Westmeath County Council	Maintenance date	TBD
Surrounding landowners	Landowners and farmers		
Wetland drainage			
Historical and current hydrological records indicate that no drainage channels were present within the site from 1829 to 1913. Currently, drains occur in the central part of the site, along the southern and western boundaries, and around the site boundary, with the predominant direction of surface water flow towards the south, ultimately entering Lough Adeel.			
Surface water inflow	Central drain flowing to the south that currently bisects the site.	Surface water outflow	The southern drain shows active flow towards the southwest.
Groundwater inflow	Site located within a groundwater discharge zone; surrounding upland karst areas likely act as groundwater recharge zones and may contribute to groundwater inflow.		
Internal drains	One drain located in the centre of the site and one drain located on the west of the site.	Perimeter drains	Two drains located along the western and southern boundaries.
On site hydrology measures			
On-site measure 1	Drain Blocking Hydrological monitoring	Role player	NPWS/Surrounding landowners
Off-site hydrology measures			

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan: Drainage Management Plan					
Off-site measure 1	Avoid creating new drainage channels			Role player	NPWS/Surrounding landowners
On-site nutrient measures					
On-site measure 1	Water quality monitoring			Role player	NPWS/Surrounding landowners
Water Monitoring					
Indicator	Water level/ Water quality	Location	Various locations across site	Role players	NPWS
Monitoring installations are proposed at five locations across the site. Two piezometers will be installed in the southern drain area to monitor groundwater fluctuations and seasonal variation. Two further monitoring points will be located in the central area to assess water level fluctuations, hydrological connectivity, and potential water loss via the existing drain. A final monitoring point will be installed within the wetter northern fen to provide baseline data and enable comparison with conditions elsewhere on the site.					

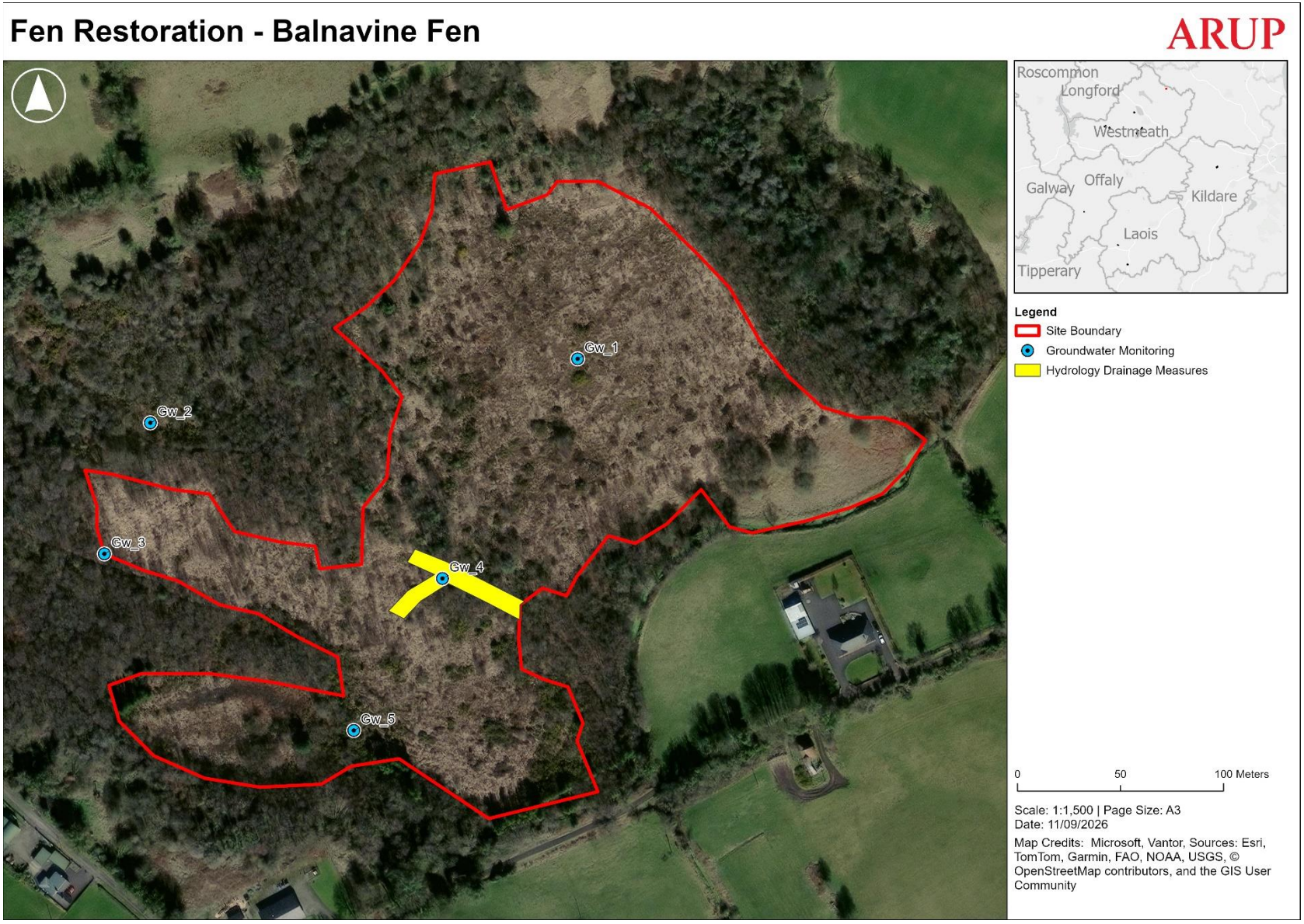


Figure 1: Hydrology measures and monitoring at Balnavine Fen