

National Parks & Wildlife Service
Tóchar Midlands Wetland Restoration Scheme

Lough Owel
PFS Site No. 1005
SAC 000688
Fen Restoration Plan

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Service

Fen Restoration Plan

Lough Owel (1005)

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Executive Summary

Lough Owel, Co. Westmeath, is located 4km north-west of Mullingar and has been designated as a Special Area of Conservation (SAC) for the presence of 7140 Transition mires and quaking bogs and 7230 Alkaline fens habitats.

This Fen Restoration Plan (referred to hereafter as FRP) has been developed to set out proposals for restoration of 7140 Transition mires and quaking bogs and 7230 Alkaline fens in order to contribute to the achievement of site-specific conservation objectives (SSCOs) for the SAC. This is a site-level plan that will be subject to refinement prior to implementation of restoration actions in each subsite. The assessment primarily considers the following pressures that may be impacting on the hydrological function and/or favourable conservation condition of the fen habitat:

- Drainage
- Scrub encroachment
- Changes to water quality, e.g. nutrient enrichment
- Over or under grazing
- Invasive species e.g. scattered self-seeding conifers

Other pressures (e.g., burning, turf cutting, damage by recreational vehicles) may be present within the site, and will be considered following the desktop assessment and following a reconnaissance visit of the targeted areas for restoration measures.

Actions of the Fen Restoration Plan

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

Central to the plan is the monitoring of water levels. More detailed hydrological analysis and monitoring is required to quantify the surface water outputs from the sites. This will inform the reliance of the lake and canal on inputs from the fens at Bunbrosna and Culleen. Once there is consensus on the drainage measures then water levels can be adjusted at Bunbrosna and Culleen, for the benefit of targeted habitats.

Lough Owel supports three Annex I habitats: 7140 Transition mires and quaking bogs occupy 1.31 ha in the south-east at Culleen, with key species such as sedges, *Eriophorum angustifolium* and *Menyanthes trifoliata*, and show overlapping boundaries with alkaline fens; pressures include water level fluctuations and scrub encroachment, but the conservation status is favourable. 7230 Alkaline fens cover approximately 2.18 ha across Ballard and Culleen, characterised by sedges and mosses including *Campyllum stellatum* and *Scorpidium cossonii*, and are impacted by scrub encroachment, nutrient enrichment and poor drain maintenance, resulting in an unfavourable-inadequate conservation status. 7210 *Cladium* fen is extremely limited at 0.01 ha in the northern section at Bunbrosna, dominated by *Cladium mariscus* and

Phragmites australis. Hydrological complexity and management of scrub and water levels remain key challenges for maintaining fen habitat integrity.

Based on the water monitoring completed to date, there is evidence of phosphate and nitrate nutrient pollution across the Bunbrosna and Culleen sites. Therefore, targeted nutrient control measures should be implemented across the catchment to address both phosphate and nitrogen pathways. This includes landowner engagement and offsite restoration measures, outlined under the Farming for Water EIP.

Finally, 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 (if needed) are practical, widely supported, and compliant with relevant legislation.

The plan also notes that there are archaeological features within the site boundary for Culleen, with associated risks to cultural heritage.

Benefits of the Fen Restoration Plan

The current water levels within the sites are not deemed adequate for supporting the existing fen habitats. Due to the competing drinking water, recreation and navigation water use for the lake a more detailed hydrological analysis is required before water levels can be adjusted within the fen habitats. Therefore, the proposed actions enable a better understanding of what the baseline hydrology is and whether there is any active natural succession in vegetation community that is occurring as a result of the current levels. The benefit of understanding this baseline is to ensure that no active management is undertaken that is later considered to be ineffective. The longer-term monitoring will provide valuable data to inform water level and vegetation management at a later stage.

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 and the Tóchar Wetlands Project Team.

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

Lough Owel SAC [000688] (PFS site code: 1005) is located approximately 4 km north-west of Mullingar, Co. Westmeath. The SAC covers a total area of 1121.44 ha and is dominated by Annex I habitat 91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*)* or wet grassland although several other associated fen and peatland habitats are also present (O’Neil et al., 2023). The qualifying features of the SAC include Annex I fen habitats 7140 Transition Mires ¹) and 7230 Alkaline fens. The Site-Specific Conservation Objective (SSCO) for both fen habitats is to maintain their favourable conservation condition. According to the Scoping Study and Pilot Survey of Fens carried out in Lough Owel SAC (O’Neill et al., 2023), the total extent of the 7140 Transition mire and 7230 Alkaline fens are 1.31 ha and 2.18 ha, respectively.

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 7140 Transition mires and 7230 Alkaline fens habitats in the SAC which contributes to the achievement of site-specific conservation objectives (SSCO) and favourable conservation condition of the fen habitat.

The main aim of the restoration actions proposed as part of this assessment is to maintain or improve the quality of existing areas of fen or improve the hydrological conditions that will allow an expansion of the measurable area of fen, thus impacting on SSCOs/ conservation condition of the fen. However, in some areas, it must be recognised that restoration 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.

Although the focus of the FRP is on fen habitats and associated SSCOs, it is anticipated that restoration actions will also benefit other wetland habitats, including 91E0 Alluvial woodland and wet grassland habitats and freshwater habitats, including 3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara spp*, which were mapped at Lough Owel SAC during the Pilot Fen Surveys (O’Neil et al., 2023). Restoration requirements actions to raise the water table of fen will improve the hydrology of adjacent Lough Owel. The implementation of the actions proposed within this FRP report may also provide wider improvements to biodiversity, reduce carbon emissions and potentially improve water quality, all of which may be demonstrable under eventual post-implementation monitoring.

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.

*Priority habitat under the EU Habitats Directive

1.2 Wider Benefits of Fen 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 notable amounts of carbon in their peat soils, contributing to climate change mitigation by reducing atmospheric carbon dioxide levels. Their ability to absorb and gradually 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 many fens in Ireland are not protected as SACs or Natural Heritage Areas (NHAs), they can play an important part for biodiversity and climate resilience.

Peatland drainage and extraction transforms 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 carbon sequestration functions.

The restoration of fen habitat can lead to improved water quality. 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 also reducing flood risk.

The restoration of fen habitat is likely to have beneficial effects for bird species too. The Lough Owel SPA [004047] overlaps Lough Owel SAC and is designated for coot (*Fulica atra*), shoveler (*Anas clypeata*) and wetland habitats (supporting migratory birds). These species are associated with wetlands and wet grasslands (including fen) which provide important foraging and nesting habitats. The conservation objective for Lough Owel SPA for is to maintain the favourable conservation condition of wetland habitats in Lough Owel SPA as a resource for the regularly occurring migratory waterbirds that utilise the area (NPWS, 2025).

A key target in the conservation objective for shoveler and coot is to restore the number of locations, area and availability of suitable roosting habitat to support populations throughout the SPA to maintain the population, along with sufficient availability of suitable foraging habitat across the SPA to support targets relating to population size, productivity rate and range. Restoration actions at Lough Owel SAC are likely to benefit shoveler and coot by improving foraging and roosting habitat for both and their prey species. Restoration of fen will also result in improvement in nesting/foraging habitats for other bird species of conservation concern recorded at Lough Owel SAC including kingfisher (*Alcedo atthis*), great northern diver (*Gavia immer*), goldeneye (*Bucephala clangula*) and snipe (*Gallinago gallinago*).

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 (Article 17 report) (NPWS 2025) in Table 1-1. The overall status is assigned as ‘Bad’ for both transitional mires and alkaline fens in the Article 17 report.

Table 1-1: National pressures to fen habitats

Habitat	Importance	Pressure
7140 Transition mires	High	PA09 Burning for agriculture PA13 Application of natural or synthetic fertilisers on agricultural land PA22 Drainage for use as agricultural land PF02 Construction of modification (e.g. of housing and settlements) in existing built-up areas PL02 Drainage (mixed or unknown drivers)
	Medium	PA08 Extensive grazing or undergrazing by livestock PA17 Agricultural activities generating pollution to surface or ground waters (including marine) PB24 Drainage for forestry PE01 Roads, paths, railroads and related infrastructure PI03 Problematic native species K01 Abstraction from groundwater, surface water or mixed water L02 Natural succession resulting in species composition change C05 Peat extraction
	Low	PA01 Conversion into agricultural land (excluding drainage and burning) PA02 Conversion from one type of agricultural land use to another (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) PA07 Intensive grazing or overgrazing by livestock PA21 Active abstraction of water for agriculture PB01 Conversion to forest from other land uses, or afforestation (excluding drainage) PB26 Other forestry activities, excluding those relating to agro-forestry PC05 Peat 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
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 undergrazing 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) PL02 Drainage (mixed or unknown drivers)
	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

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 laws and regulations 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.
- 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.
- Regulation (EU) 2024/1991 of the European Parliament and of the Council of June 2024 on nature restoration and amending Regulation (EU) 2022/869.

- 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.
- 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 Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

SACs are designated 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 designated, are the qualifying interests (QI) of the SAC and special conservation interest (SCI) of the SPA. Conservation objectives for the site are defined for these qualifying interests.

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.

The Water Framework Directive (WFD, 2000/60/EC) aims to achieve good water quality and ecological status for all water bodies, which directly benefits fen habitats that rely on specific hydrological conditions. By regulating water quality and quantity, the WFD helps maintain the delicate balance of nutrients and water levels essential for ecosystems such as fens. The Directive also promotes the restoration of degraded water bodies, to ensure the long-term conservation of these habitats. 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 Lough Owel SAC and the conservation objectives for 7140 and 7230 fen habitat.
- Section 3 outlines the findings from the land and water desktop and site monitoring surveys that were carried out to inform the development of the FRP.
- Section 4 outlines the findings from the ecological desktop and site monitoring surveys that were carried out to inform the development of the 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 the potential role players in the FRP and 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. Regarding maps presented, and following consultation with NPWS, due to the sensitivity of many of the species recorded or referenced, species names have been omitted from Map legends. This is to ensure no confidential or highly sensitive locations are revealed which might result in negative impacts. GIS Shapefiles which accompany this report include all relevant data on referenced species.

2 Site Overview

2.1 Lough Owel

Lough Owel SAC is located 4 km north-west of Mullingar, Co. Westmeath. The site is a SAC for the following qualifying interests: Hard oligo-mesotrophic waters with benthic vegetation of 3140 *Chara* spp, 7140 Transition mires, 7230 Alkaline fens, and the 1092 White-clawed crayfish (*Austropotamobius pallipes*) as listed on Annex I/II of the E.U Habitats Directive. For the purpose of this study, Lough Owel has been distributed into three sites, namely Bunbrosna in the northwest, Culleen in the southeast, and Ballard in the southwest (Figure 2-1). Not all areas of the study area are included in the SAC.

Elevation at the site ranges from 105m OD to 95m OD, and the topography is characterized by drumlins oriented in a northwest to southeast direction surrounding Lough Owel with topography gently sloping towards the Lough. Figure 2-1 outlines the location and extent of Lough Owel SAC.



Figure 2-1: Site Location Map

Historical maps show that Lough Owel has reduced in size since the mid 1800's due to draw down of water levels in the lake from historical drainage activities. In the Bunbrosna site, there are two historical drains present as seen on the OSI 6-Inch map, one to Lough Owel which drains to the southeast and one that drains to the west to Lough Iron during overflow. More recent site visits completed as part of the Pilot Fen Survey (PFS) in 2020 had observed and noted these two drains (O'Neil et al., 2023). In the Culleen site, the Lough feeds into the Royal

Canal through a drain to the southeast of the site which is visible on the historic 6-inch map in the mid 1800's. Site visits by Arup have confirmed there are two drains entering the Royal canal from the Culleen site. In the Ballard site, drains are identified on the historical 6-inch maps flowing north into Lough Owel. At present, the drains appear not to be maintained and are infilled with vegetation from observations made during the PFS 2020 site visits (O'Neil et al., 2023).

The site synopsis (NPWS, 2013) for Lough Owel SAC notes it is a relatively shallow hard water lake with a rocky, marl-covered bottom. The rocky nature of the shoreline has allowed for marginal vegetation to develop. There are two areas of wetland vegetation of particular interest in the north-west (Bunbrosna) and south-west of the lough which contain a mosaic of vegetation types including fen habitats. There are places where quaking mire grades into alkaline fen surrounding Lough Owel.

Lough Owel is the main water supply for Mullingar (managed by Uisce Éireann) and is the balancing supply for the Royal Canal (managed by Waterways Ireland). Mullingar Water Resource Zone is supplied from Lough Owel through Portloman Water Treatment Plant (WTP)² on the western edge of the lake (Figure 2-2). It has been highlighted that the abstraction of water from Lough Owel is complex due to its reliance on springs and vulnerability to climate change. During the 2018 drought there were very low water levels, which emphasised the need to balance competing water uses. In 2018 the low level in the lake prompted a large-scale water conservation campaign and implementation of night-time restrictions. This also prompted increased find and fix work to water infrastructure in the region. In 2020 and 2025 Water Conservation Orders were needed during drought conditions³.

² In 2018 it was serving a population of 50,000 with an abstraction of 20,167m³/d

³ [Concern over Lough Owel water levels | Westmeath Examiner](#)

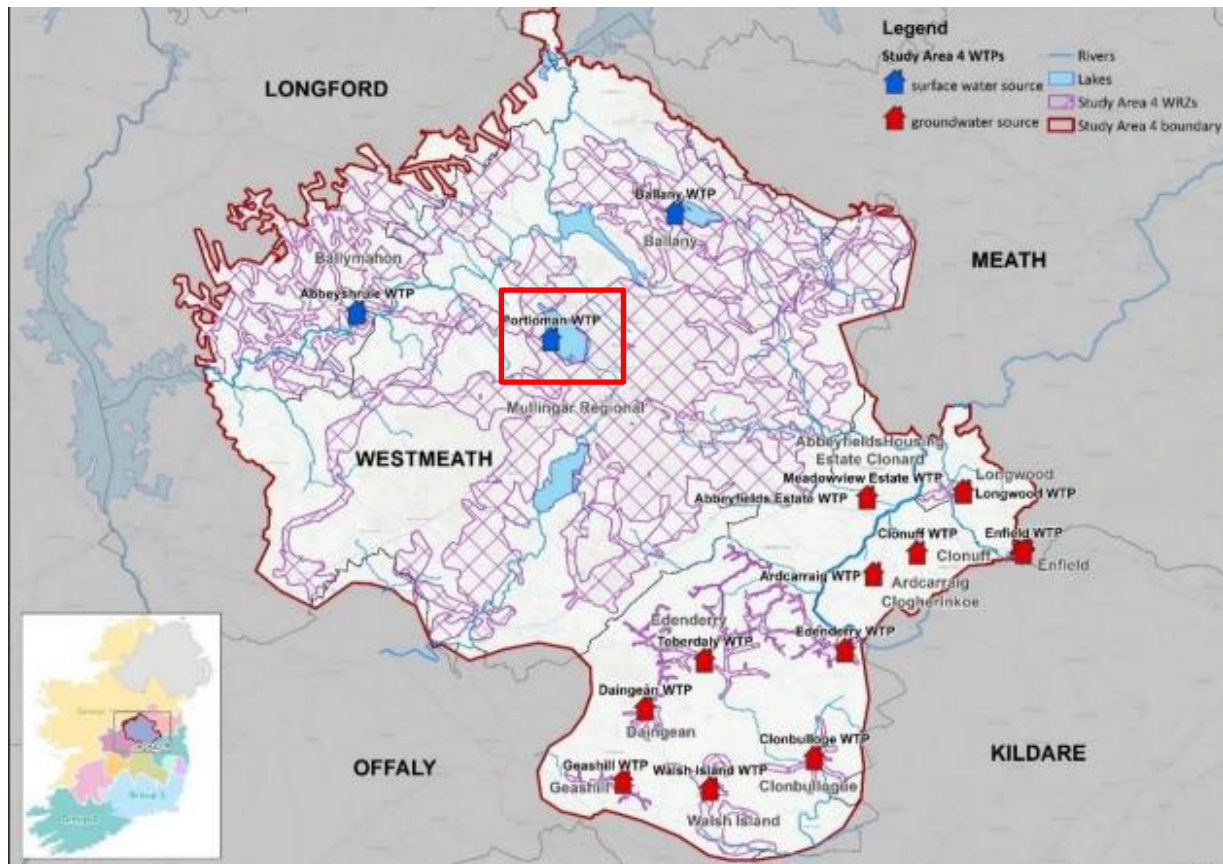


Figure 2-2: Water management areas within study area 4, with Lough Owel indicated in red box (UE, 2022)

Under the abstraction licence for Lough Owel, there is a condition that states that the abstraction should ensure that the level of the lake does not fall below 98.90m OD. The operation of the controls at the southern end of the lake on the feeder canal to the Royal Canal must include the provision and operation of works to provide 3 million gallons compensation water per day to the feeder canal and wherever the level of the lake falls to 99.36m OD, to provide for the return to the lake of 1 million gallons per day (UE, 2022).

It is noted that water supplies within the region were developed prior to most modern environmental legislation, with current abstractions not being developed through any formalised abstraction process. The update to the Water Environment (Abstraction and Associated Impoundment) Regulations 2024⁴ will impact Lough Owel, and water resource studies are ongoing to assess what this means for the operation of the WTP and canal feeder. There is also a water abstraction for a fish farm at the canal feeder downstream of Culleen. Other competing water uses for the lake is its designation for bathing water under the Bathing

Water Quality Regulations 2008 (S.I. No. 79/2008), as amended by S.I. No. 322/2024)⁵ and its use for fishing.

Lough Owel occurs within the Brosna Arterial Drainage Scheme, which was the first major OPW scheme under the Arterial Drainage Act 1945. This scheme improved land for agriculture and flood mitigation by deepening and widening channels, modifying bridges and weirs, and constructing embankments. The outfall of Lough Owel feeds into the Brosna which flows through Mullingar to discharge into Lough Ennell (Figure 2-3).



Figure 2-3: The catchments for Lough Ennell and Lough Owel (Lauder and LECMP partners, 2025)

⁵ [S.I. No. 322/2024 - Bathing Water Quality \(Amendment\) Regulations 2024](#)

2.2 Fen Condition Assessment

1005 Lough Owel SAC was surveyed as part of the PFS between 25th of May 2020 to the 12th of June 2020. The overall conservation condition of Annex I habitats was assessed as 7140 (Favourable), 7210 (Not assessed), and 7230 (Unfavourable-Inadequate) (O'Neill et al., 2019). The results of the conservation status assessment of 7140, 7210, and 7230 habitats carried out as part of the PFS surveys at Lough Owel SAC are summarised in Table 2-1.

Table 2-1: Conservation Status Assessment of 7140/7210/7230 Fen (O'Neill et al., 2019).

Annex 1 habitat	Area	Overall Status	Rationale
7140	<i>Favourable</i>	<i>Favourable</i>	The impacts recorded in the 7140 habitat from the Pilot Fen Survey (PFS) conducted in 2020 include agricultural activities generating diffuse pollution to surface and groundwater, water abstractions, and flooding (natural)
7210	<i>Favourable</i>	<i>Not assessed</i>	Not assessed/ Included in the PFS
7230	<i>Favourable</i>	<i>Unfavourable - Inadequate</i>	The impacts recorded in the 7230 alkaline fen from the PFS 2020 survey include abstractions from groundwater, surface water or mixed water, scrub encroachment, and flooding (natural).

2.3 Site-Specific Conservation Objectives

Detailed SSCOs aim to define the conditions necessary to maintain or achieve the favourable conservation condition of a habitat or species at site level. The maintenance of habitats and species within sites at favourable condition will contribute to the maintenance of favourable conservation status of those habitats and species at a national level.

The conservation objective for both the 7140 Transition mires and the 7230 Alkaline fens is '*To maintain/restore the favourable conservation condition of Transition mires and quaking bogs/Alkaline fens in SAC*'.

This document does not present the full suite of attributes, targets, and measures for the Annex I habitats. The selection provided in (Table 2-2) reflects a conscious decision to focus on those with clear, direct benefits from the FRP measures. While these are listed below, it is anticipated that the remaining attributes, targets, and measures will also experience positive outcomes as restoration measures are implemented.

Table 2-2: Attributes and Targets for 7140 Transition mires and 7230 Alkaline fens (NPWS,2018)

Attribute	Measure	Target	Addressed by FRP?	Will restoration actions contribute to achieving target?
7140 Transition mires				
Vegetation composition: typical vascular plants	Percentage cover at a representative number of 2m x 2m monitoring stops	Maintain adequate cover of typical vascular plant species	Yes	Yes. Monitoring will assess baseline conditions and inform appropriate measures for management of this habitat e.g. appropriate grazing regime
Vegetation composition: native negative indicator species	Percentage cover at a representative number of 2m x 2m monitoring stops	Native negative indicator species at insignificant levels	Yes	Yes. Monitoring will assess baseline conditions and inform appropriate measures for management of this habitat e.g. appropriate grazing regime
7230 Alkaline fens				
Vegetation composition: typical vascular plants	Percentage cover at a representative number of 2m x 2m monitoring stops	Maintain adequate cover of typical vascular plant species	Yes	Yes. Monitoring will assess baseline conditions and inform appropriate measures for management of this habitat e.g. appropriate grazing regime
Vegetation composition: native negative indicator species	Percentage cover at a representative number of 2m x 2m monitoring stops	Cover of native negative indicator species at insignificant levels	Yes	Yes. Monitoring will assess baseline conditions and inform appropriate measures for management of this habitat e.g. appropriate grazing regime

3 Land and Water

3.1 Desk 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 30 years from the closest weather station, Mullingar, has been compiled to assess long-term rainfall patterns and seasonal variability in rainfall at the site and surrounding areas (Met Eireann, 2025).

Two datasets have been visualised: (1) average yearly precipitation (mm) to display long-term rainfall patterns over a 30-year period (Figure 3-1) and (2) average monthly precipitation to show seasonal distribution patterns over a 30-year period (Figure 3-2). This information is important to assess the water availability and to evaluate the feasibility and sustainability of restoration actions aimed at restoring or maintaining suitable hydrological conditions.

The average yearly precipitation has slightly increased over the 30-year period and ranges from 61 mm in 2003 to 101 mm in 2002 (Figure 3-1). The maximum yearly precipitation trend shows a general increase since 1994 and a higher variance in annual rainfall, suggesting more erratic weather conditions in recent years. The minimum yearly precipitation has slightly increased since 1994 and displays an increased annual variability in the last 10 years, although not as extreme as the maximum precipitation values.

The average monthly rainfall is highest in the winter months (October to January) and lowest in late spring (April and May) (Figure 3-2). Minimum rainfall follows a similar pattern, while the maximum monthly rainfall shows a notable increase in winter.

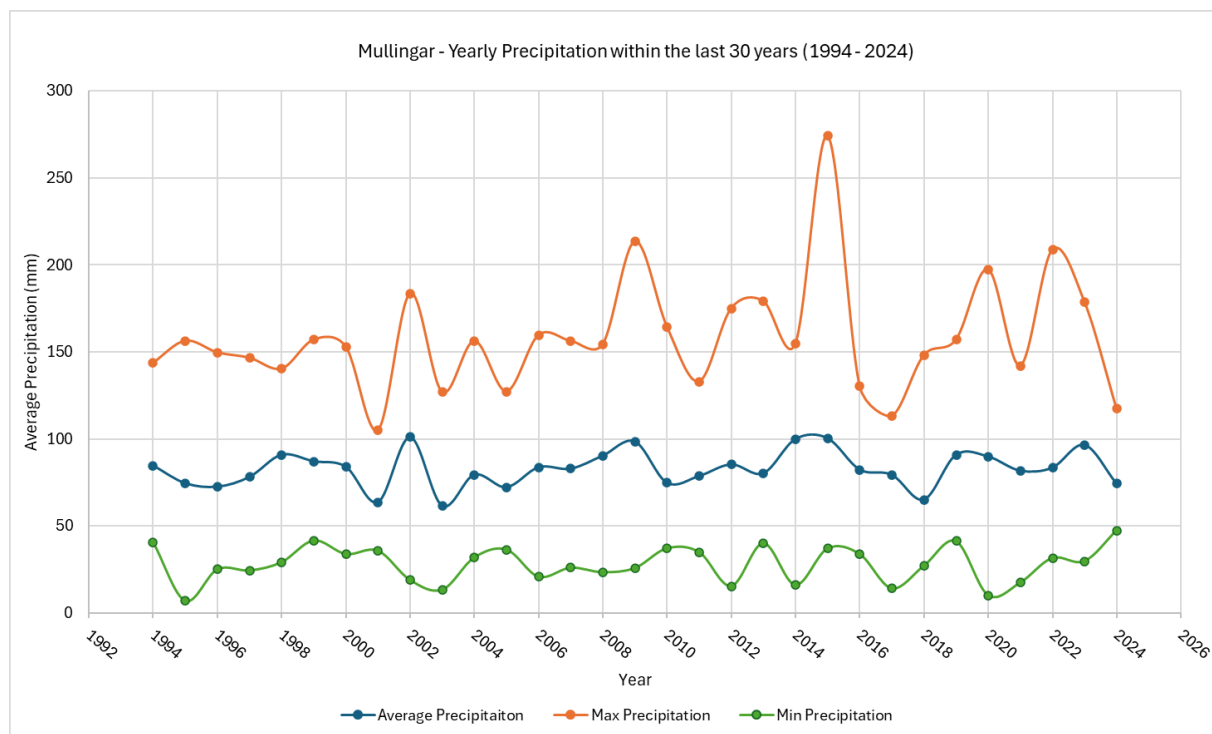


Figure 3-1: Mullingar weather station – (1) average, (2) maximum, and (3) minimum yearly precipitation from 1994 to 2024

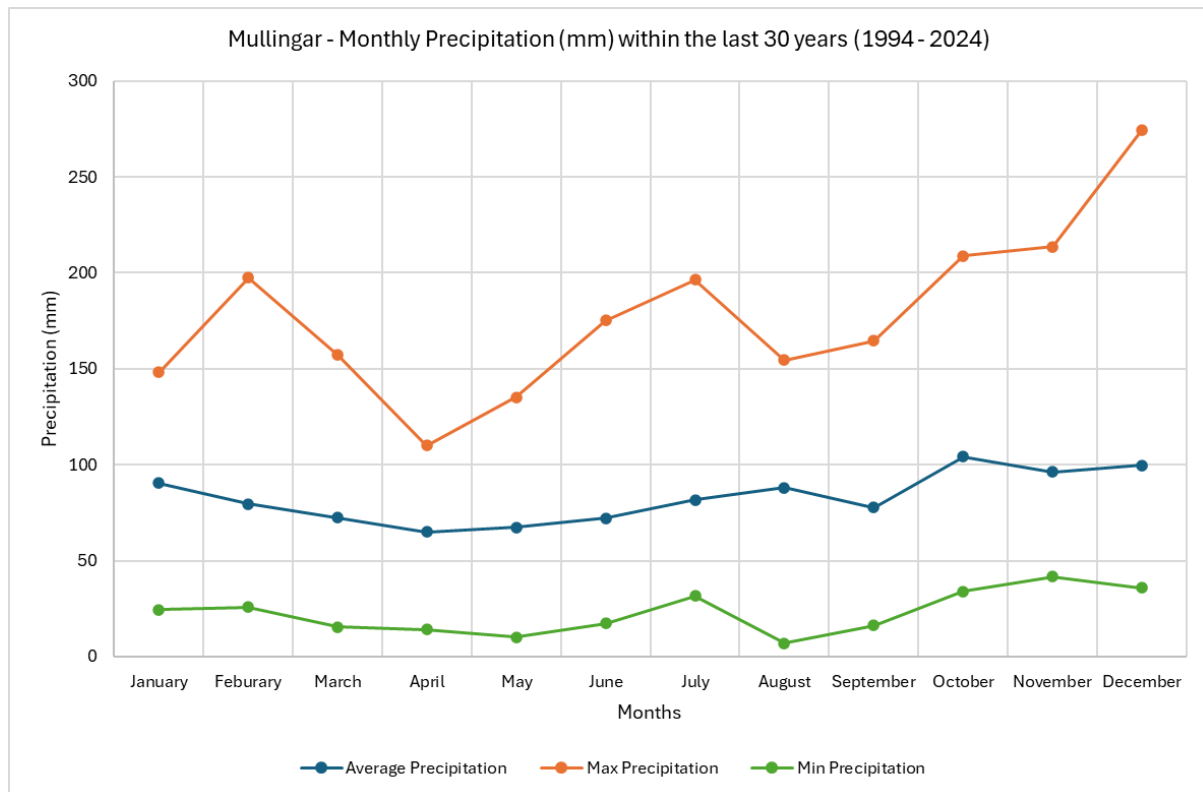


Figure 3-2: Mullingar weather station - (1) average, (2) maximum, and (3) minimum monthly precipitation from 1994 to 2024

A lake level analysis was conducted for 2024 to 2025 time-period for Lough Owel, to assess the impact of the drought on lake levels (Figure 3-3). In 2025 the lake levels were particularly low (below 96.3 mOD). This was caused by the lack of rainfall in the area over previous months, especially since May 2024. As Lough Owel is a rain and groundwater fed source, it takes a longer time to replenish than other types of water sources, and is very sensitive to repeated drawdowns (UE, 2025), recovery of the lake level needs both additional rainfall and a reduction in water demand (UE, 2025).

Percentile Level	Explanation
Above Normal	30%tile < Daily Average Level < 10%tile
Normal	70%tile < Daily Average Level < 30%tile
Below Normal	95%tile < Daily Average Level < 70%tile
Particularly Low	Daily Average Level < 95%tile

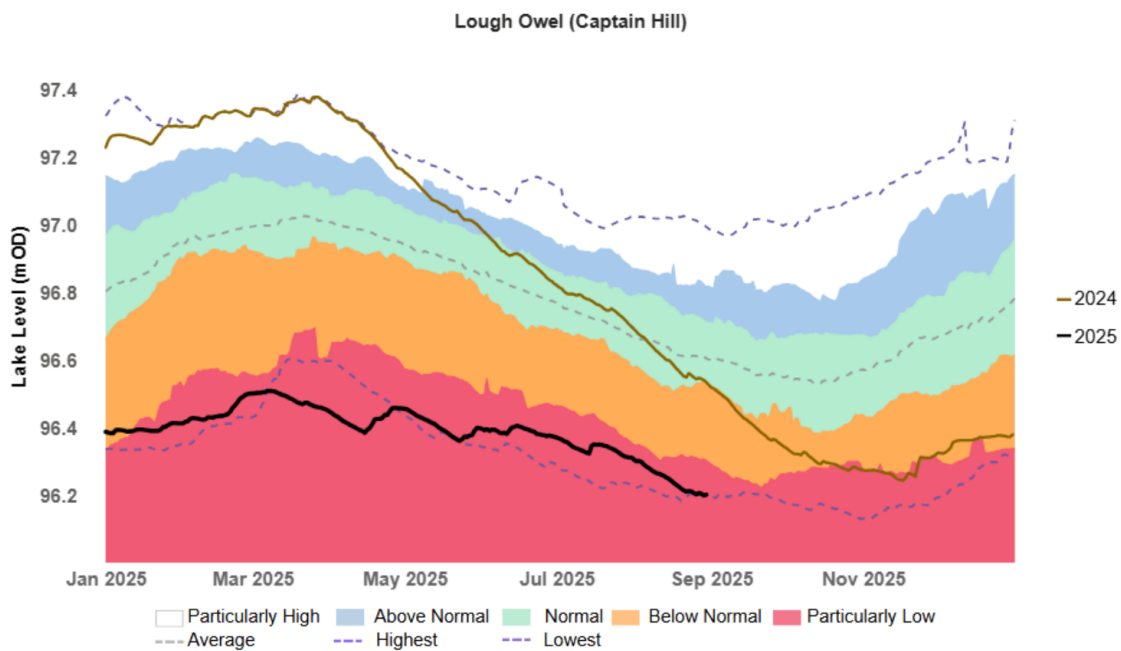


Figure 3-3: Lake levels (mOD) at Lough Owel during 2024 and 2025 compared to level percentiles for all available data (since 1979) (UE, 2025)

3.1.2 Hydrogeological Setting

The GSI's Bedrock Geology 1:100,000 mapping indicates the three site areas within the Lough Owel SAC are underlain by the Lucan Formation, described as a dark limestone and shale (calp). The three site areas belong to the Dinatian Upper Impure Limestones rock unit group (Figure 3-4).

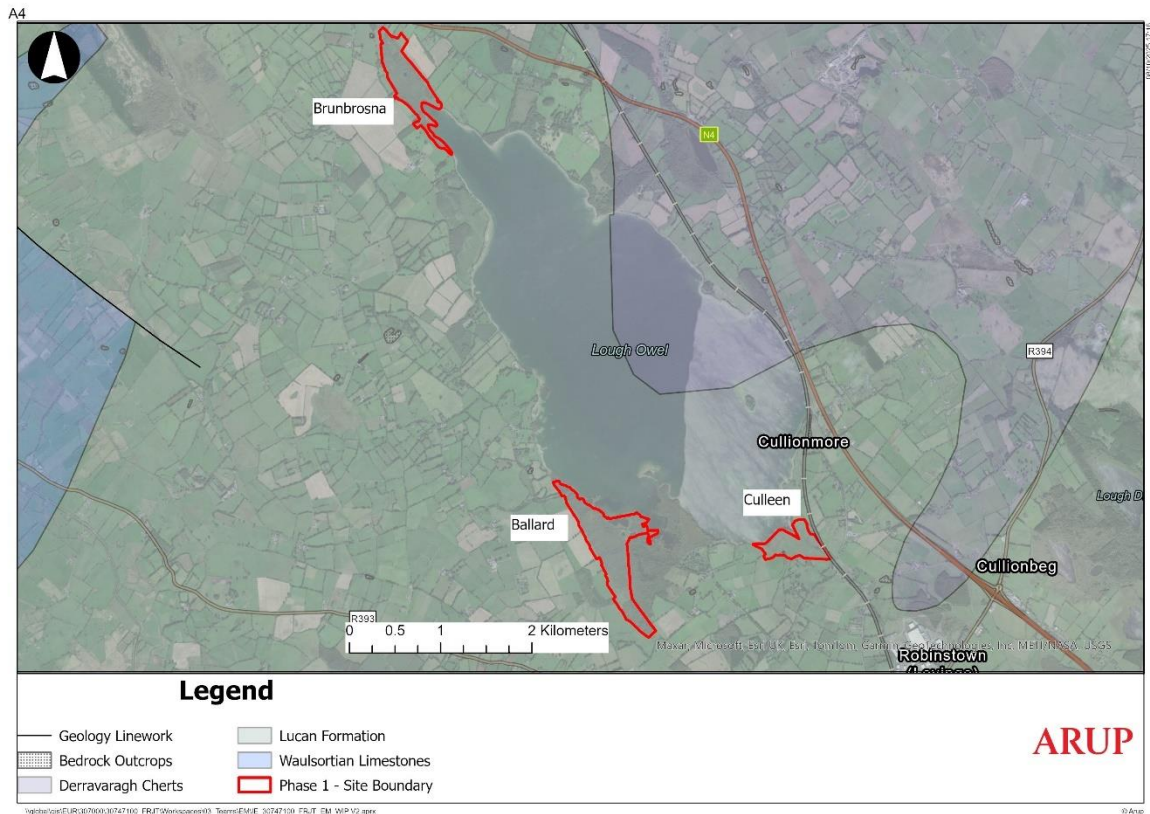


Figure 3-4: Bedrock Geology of Lough Owel SAC (GSI, 2025)

The GSI bedrock aquifer mapping shows the three sites are underlain by a Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones. This bedrock aquifer is associated with the Lucan Bedrock geology type. There are no karst features within the three sites (Figure 3-5).

The main subsoil type underlying the three sites according to the GSI Quaternary Sediments is Fen Peat (FenPT) which is surrounded by Till derived from limestones (TLs) (Figure 3-6).

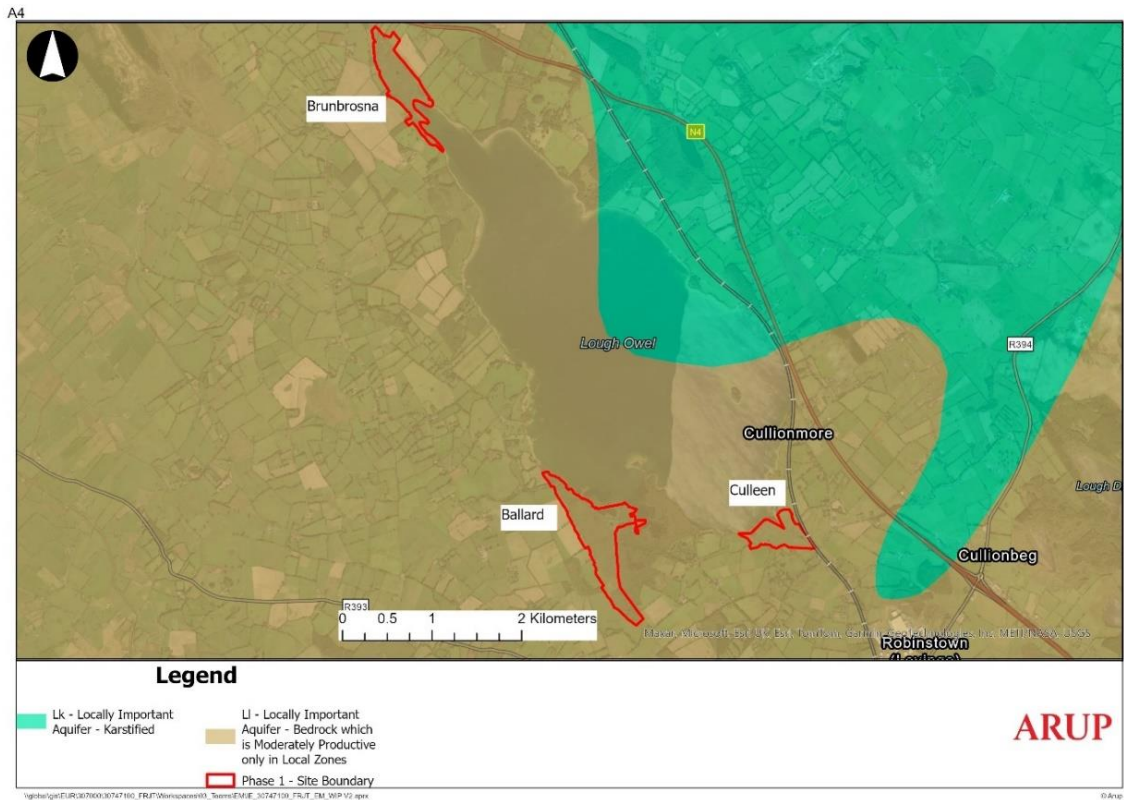


Figure 3-5: Aquifer classification and karst underlying Lough Owel SAC (GSI, 2025)

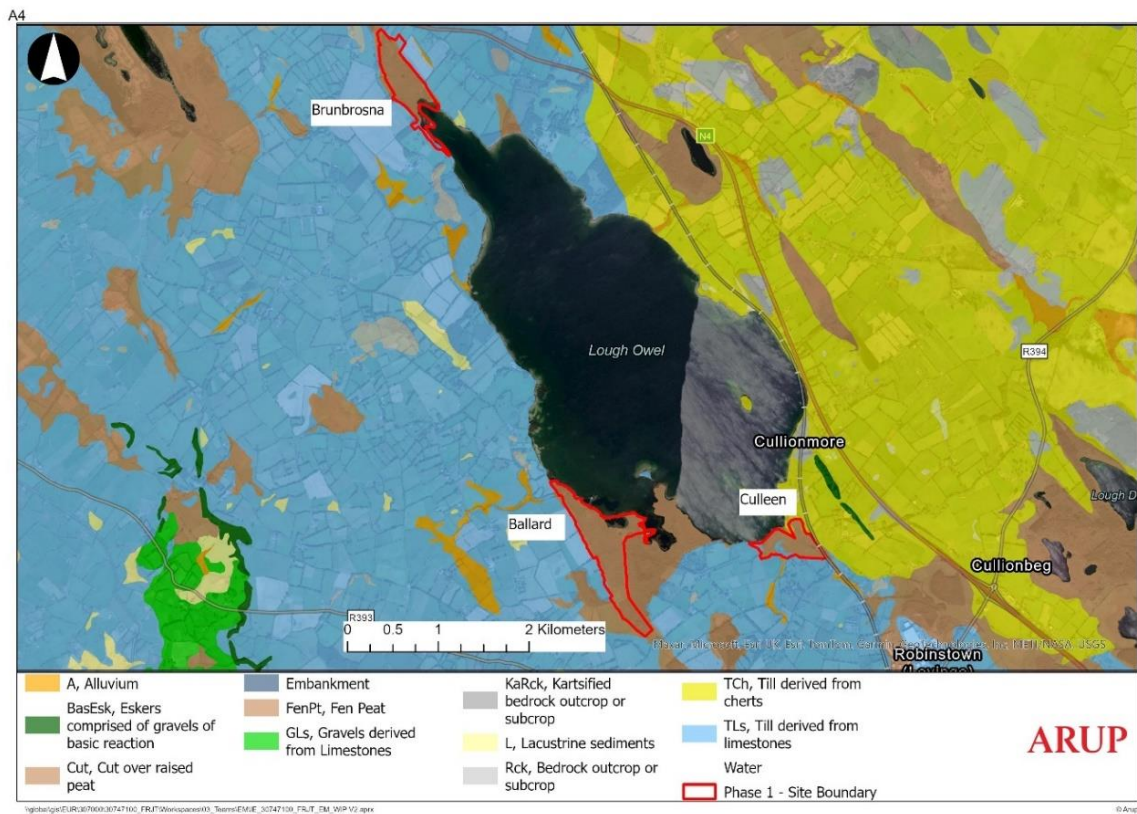


Figure 3-6: Sub-soil type underlying Lough Owel SAC (GSI 2025)

Aquifer or groundwater vulnerability is a relative measure of the ease with which the groundwater could be contaminated by human activity and depends on the aquifer's intrinsic geological and hydrogeological characteristics. The vulnerability is determined by the permeability of any overlying deposits.

The GSI data on groundwater vulnerability shows the area of Bunbrosna is classified as Moderate groundwater vulnerability, the Ballard site is predominantly low vulnerability with areas of Moderate vulnerability (Figure 3-7). The Culleen site is classified as a Moderate groundwater vulnerability.

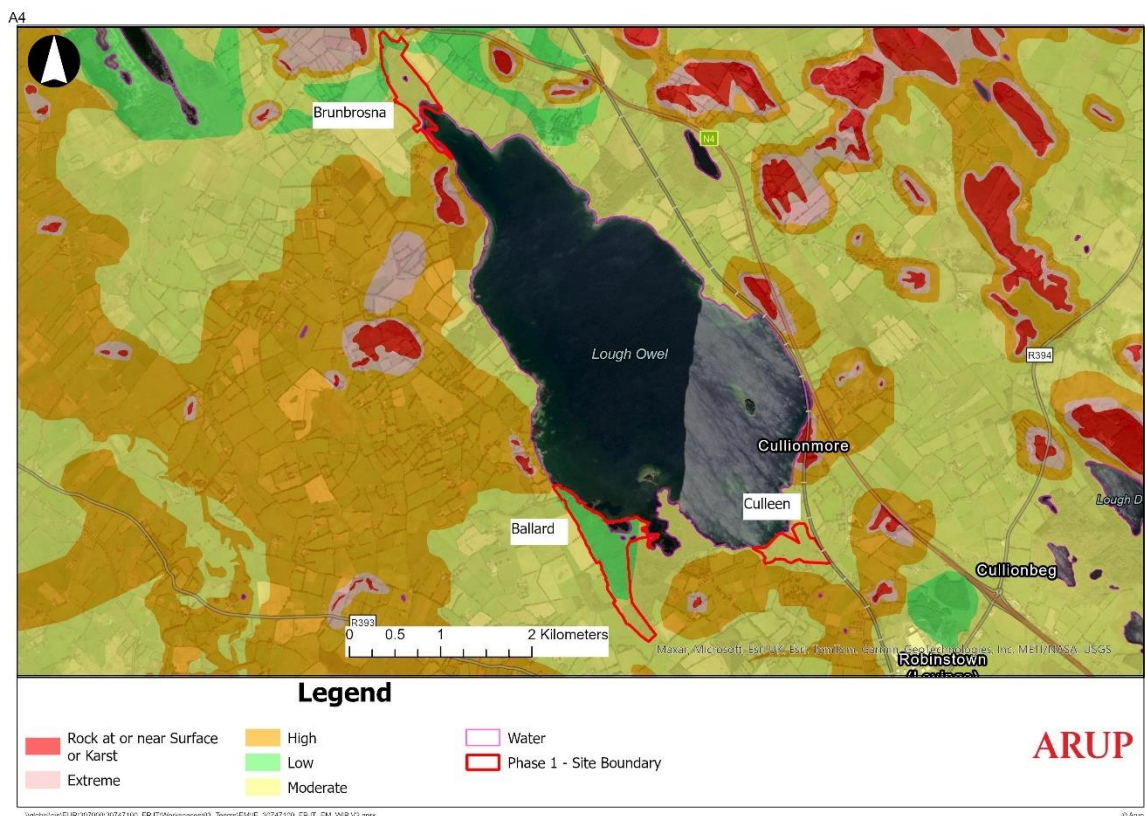


Figure 3-7: Groundwater vulnerability map for Lough Owel SAC (GSI 2025)

3.1.3 Topography and Surface Water Drainage

The three sites are located within the WFD catchment: 25A Lower Shannon, WFD sub-catchment: River Brosna and WFD sub-basin: Brosna_010 (

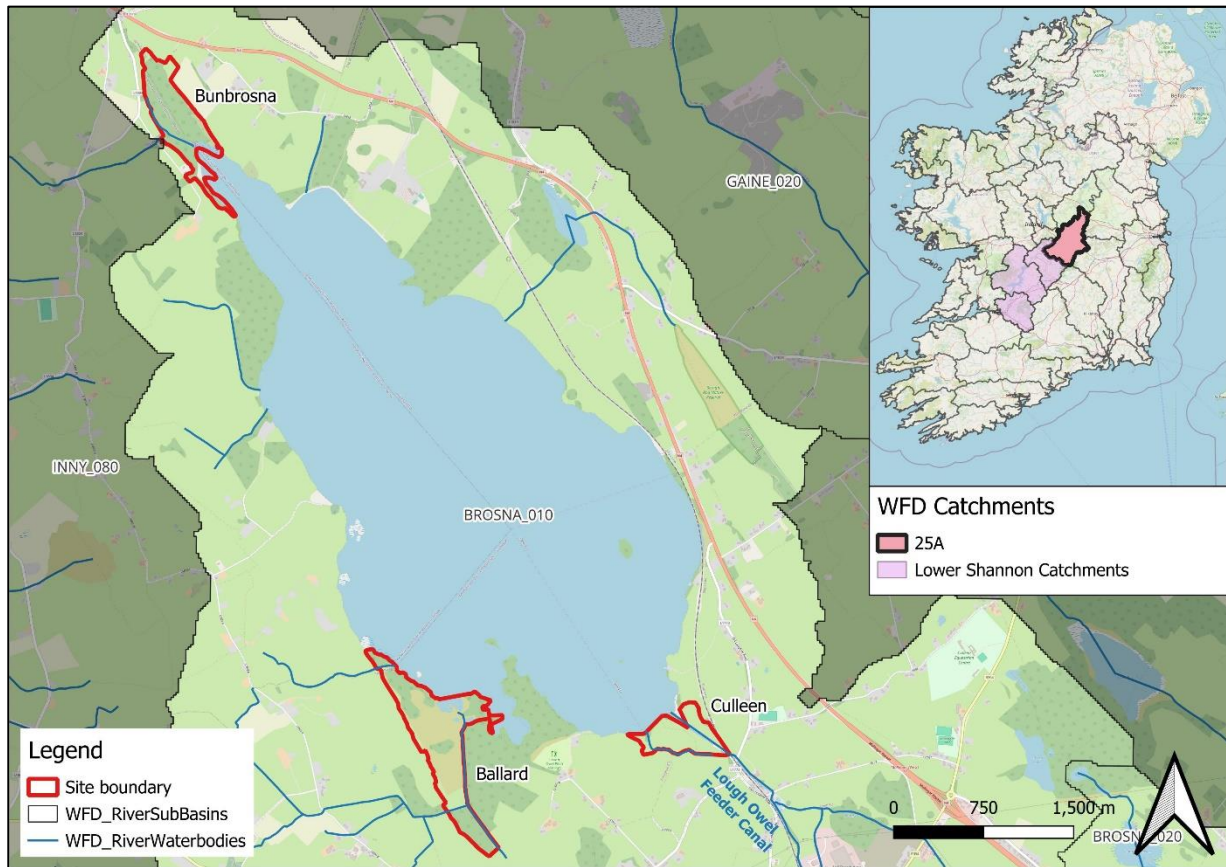


Figure 3-8). Brosna_010 catchment area is 41.78 km². The lake itself is made up of a WFD Lake Lough Owel main (IE_SH_26_703) as well as a WFD Lake Lough Owel Southeast Part (IE_SH_26_608) for a small part of the lake separated by a railway line. The main lake is about 10 km². Although historically the lake levels would have been higher, with overflow also being directed to Lough Iron in the north-west, currently flow is towards the south into the feeder canal for the Brosna and Royal Canal.

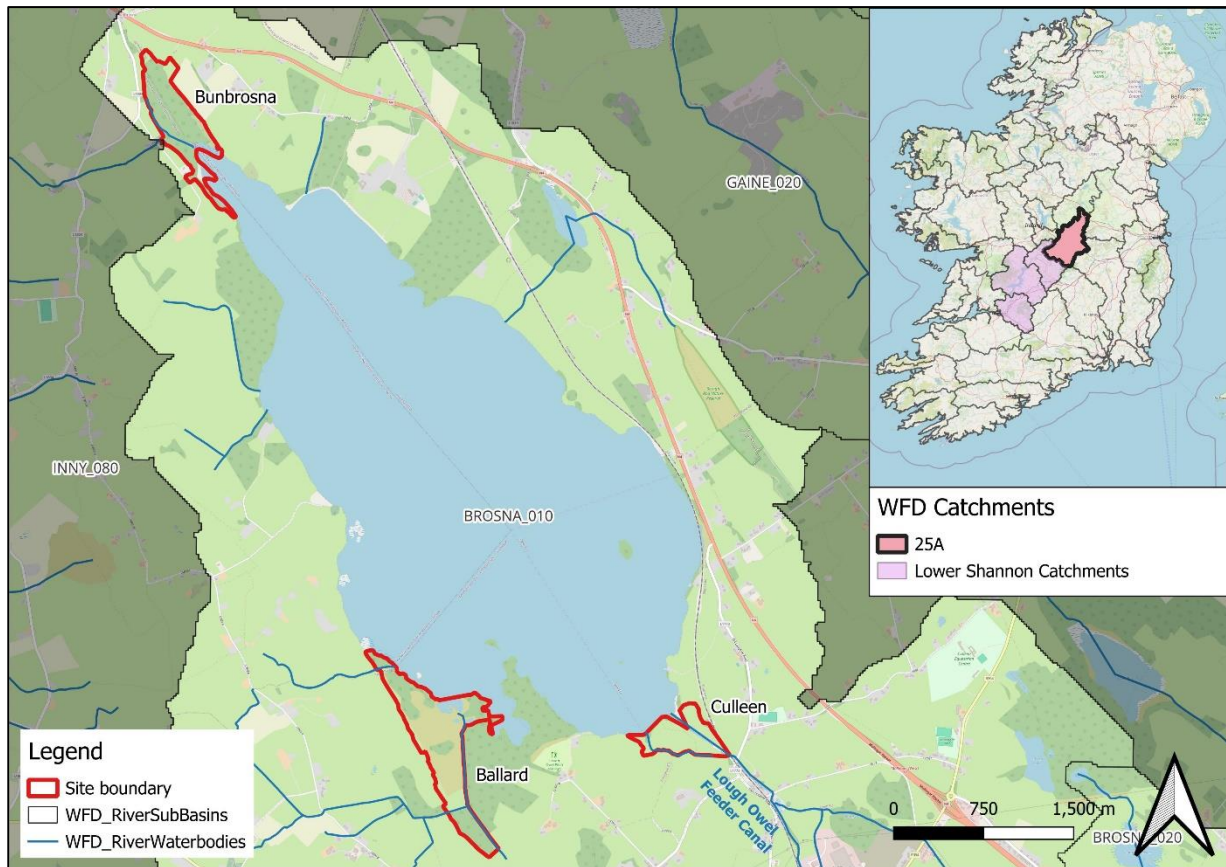


Figure 3-8: Surface water catchments for Lough Owel (EPA, 2025)

3.1.3.1 Bunbrosna

Assessment of historical maps indicates that there may have been two springs at about 110m OD contributing surface water to the downstream wetland area at the Bunbrosna site in the 1900s (Figure 3-9). There was a central channel directing the spring water through the wetland, labelled as 'River Brosna'. The other spring is on the eastern hillslope and is directed to the smaller marl lake are on the eastern boundary of the wetland. There are perimeter drains along the western boundary evident in the 1900's.

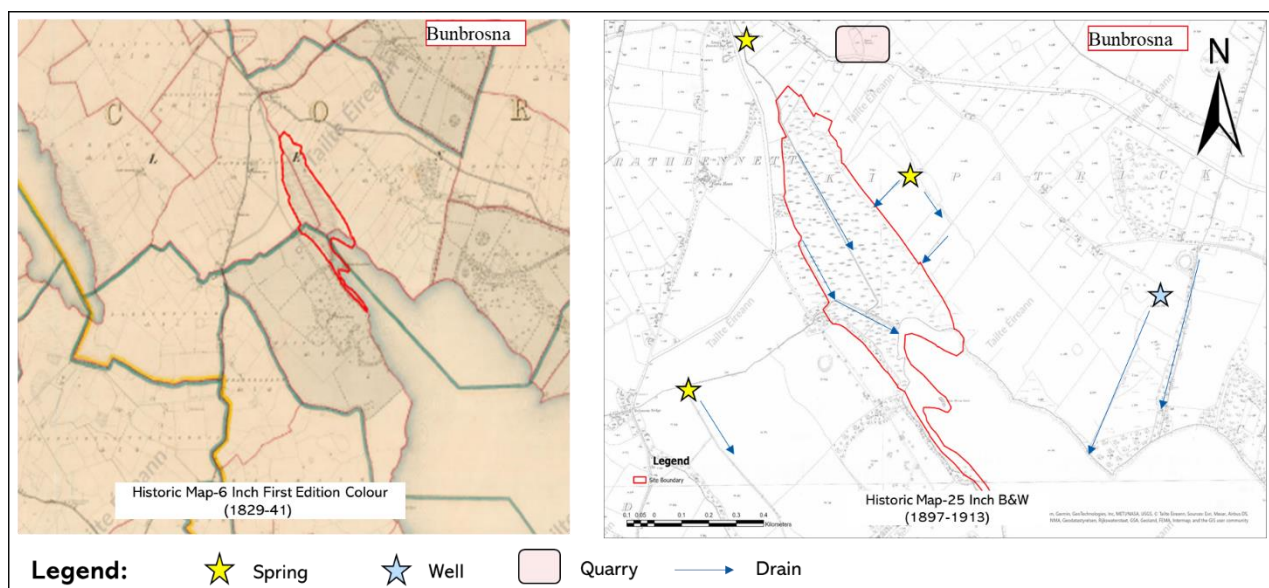


Figure 3-9: Historical water distribution and retention within Bunbrosna (Tailte Éireann Historical mapping)

The topography within the Bunbrosna site ranges from approximately 102m OD to 96m OD at the lakeshore. The surrounding catchment is bound by the turn off from the N4 in the north at approximately 104m OD; the N4 to the east at approximately 135m OD; and a rural road to the west at approximately 105m OD.

Figure 3-10: Topographic (LiDAR) map of BunBrosna (placeholder)

The mapped Wetness Index⁶ classifies the site near the marl lake as temporarily wet, indicating alternating periods of saturation and dryness over the period of 2012 to 2018. This pattern suggests that within the centre of the site there is a mosaic of variable soil moisture conditions, supporting intermittent wetland characteristics to the north of the site (Figure 3-11). Total productivity mapping further illustrates the site's hydrological variation (Figure 3-12). The western part of the site is classified low productivity, which is characteristic of relatively intact peatland.

⁶ Dataset available at 10m resolution indicating the occurrence of water and wet surfaces over the period from 2012 to 2018. Need reference for this and add it to References list

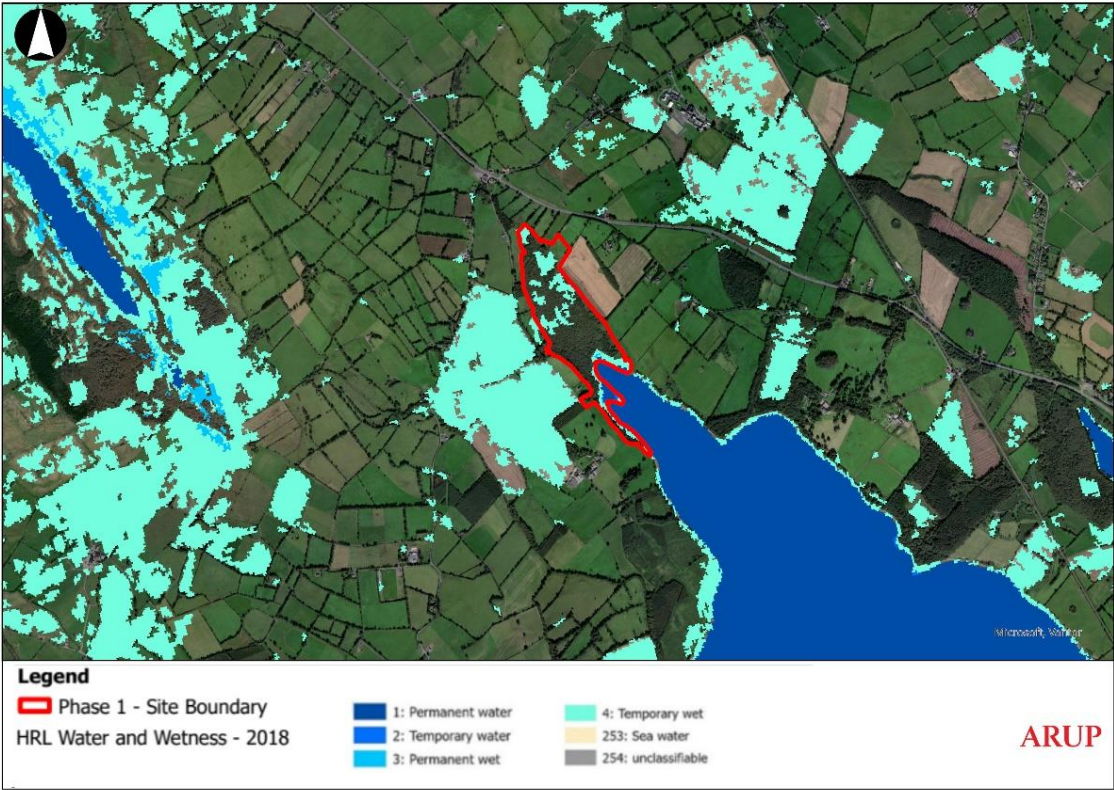


Figure 3-11: HRL Water and Wetness – 2018 (Copernicus, 2025)

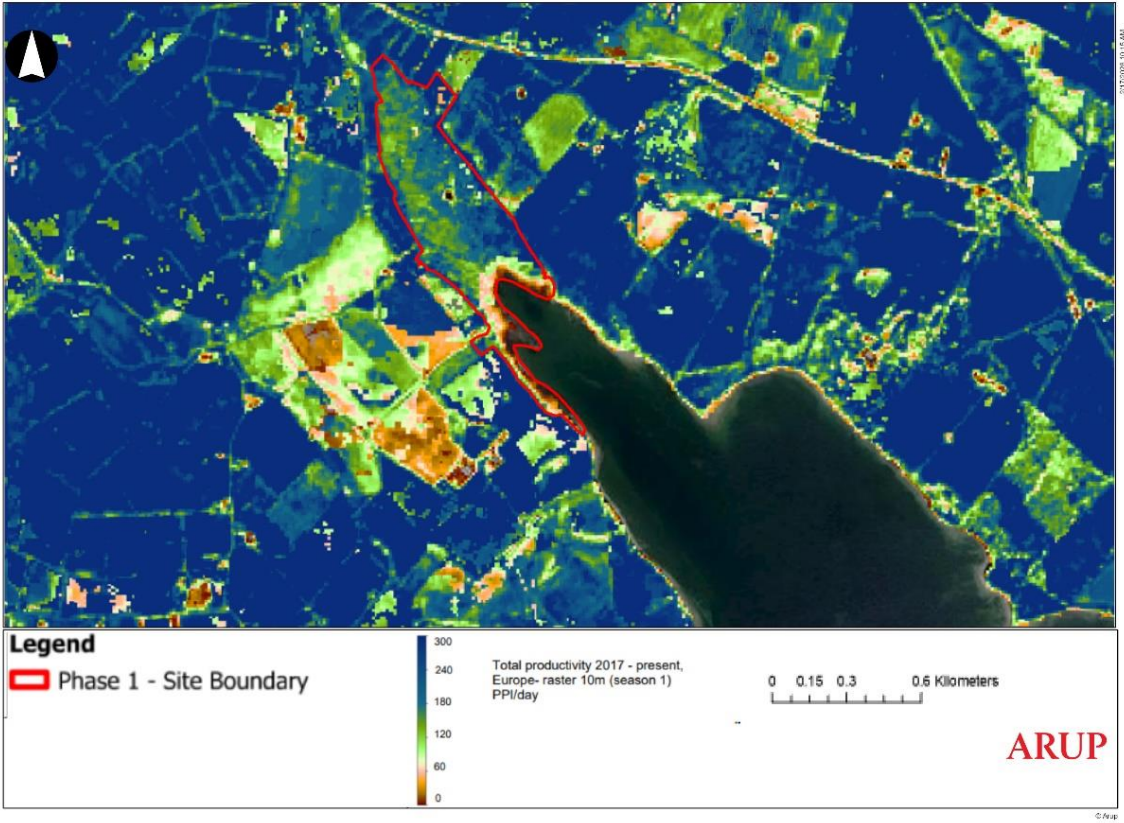


Figure 3-12: Total Productivity 2017 -present, Europe – raster 10m (season 1) (Copernicus, 2025)

The available desktop data on drainage within the wetland is complicated by the original digitisation using satellite imagery (i.e. OSI and EPA maps) (Figure 3-13). Although historical maps identify a drain through the centre of the wetland, and the PFS also identifying this same drain (Figure 3-14)., in reality this drain is not active and is dry for most of the year.. There is a connecting drain to the west towards Lough Iron, but this does not seem to be active, as observed during the PFS site visits (O'Neill et al., 2023). There is evidence of historical internal drains within the wetland and on the western perimeter. A marl lake is present on the eastern section of the site.

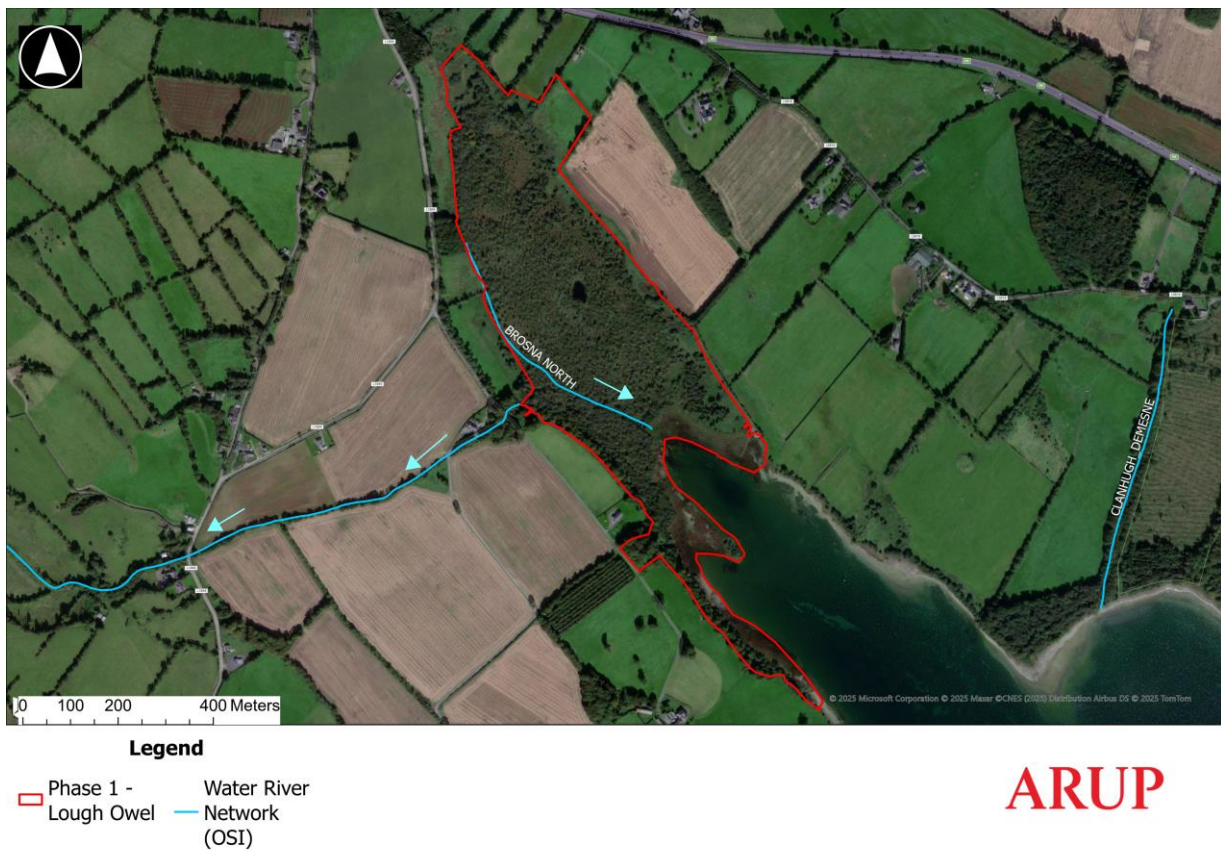


Figure 3-13: Drainage map of Bunbrosna (OSI)



Figure 3-14: Drainage map of Bun Brosna (PFS identified drains (O'Neill et al., 2023))

3.1.3.2 Culleen

Assessment of historical maps indicates that the canal has modified the wetland area since the 1800's (Figure 3-15), essentially being created due to the near surface water levels and blockages to flow.

- On the northern part of the wetland flow is redirected away from Lough Owel towards the main canal. In the 1900s there does not seem to be a formal stormwater drain from the railway at 100m OD to the north.
- On the southern part of the wetland near the canal there appears to be a drain that collects surface water and redirects it to the main canal further east. There also seems to be a central and perimeter drain that directs surface water towards the main canal.

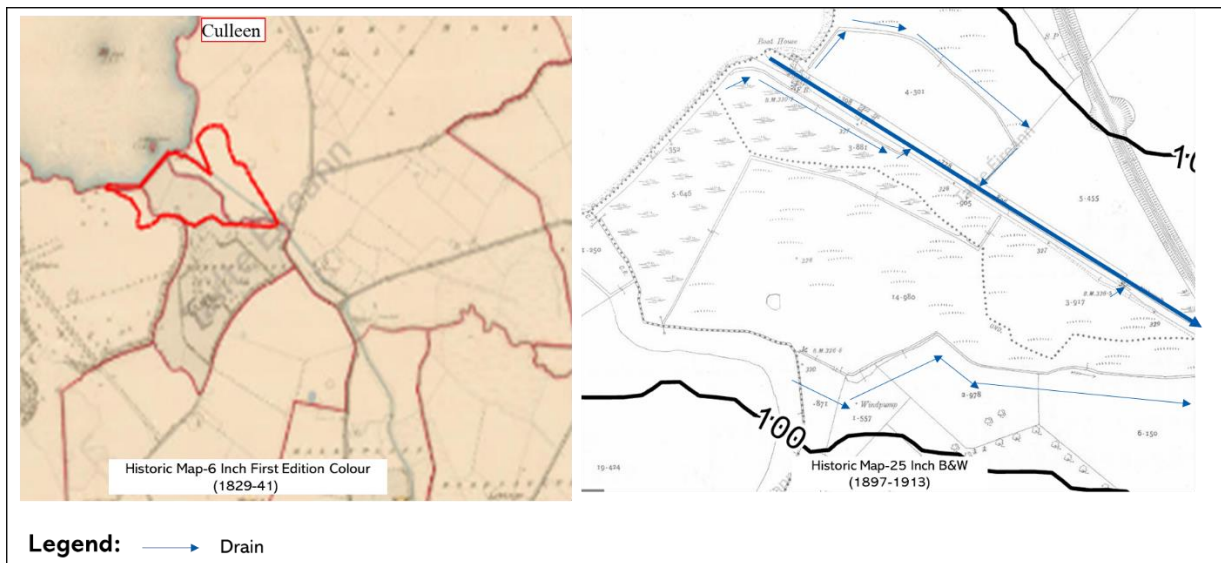


Figure 3-15: Historical water distribution and retention within Culleen (Tailte Éireann Historical mapping)

The topography within the Culleen site ranges from approximately 100m OD to 91m OD at the lakeshore (Figure 3-15). The wetland is divided by the feeder canal to the Royal canal through its centre, isolating the drainage of the site into a northern and southern portion.

- For the northern part of the wetland, the surrounding catchment is bound to the north-east by a rural road at approximately 112m OD and a railway track at approximately 99m OD. The centre of the eastern part of the wetland has a similar elevation as the lake at approximately 96m OD. Towards the lakeshore and near the railway the elevation is raised which has confined the surface flow within the eastern portion of the wetland.
- For the southern part of the wetland, the surrounding catchment is bound to the north at approximately 109m OD. The centre of the southern part of the wetland has a similar elevation as the lake at approximately 95m OD. At the lakeshore the elevation is raised, the extent of which can be identified as a prominent line in aerial imagery. This corresponds with the boundary of the SAC and is likely associated with a fence. This isolates two surface flow areas in the southern portion of the wetland.

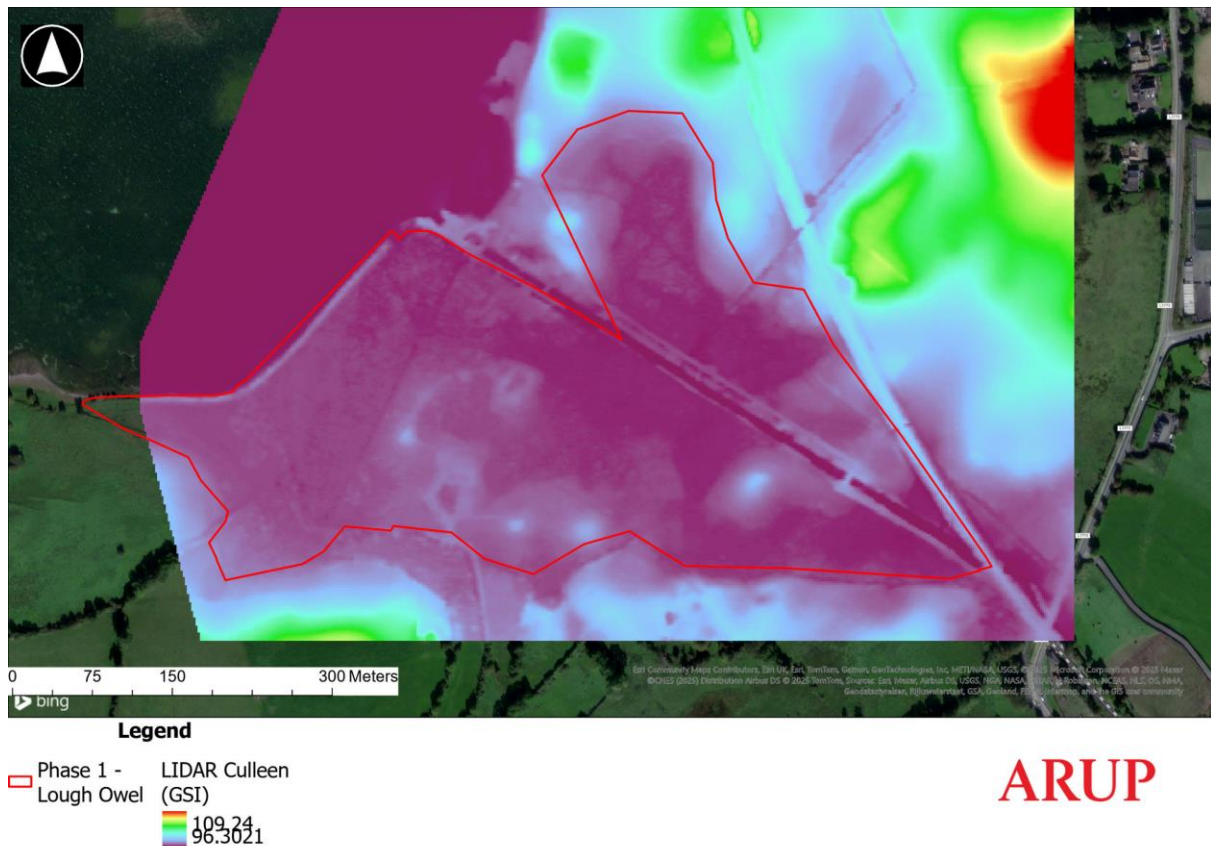


Figure 3-16: Topographic (LiDAR) map of Culleen

The mapped Wetness Index classifies the northern part of the site close to the canal feeder culverts as temporarily wet, indicating alternating periods of saturation and dryness over the period of 2012 to 2018. This pattern suggests that there are two areas of surface water accumulation within the wetland where there is a mosaic of variable soil moisture conditions, supporting intermittent wetland characteristics (Figure 3-17). Total productivity mapping further illustrates the site's hydrological variation. The wetter areas of the site are classified low productivity, which is characteristic of relatively intact peatland (Figure 3-18).

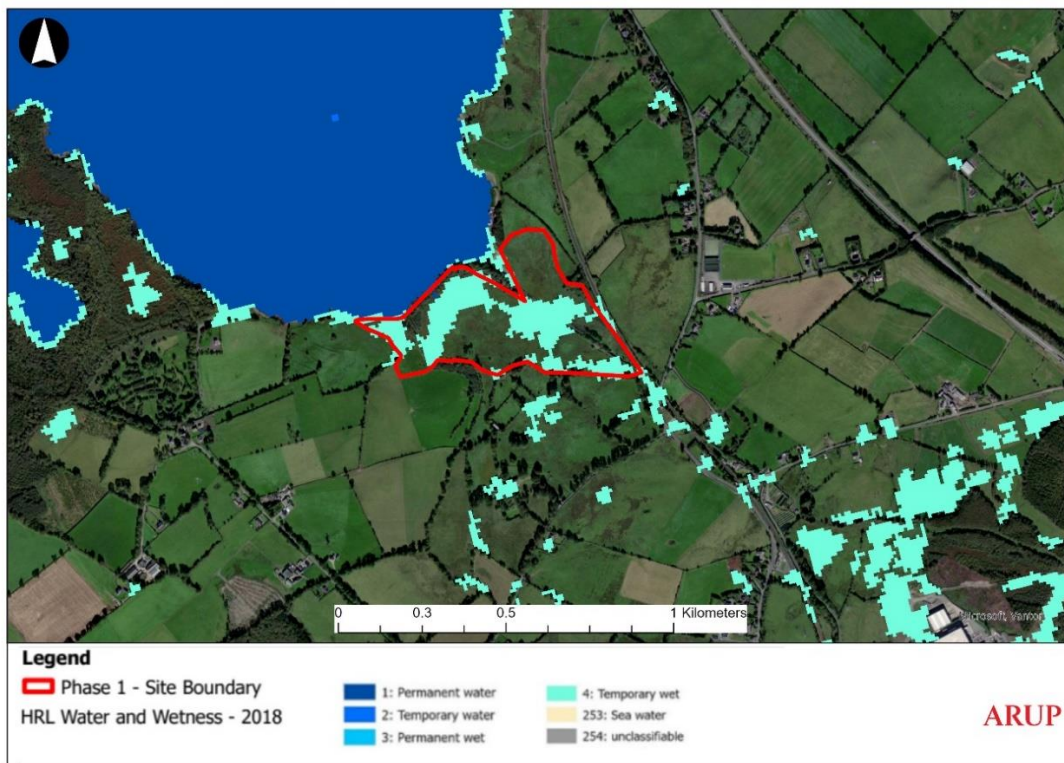


Figure 3-17: HRL Water and Wetness – 2018 (Copernicus, 2025)

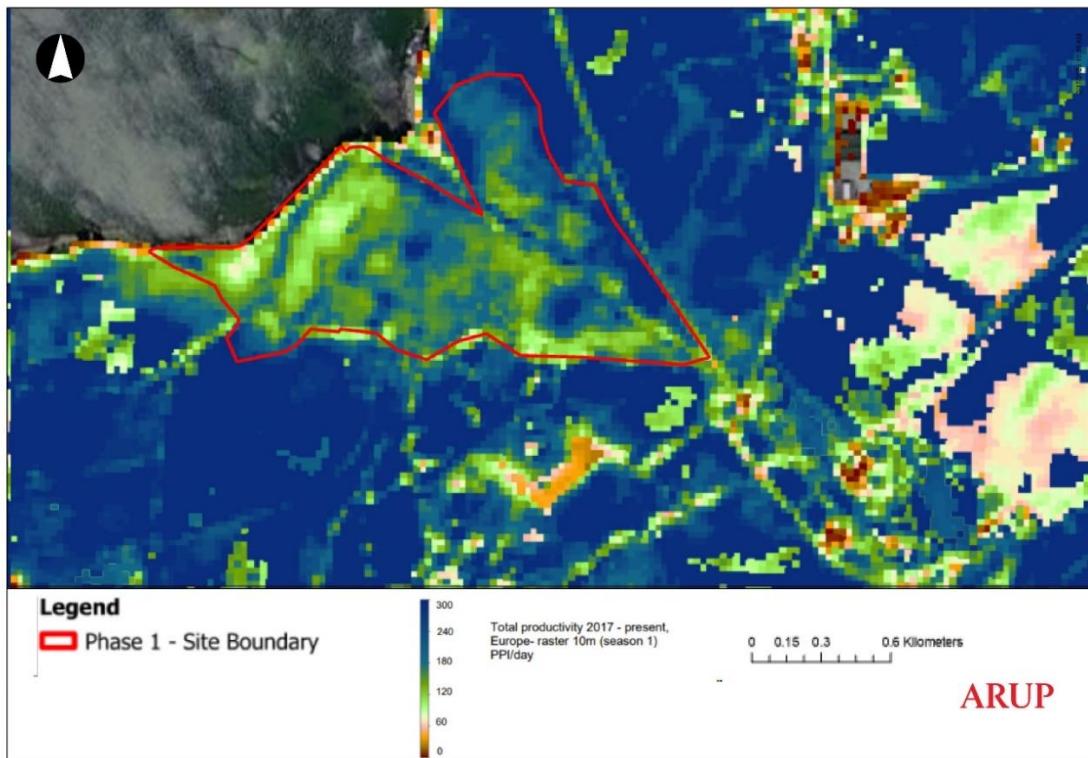


Figure 3-18: Total Productivity 2017 -present, Europe – raster 10m (season 1) (Copernicus, 2025)

The available desktop data on drainage within the wetland is complicated by the original digitisation using satellite imagery (i.e. OSI and EPA maps) (Figure 3-19). Although historical maps identify a drain or road across the western part of the wetland, this will need to be confirmed with a site visit. The PFS Pilot Study also identified drains across the site (Figure 3-20), but it is unknown if these are active drains

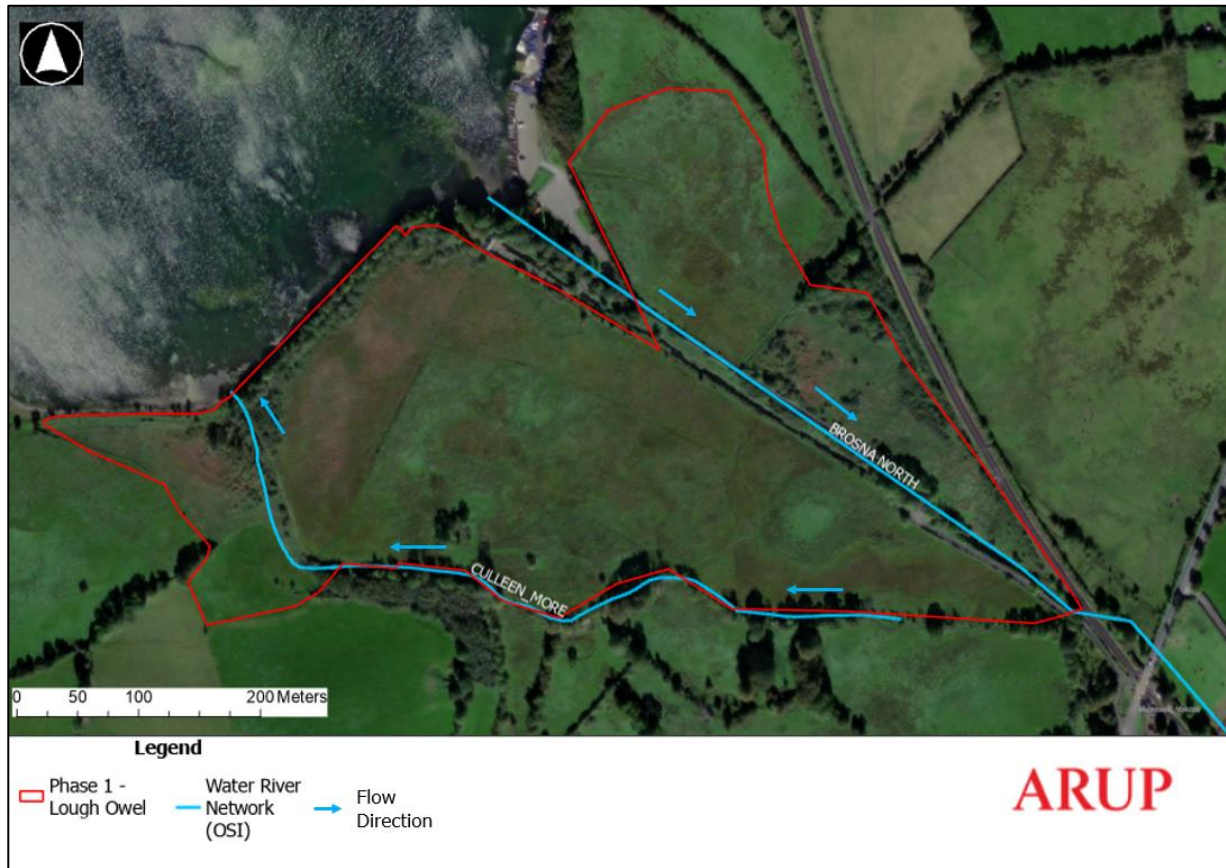


Figure 3-19: Drainage map of Culleen (OSI)

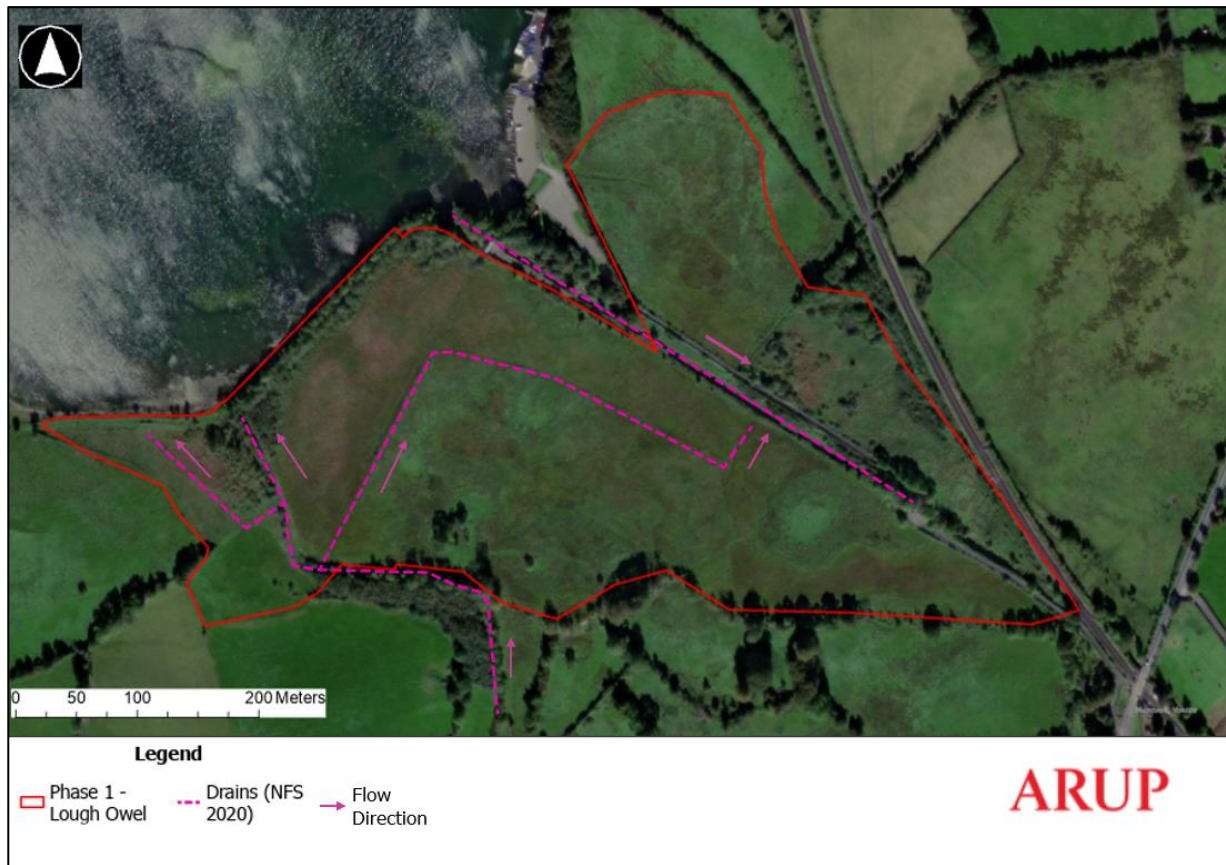


Figure 3-20: Drainage map of Culleen (PFS identified drains (O'Neill et al., 2023))

3.1.3.3 Ballard

Assessment of historical maps indicates that there are two main surface water sources into the wetland: a drain from the west at the northern border of the wetland and a drain from the south that collects input from the east and drains towards Lough Owel (Figure 3-21).

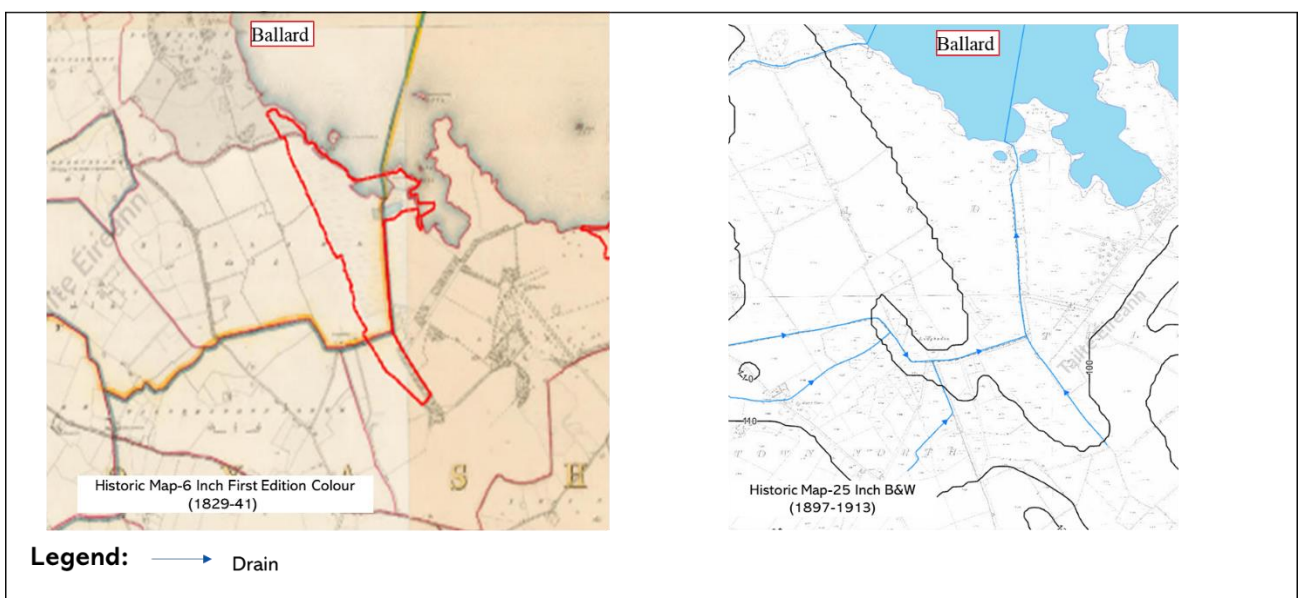


Figure 3-21: Historical water distribution and retention within Ballard (Tailte Éireann Historical mapping)

The topography for Ballard is characterised by drumlins within the site rising to approximately 107m OD to approximately 96m OD at the lake. There are three main drainage areas within the wetland: the south, south-west and north (Figure 3-25).

- For the southern part of the wetland the surrounding catchment is bound to the south at approximately 126m OD. The eastern part of the wetland is bound by the elevated slopes which are currently under forestry land use. The western part of the wetland has surface water inputs from surrounding farmland.
- For the south-western part of the wetland the surrounding catchment is bound to the south-east at approximately 133m OD.
- For the northern part of the wetland the surrounding catchment is bound to the north at approximately 137m OD.

Figure 3-22: Topographic (LiDAR) map of Ballard (Placeholder)

The mapped Wetness Index classifies the site near the lake and at the western inflow as temporarily wet, indicating alternating periods of saturation and dryness over the period of 2012 to 2018. This pattern suggests that within the centre of the site there is a mosaic of variable soil moisture conditions, supporting intermittent wetland characteristics to the north of the site (Figure 3-23). Total productivity mapping further illustrates the site's hydrological variation (Figure 3-24). Closer to the lake the site is classified low productivity, which is characteristic of relatively intact peatland.

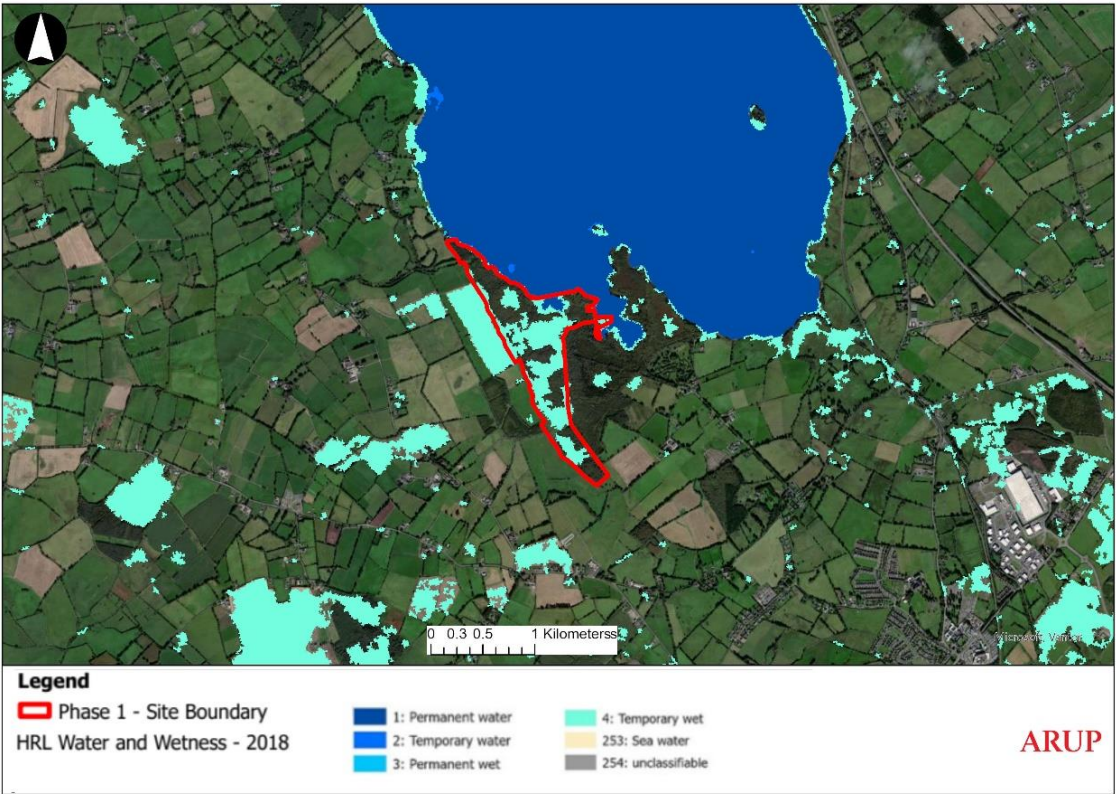


Figure 3-23: HRL Water and Wetness – 2018 (Copernicus, 2025)

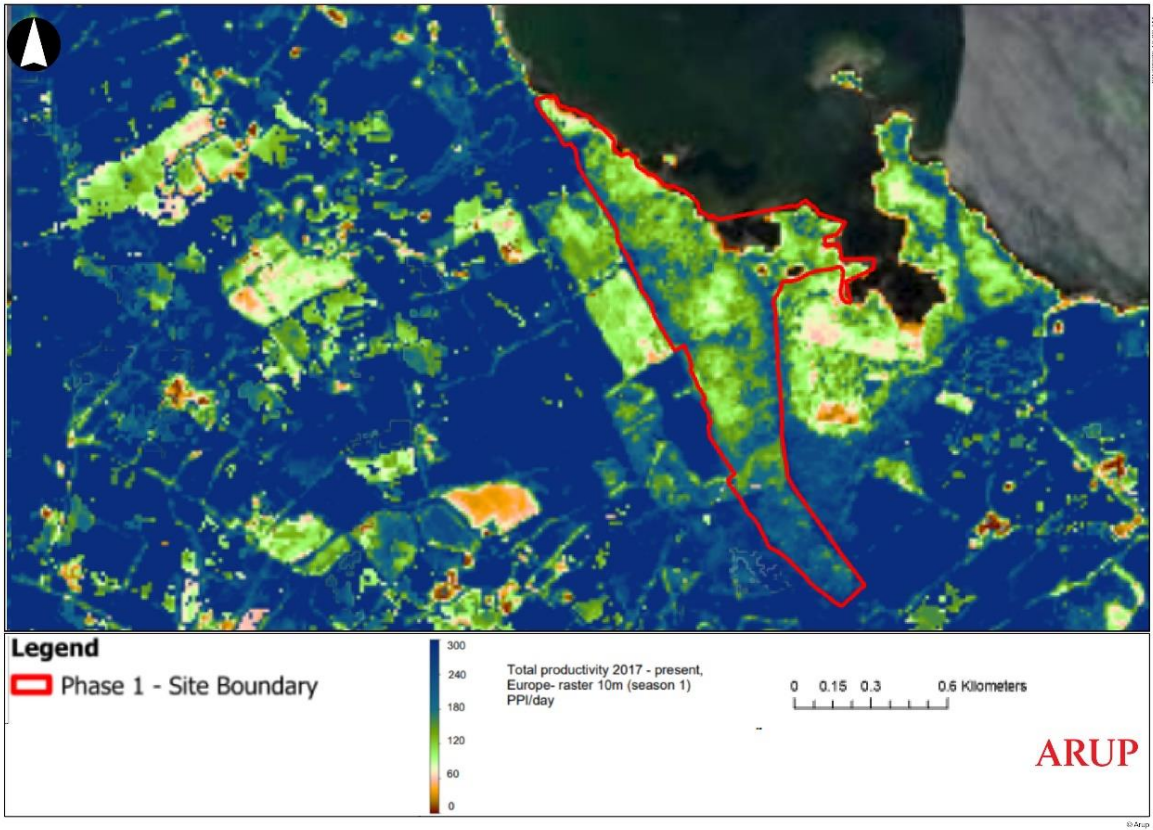


Figure 3-24: Total Productivity 2017 -present, Europe – raster 10m (season 1) (Copernicus, 2025)

The main drainage channels for Ballard are identified in the OSI dataset (Figure 3-25) with three main watercourses draining towards Lough Owel. In addition to these watercourses the PFS identified smaller drains near the discharge of Farrow stream into Walshestown stream (Figure 3-26Figure 3-33).



Figure 3-25: Drainage map of Ballard (Ordnance Survey Ireland)

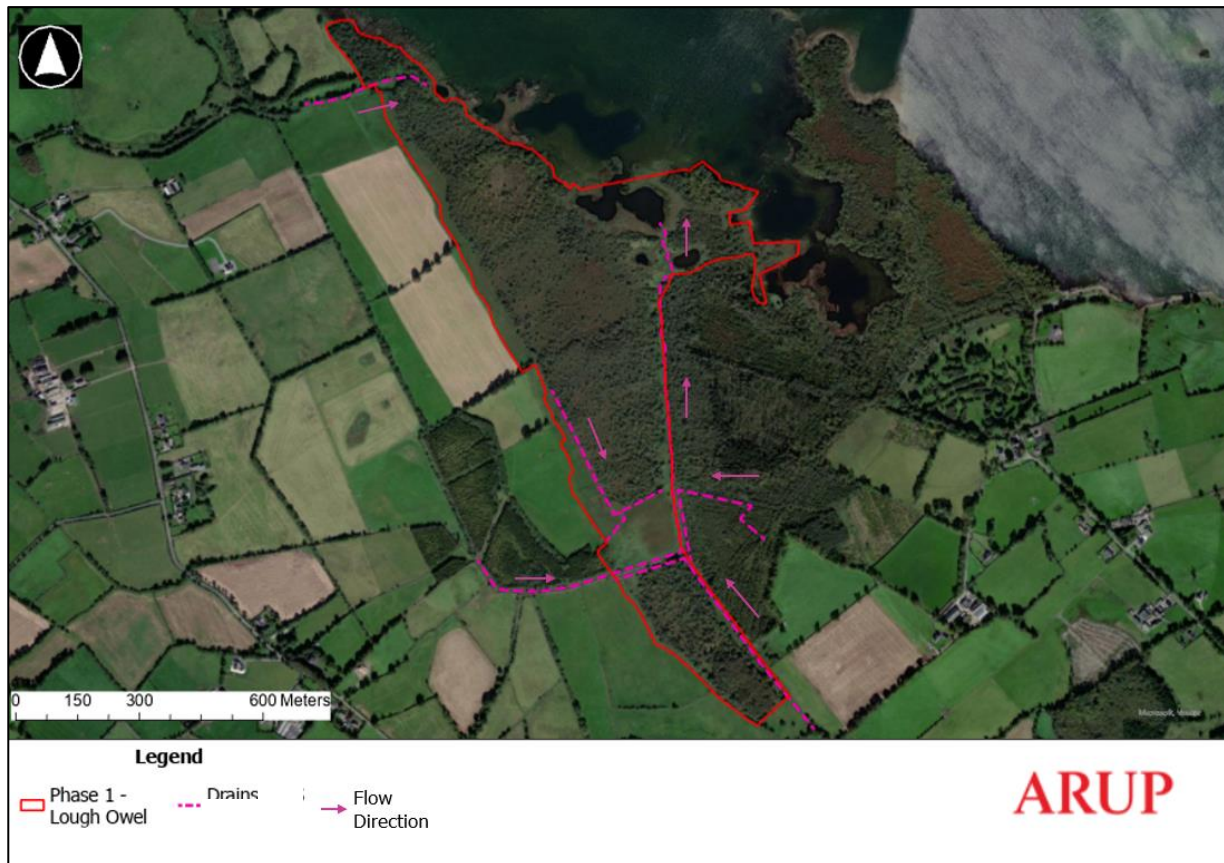


Figure 3-26: Drainage map of Ballard (PFS 2020 drains (O'Neill et al., 2023))

3.1.4 Land Use Pressures and Water Quality

The Brosna_010 river WFD water body is in a 'moderate' WFD Status and 'at risk' of not achieving its WFD objectives (EPA, 2025). The Lough Owel groundwater body, GWDTE-Lough Owel Fens & Mires (SAC000688 & SAC000692), which underlies the site is at 'good' WFD status and 'not at risk' of achieving its WFD objectives. There is a site for river ecological monitoring downstream of Culleen at the R394 which was last sampled in 2024 (EPA, 2025). This indicated a moderate river Q-value.

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.

High risk areas for phosphorus loss typically have poorly draining soils and dominant overland flow pathways (Table 3-1). There are potential preferential pathways for phosphorus leading to all sites (**Bunbrosna**: Figure 3-27; Figure 3-28; **Culleen**: Figure 3-29; Figure 3-30 ; **Ballard**: Figure 3-31; Figure 3-32).

Freely draining soils and substantial groundwater pathways are high risk for nitrate losses. The risk of nitrate loss is generally low within the sites, with high levels in the surrounding land of Ballard and Bun Brosna (Table 3-1 and Figure 3-33).

Water quality was measured in the Culleen site as part of the PFS Pilot 2020 survey only. Results showed that pH levels were between 6-7 and there was a small area of algae within the site due to effluent run-off into this part of the site. The surrounding land-use is organic agriculture comprising of mostly cattle.

Table 3-1: Pollution impact potential for Lough Owel

Site	Phosphorous	Nitrate
Bunbrosna	Not present within the site but range from Low to High surrounding the site. Flow delivery paths towards marl lake and on perimeter of the site.	High levels surrounding the western and northern sides of the site.
Culleen	Medium to High phosphorous with delivery flow path, higher to the south of the site.	Low levels across the site which decrease to the east, west, and south of the site.
Ballard	No results within the site. West of site has High ranking. Flow delivery paths within the site and mainly to the north of site.	High levels off-site to the west.



Figure 3-27: PIP- P - Flow delivery paths and points for Phosphorus at Bunbrosna (EPA, 2025)



Figure 3-28: PIP maps (Phosphorus) at Bunbrosna (EPA, 2025)

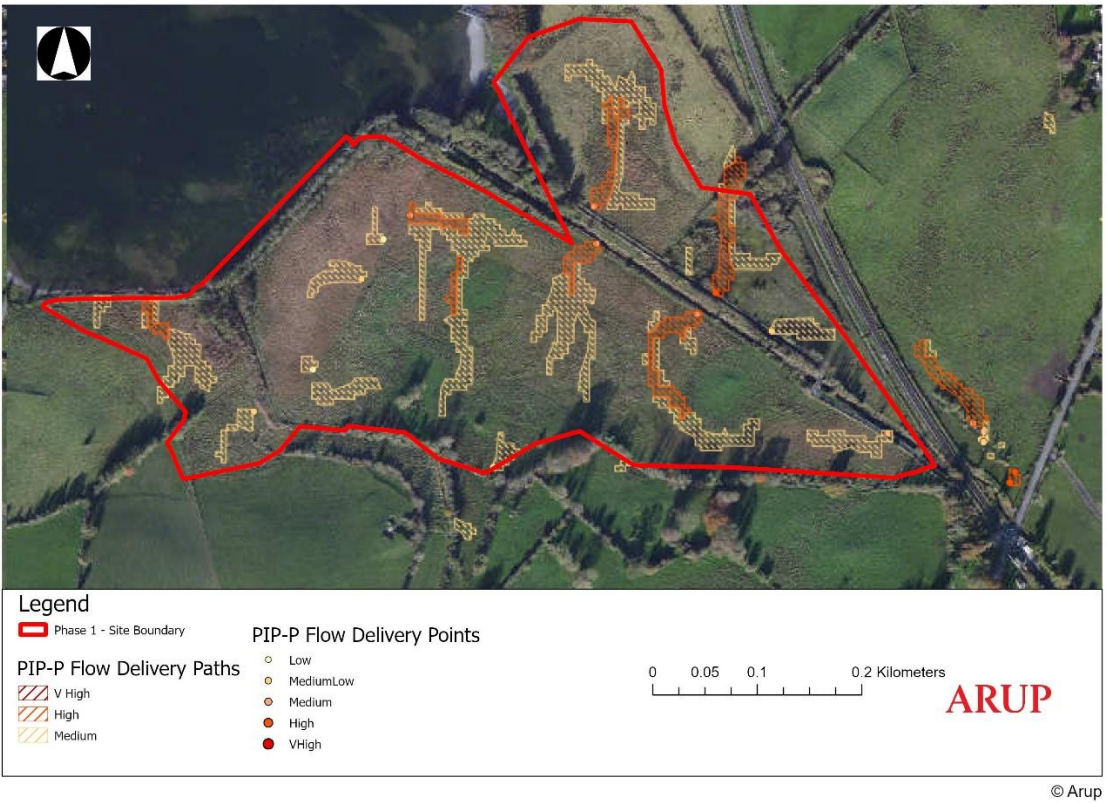


Figure 3-29: PIP- P - Flow delivery paths and points for Phosphorus at Culleen (EPA, 2025)

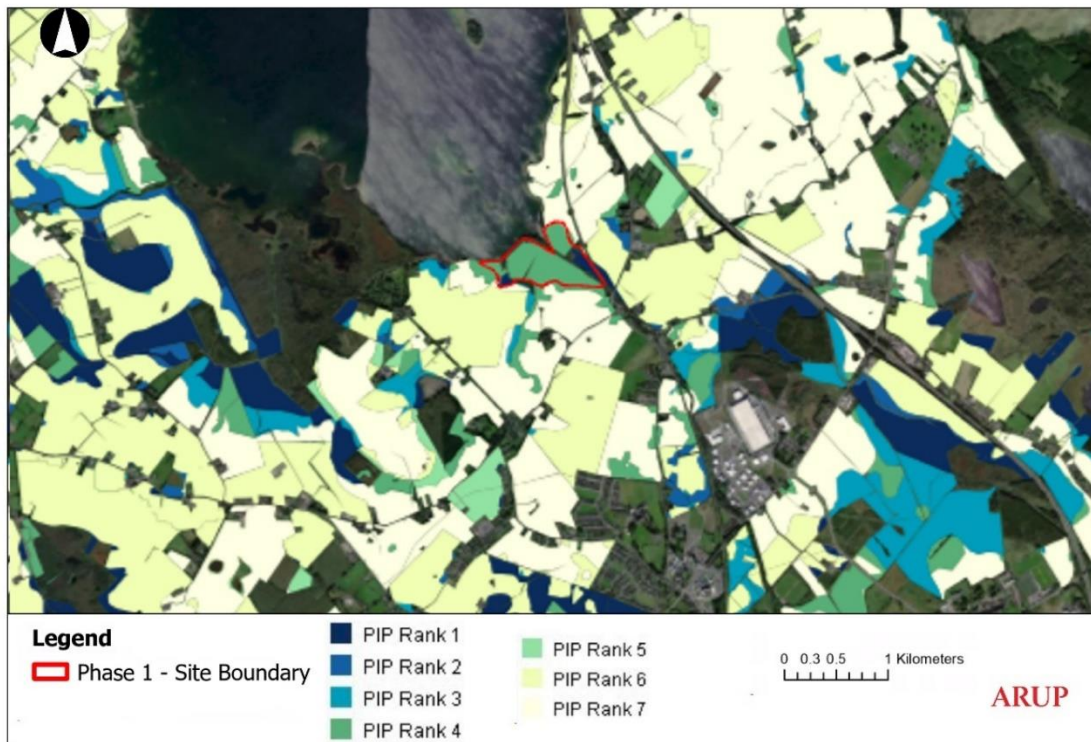


Figure 3-30: PIP maps (Phosphorus) at Culleen (EPA, 2025)

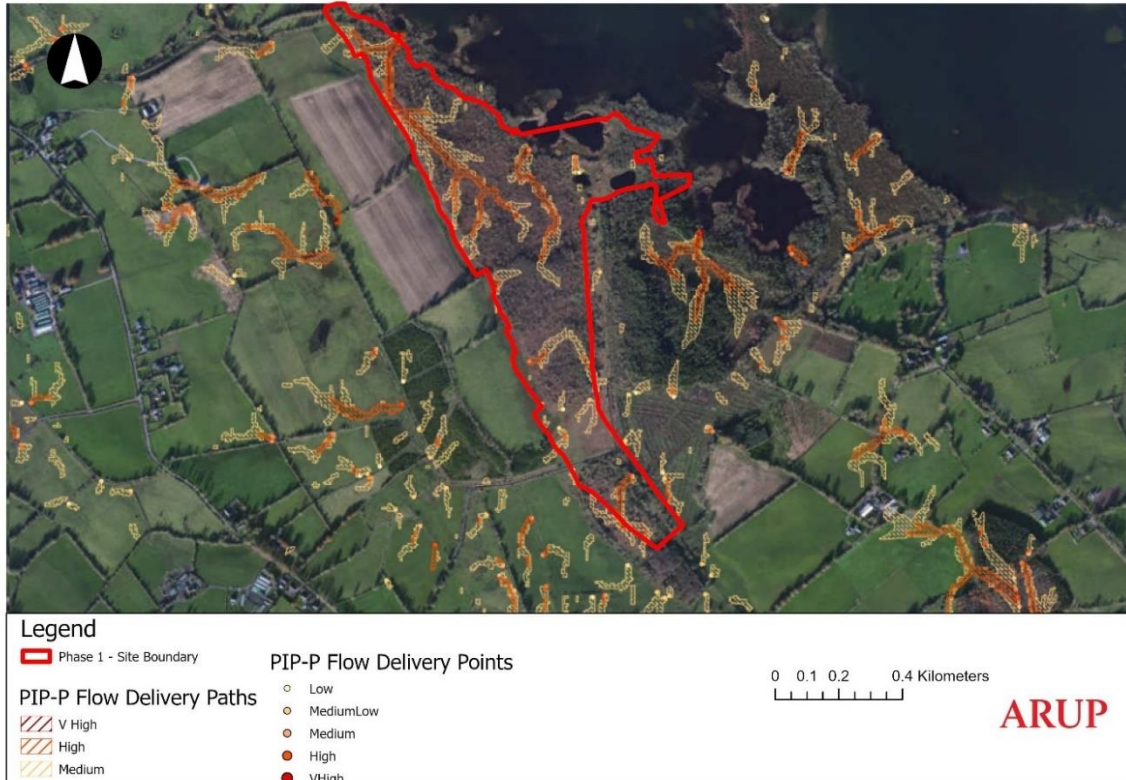


Figure 3-31: PIP- P - Flow delivery paths and points for Phosphorus at Ballard (EPA, 2025)

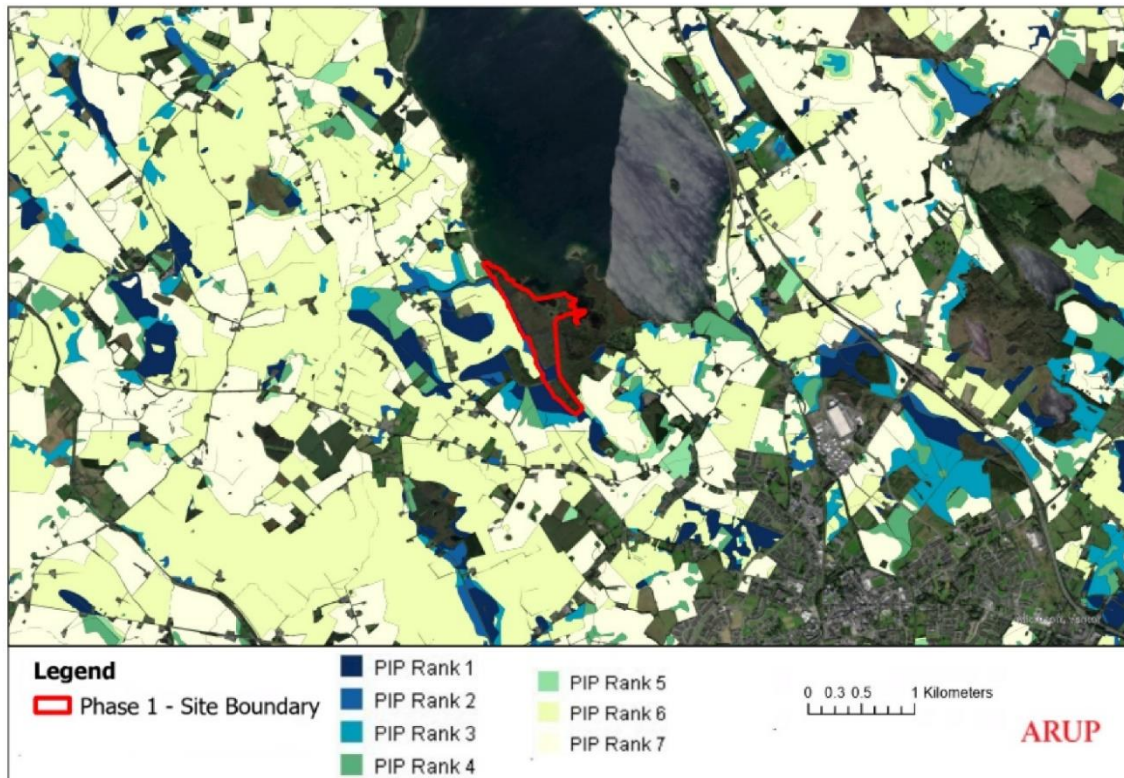


Figure 3-32: PIP maps (Phosphorus) at Ballard (EPA, 2025)



Figure 3-33: PIP maps (Nitrate) of Lough Owel SAC (EPA, 2025)

3.2 Field Survey Data

Site monitoring was undertaken in September and October 2025 for Bunbroсна and Culleen, focusing on developing the understanding of the water regime, pressures and implementation of restoration measures within the habitat. The site monitoring included peat depth probing, water quality monitoring and observations of water flow in the drainage network.

Water quality data were collected across multiple areas within and around the site, including fens, transition mires, wet grasslands, and associated watercourses. The parameters recorded included pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), nitrate, and phosphate. Peat depths were probed to assess substrate characteristics.

Monitoring locations are presented in Figure 3-34 and Figure 3-35.



Figure 3-34: Monitoring locations (1-17) at Bunbroсна

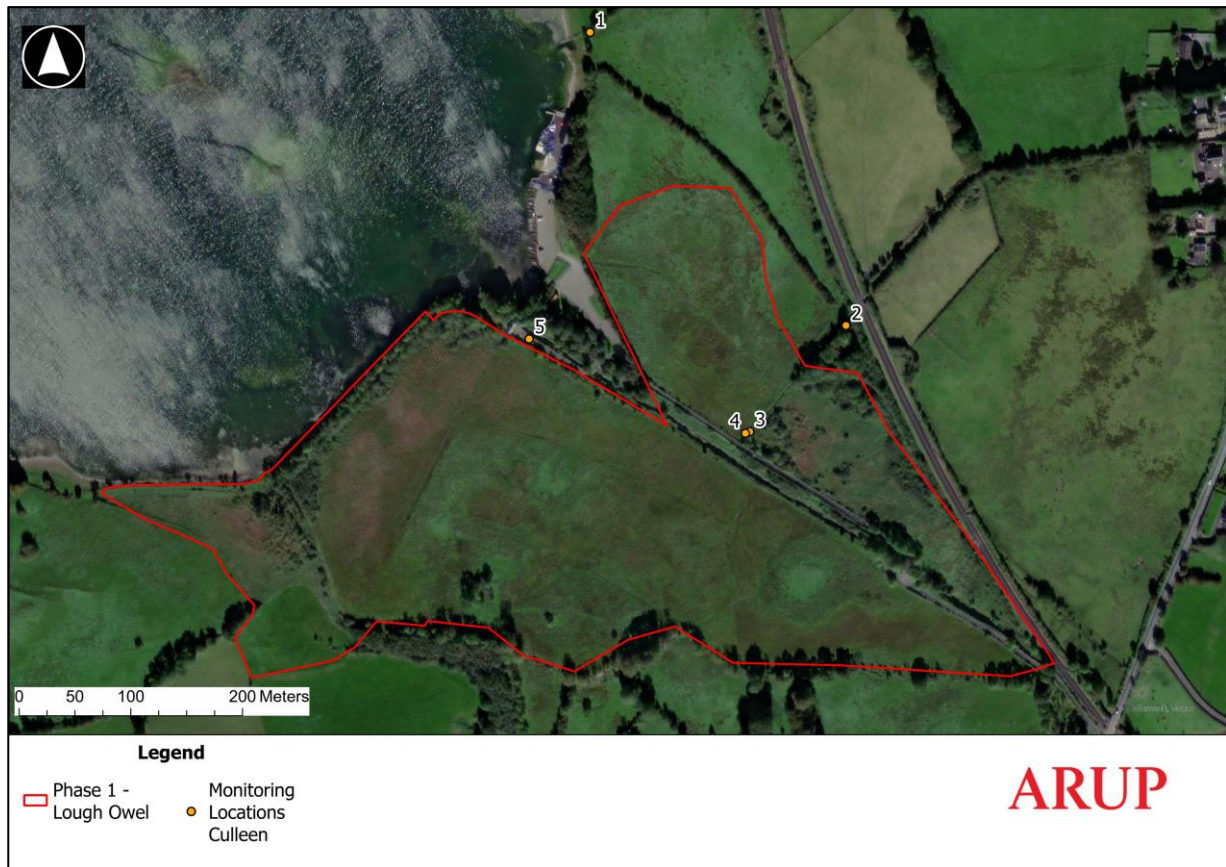


Figure 3-35: Monitoring locations (1-5) at Culleen

3.2.1 Peat Depth Probing

3.2.1.1 Bunbrosna

There were five peat depth probe measurements taken along the western side of Bunbrosna. The peat depth measurements range from 1.5m depth taken at the northern section to 2m depth at the western portion. Peat depths during the site surveys are shown in Figure 3-36.

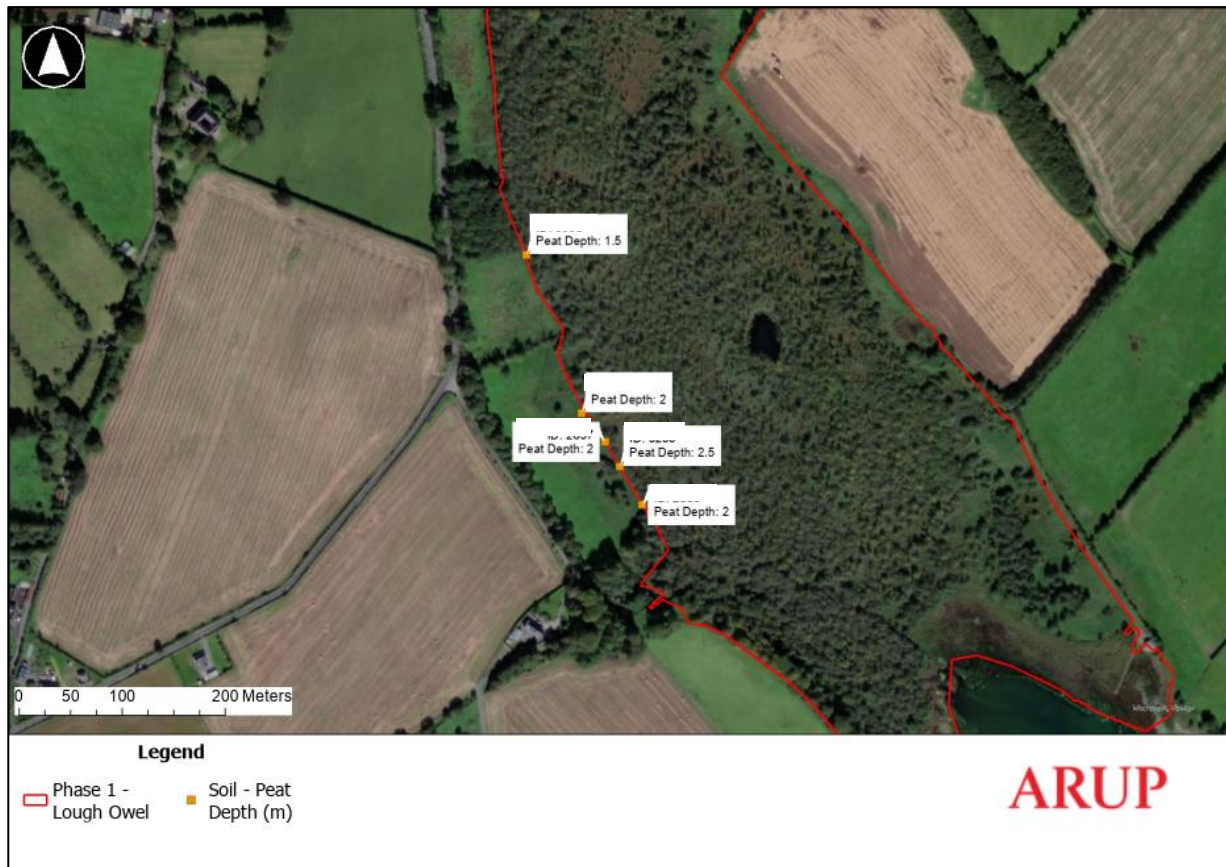


Figure 3-36: Peat depth (m) at Bunbrosna

3.2.1.2 Culleen

There was one peat depth measurement taken at Culleen using a peat probe. The peat depth was measured at 3m depth in the north of the site. Peat depths during the site surveys are shown in Figure 3-37.

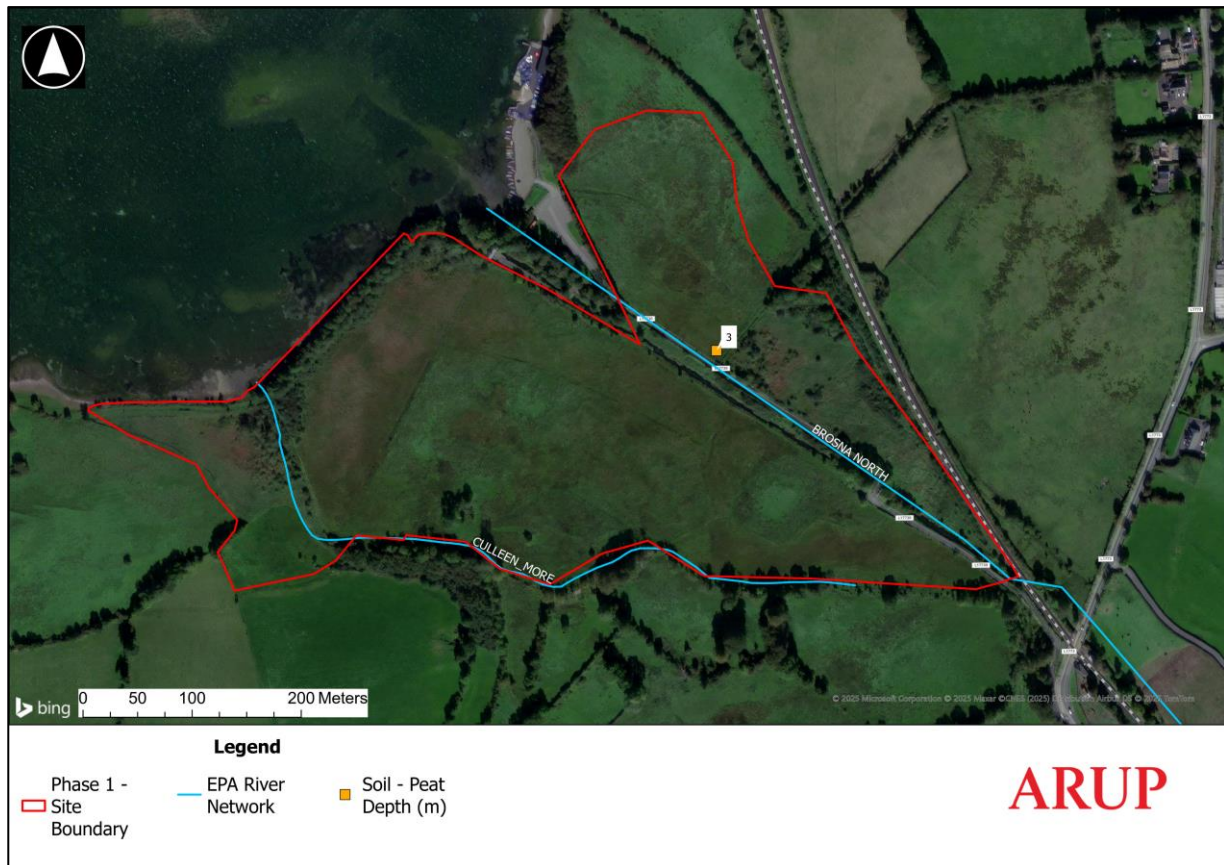


Figure 3-37: Peat depth (m) at Culleen

3.2.1.3 Ballard

There were no peat depth measurements taken at Ballard due to access issues.

3.2.2 Groundwater Levels and Springs

No springs or surface flushes were observed within the Bunbrosna and Culleen sites during the site walkovers although for Bunbrosna historical maps indicate the presence of two springs outside of the site boundary. The seasonal drains may relate to these springs.

3.2.3 Surface Water Levels and Drainage

3.2.3.1 Bunbrosna

Initial site visits identified drain locations to the south-west of the site which flows towards the lake. Follow up site visits identified a perimeter drain to the east of the site and surface water inputs from the southwest. The origin of the 'central drain' identified as River Brosna in the EPA maps was identified at the northern border of the site. This was fairly dry and overgrown, with limited depth.

The deeper western drains were generally overgrown. There were an overgrown area of stagnant water and a drain flowing southeast towards Lough Owel. Water measurements were taken along this drain and measured water depth at 0.5m to 1m depth indicating an increase in depth towards the lake (Figure 3-38).

There were two previously unmapped drains observed perpendicular to the eastern boundary of the site in the surrounding farmland, flowing downslope towards the southwest and then towards Lough Owel. Measured water depth was at 0.3m.

The northernmost drain was observed to have more flow than the southern drain. This region was identified as having a spring in historical maps therefore connection to the water table is likely. There is also a marl lake on the eastern section of the site.

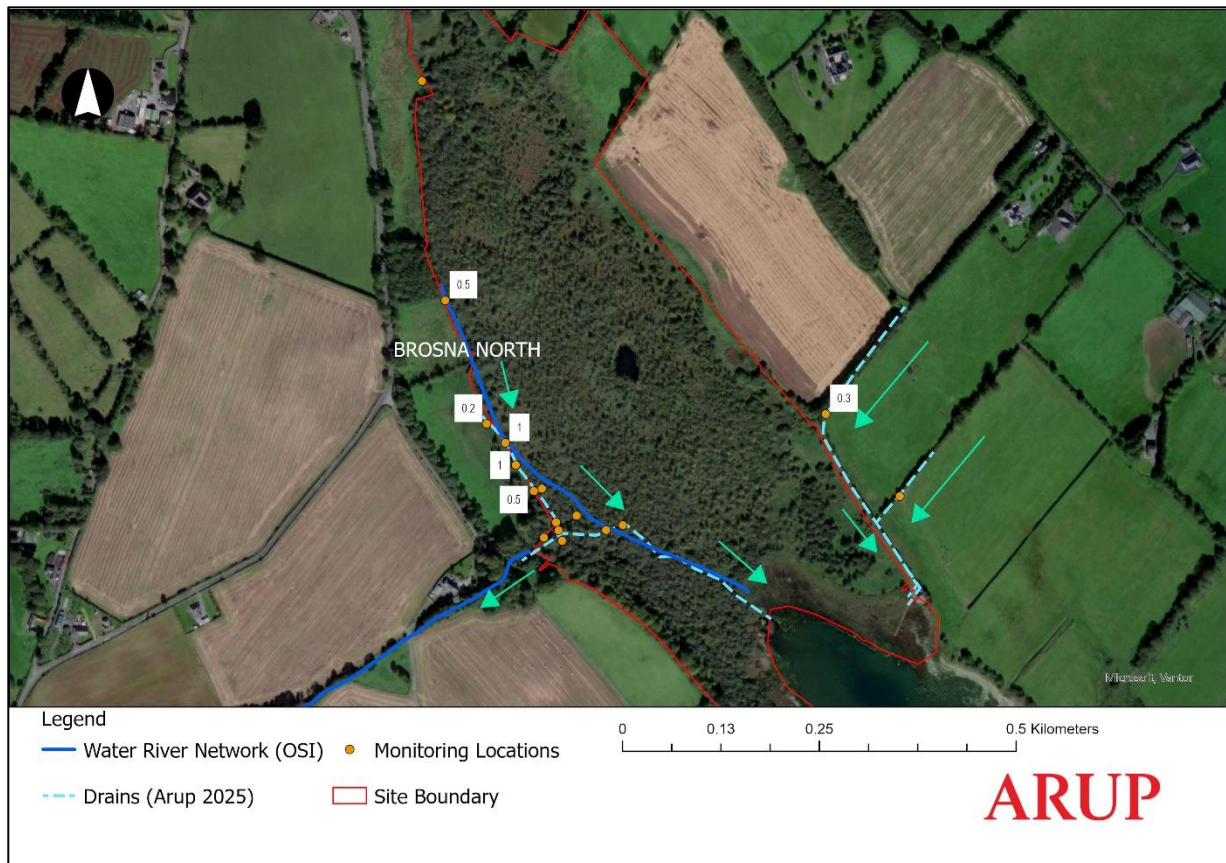


Figure 3-38: Surface water levels at Bunbrosna

3.2.3.2 Culleen

Due to landowner consent delays, the focus for field surveys in Culleen was for the eastern part of the wetland. Monitoring locations and drains observed during the Arup site visits can be viewed in Figure 3-39. There were two drains identified on the north and southern side of the Royal Canal, which both feed into it. There were five monitoring locations at Culleen. Water measurements were taken at the drain from the north-west, which measured 0.7m water depth.

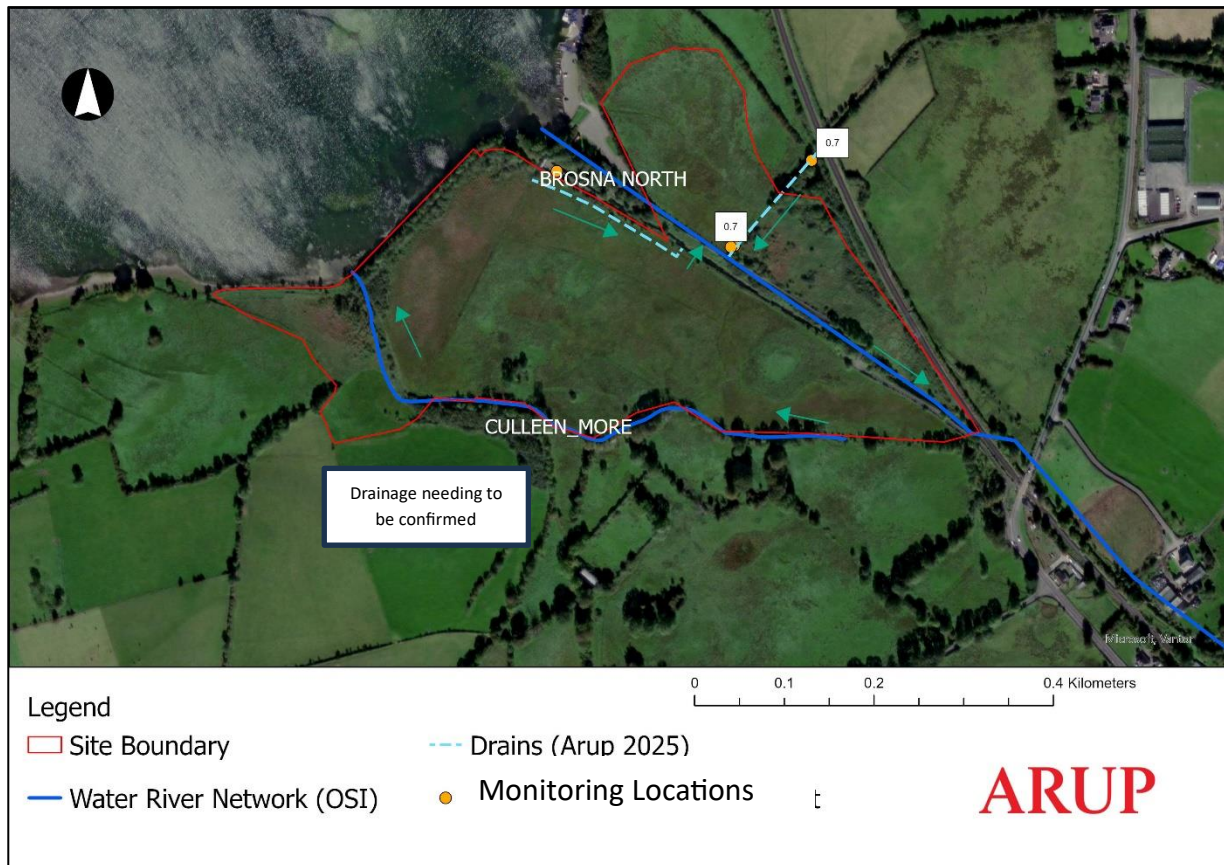


Figure 3-39: Surface water levels at Culleen

3.2.3.3 Ballard

Due to landowner consent delays the focus for Ballard has been on a conceptual understanding of flow inputs and surrounding land use.

3.2.4 Water Quality

3.2.4.1 Bunbrosna

Water quality monitoring shows spatial variation and potential sources of nutrient enrichment across the site, particularly in areas adjacent to agricultural activity and livestock.

Phosphate concentrations (PO_4) across the site varies, with some measurements above the 'good' status environmental quality standard of 0.107 mg/l PO_4 for rivers ($0.035 \text{ mg/l PO}_4\text{-P}$)⁷, and some below (Figure 3-40). The northernmost part of the site had one measurement of phosphate at 0.03 mg/l PO_4 . In the southwestern part of the site, Phosphate concentrations ranged from 0.03 to 1.38 mg/l PO_4 . Along the eastern boundary of the site had one

⁷ Government of Ireland (1998) S.I. No. 258/1998 — Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorus) Regulations 1998. Available at: <https://www.irishstatutebook.ie/eli/1998/si/258/made/en/print>

measurement of phosphate at 0.92 mg/l PO₄, exceeding the good status environmental quality standard threshold⁸.

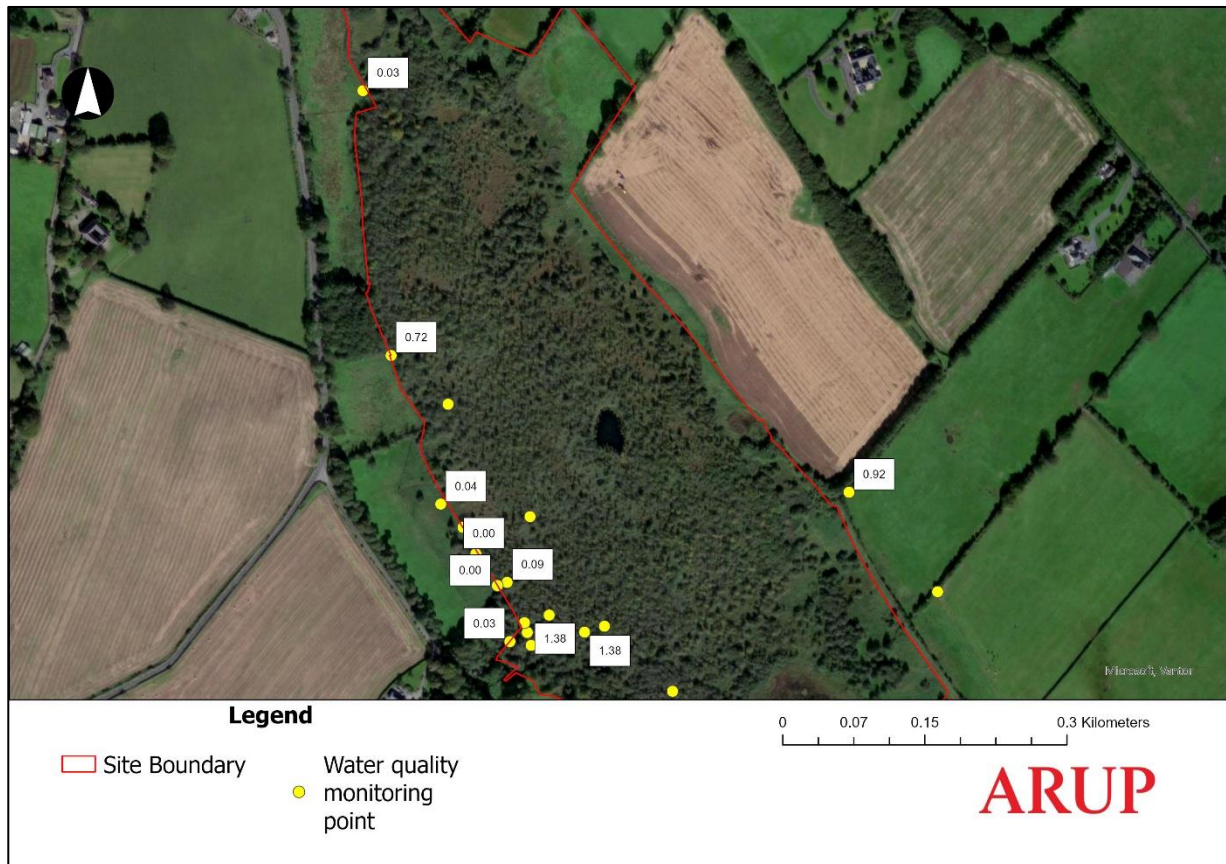


Figure 3-40: Phosphate (mg/l PO₄) at survey points at Bunbrosna

Nitrate (NO₃) across the site has areas above and below the regulatory groundwater threshold¹⁰ of 37.5 mg/l NO₃. Although there is no regulatory surface water threshold for nitrate, mean nitrate concentrations of greater than 8 mg/l NO₃ may impact the ecological health of rivers (EPA, 2025b).

Nitrate concentrations ranged from 0.03 to 1.38 mg/l NO₃ in the southwestern part of the site (Figure 3-41). Concentrations were highest along the eastern boundary of the site with one measurement of 114.2 mg/l NO₃. This is an unusually high value of Nitrate although it may be attributed to the agricultural land-use in that area.

⁸ Government of Ireland (1998) S.I. No. 258/1998 — Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorus) Regulations 1998. Available at: <https://www.irishstatutebook.ie/eli/1998/si/258/made/en/print>

¹⁰ Government of Ireland (2010) S.I. No. 9/2010 — European Communities Environmental Objectives (Groundwater) Regulations 2010. Available at: <https://www.irishstatutebook.ie/eli/2010/si/9/made/en/print>

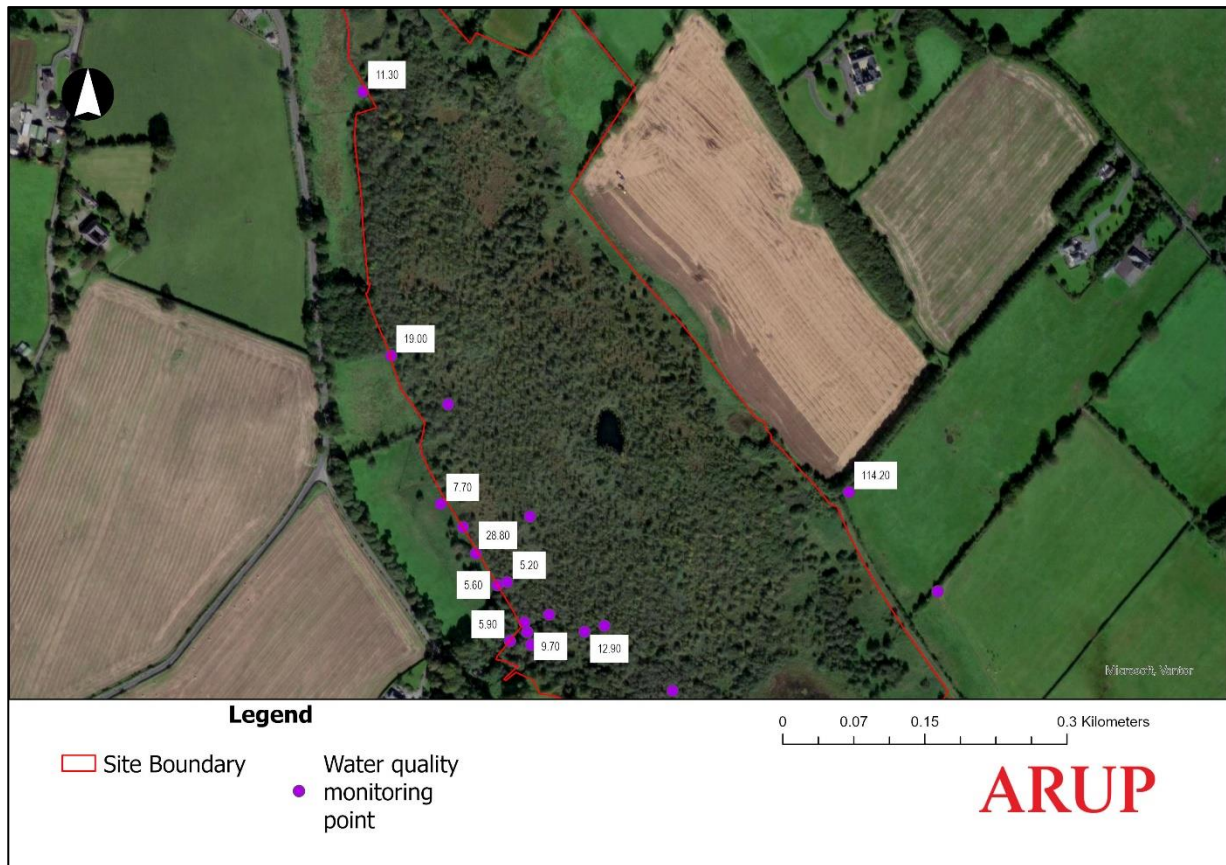


Figure 3-41: Nitrate (mg/l NO₃) at survey points at Bunbrosna

pH ranged from 6.95 within the site to 8.14 in a drain to the east of the site (Figure 3-42). EC was lower within the site (342 µS/cm) and higher at drains to the north (846 µS/cm) and east

of the site (765 $\mu\text{S}/\text{cm}$) (

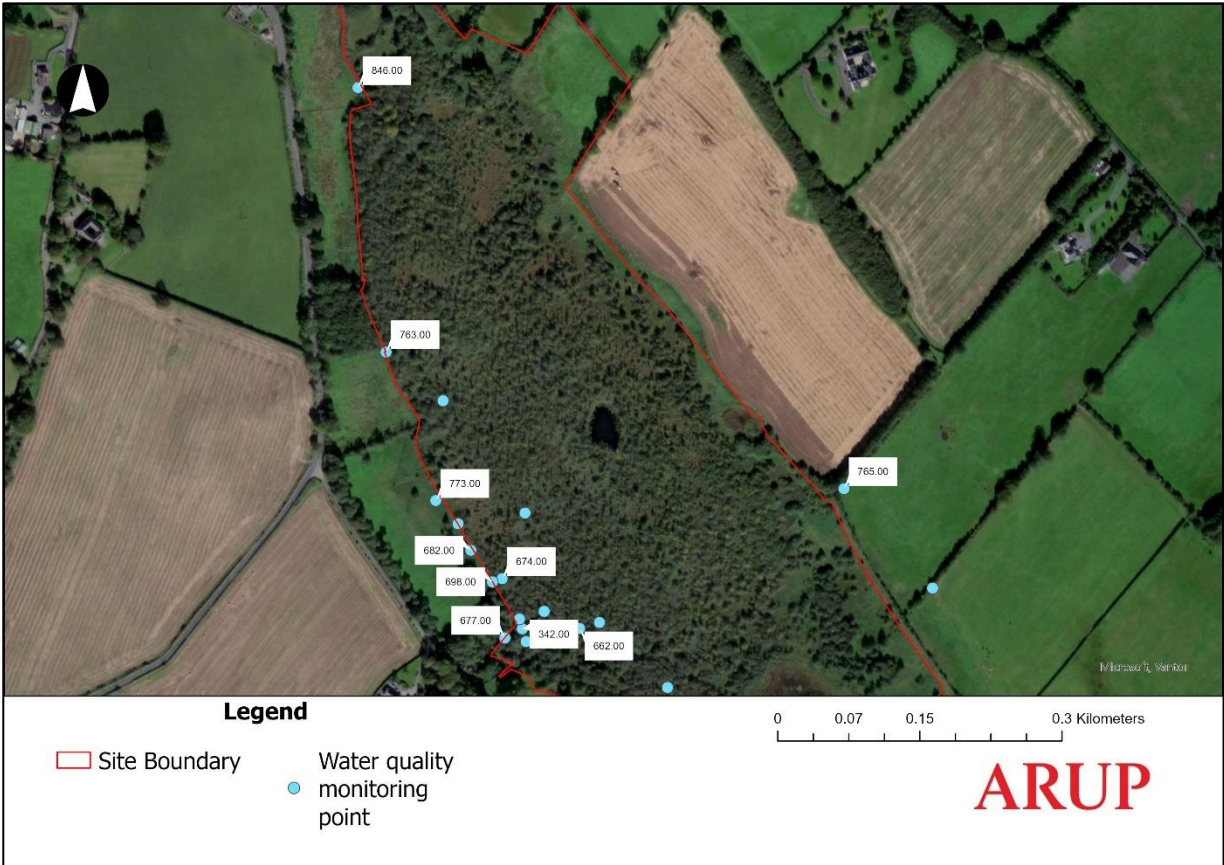


Figure 3-43).

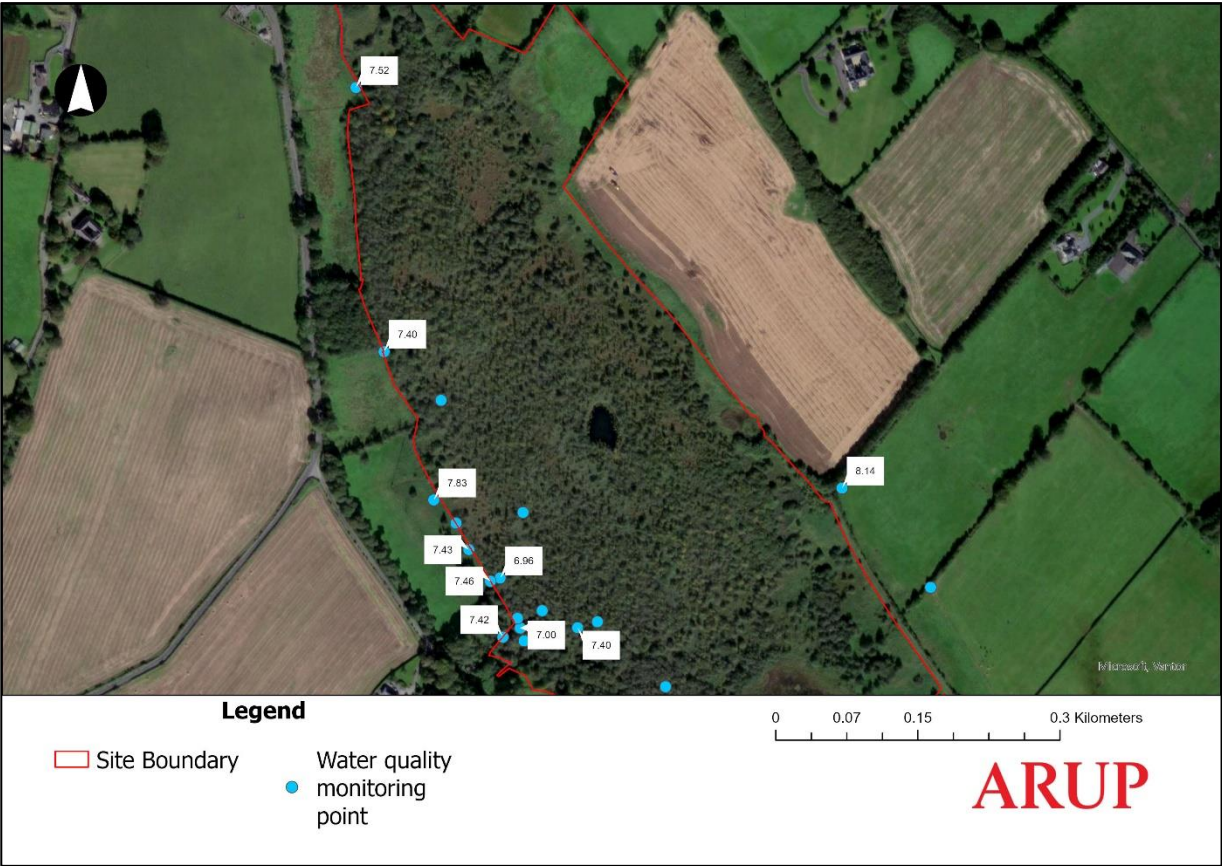


Figure 3-42: pH at survey points at Bunbrosna

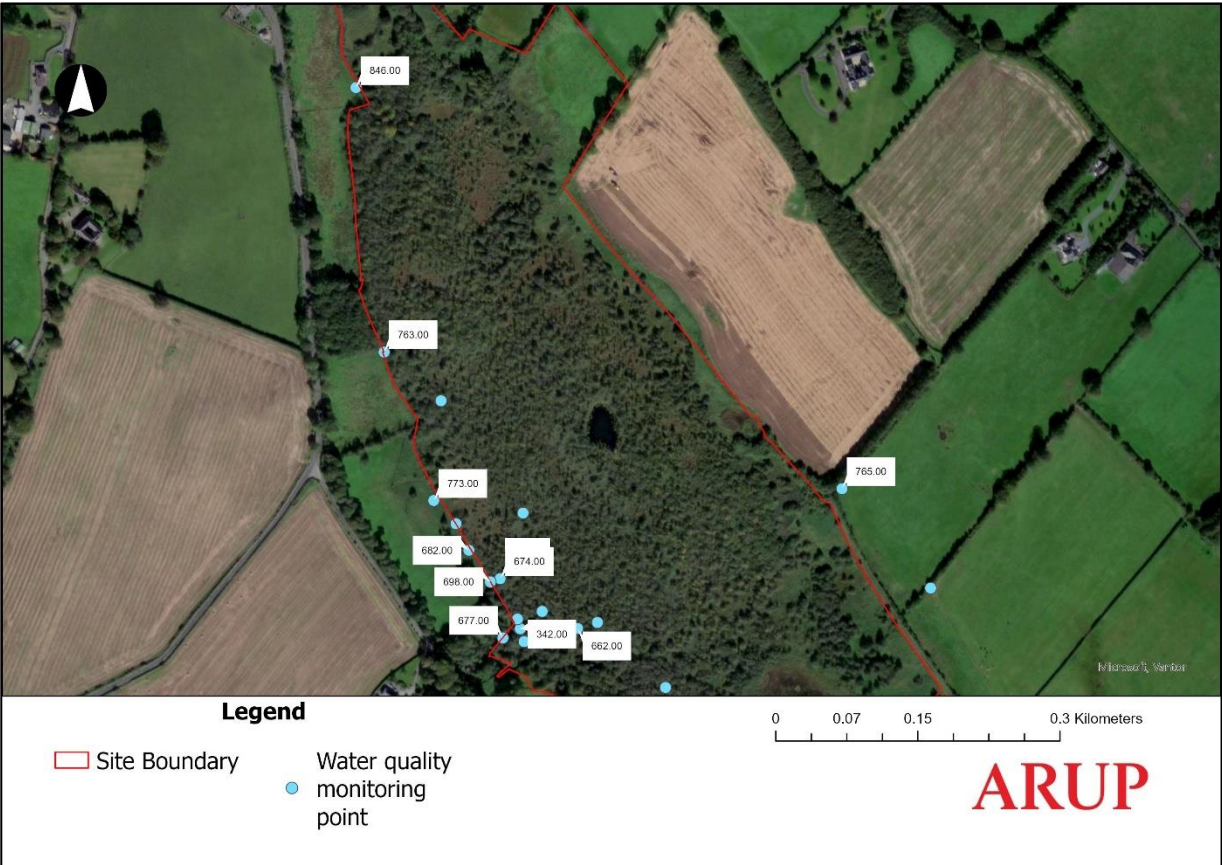


Figure 3-43: Electrical Conductivity (EC) (µS/cm) at survey points at Bunbrosna

3.2.4.2 Culleen

Surface water quality measurements were taken at Culleen in October and November 2025.

PO₄ concentrations were generally low across the northern portion of the Culleen site (Figure 3-44). Results ranged from 0 to 0.34 mg/l PO₄. Concentrations were lowest in the northeastern-most portion of the site at 0 mg/l PO₄ and were higher in the central portion of the site at 0.09 and 0.34 mg/l PO₄.

NO₃ concentrations were measured in four locations across the northern portion of the Culleen site (Figure 3-45). Nitrate values ranged from 0 to 5.6 mg/l NO₃. Values were highest in the northeastern portion of the site and were lowest in the central part of the site adjacent to the Royal Canal.

pH ranged from 6.82 at the drain to the east within the site to 8.1 in the main canal (Figure 3-46). EC was lower at the canal (265 µS/cm) and higher at drains to the north (862 µS/cm) (Figure 3-47).

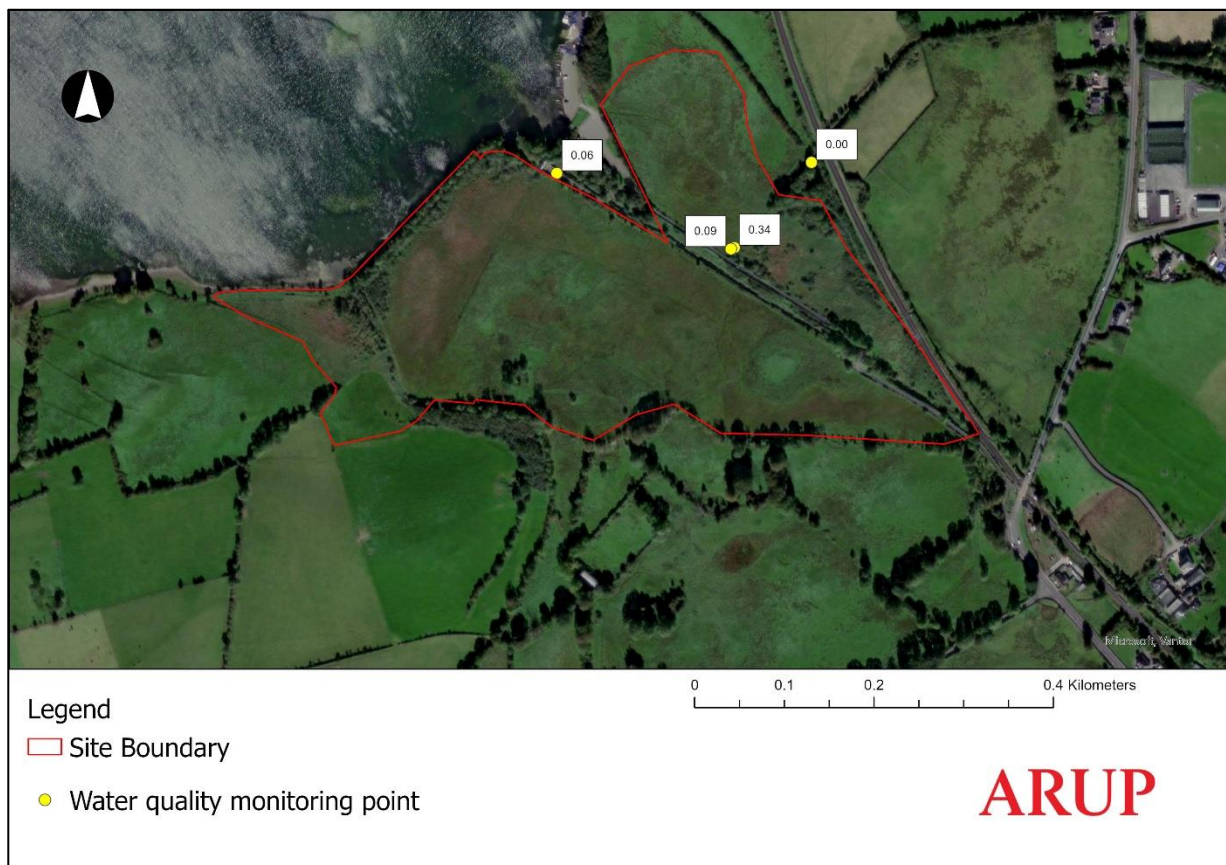


Figure 3-44: Phosphate (PO₄) at survey points at Culleen

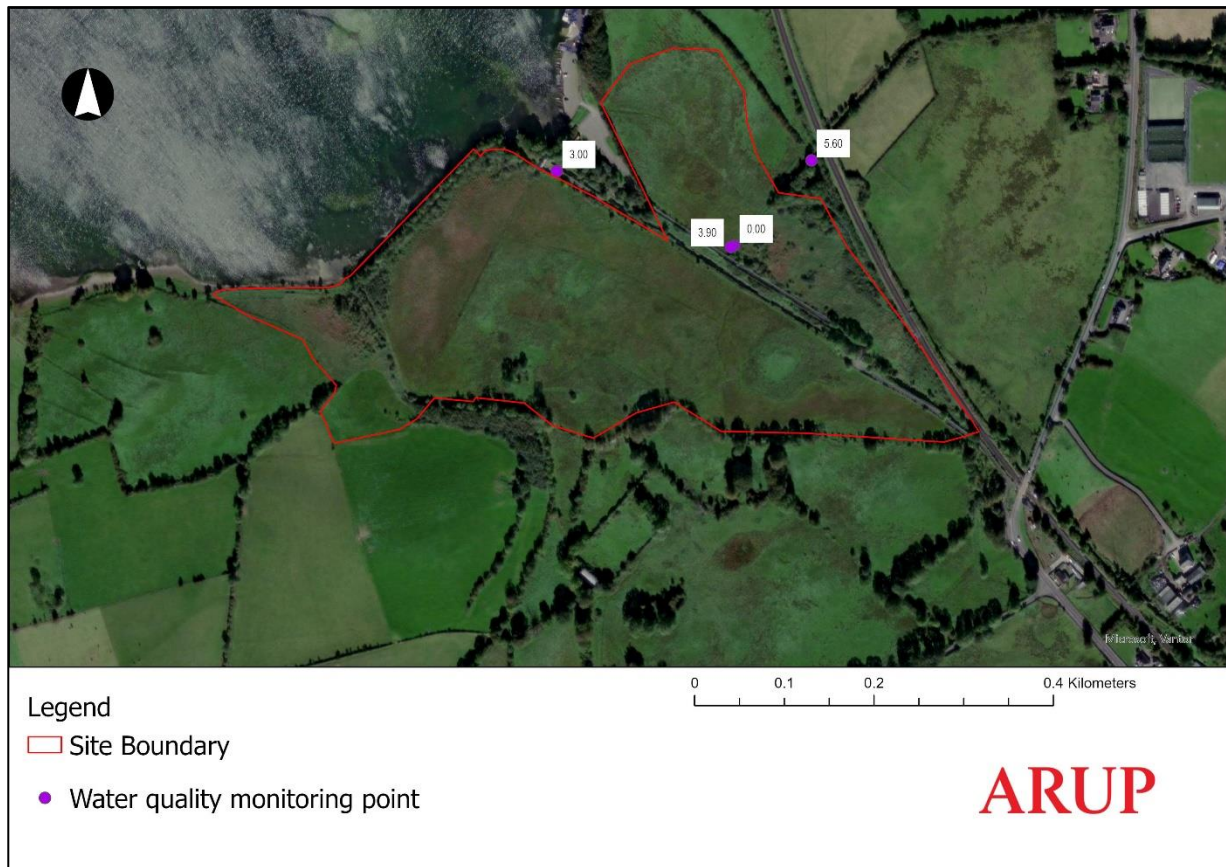


Figure 3-45: Nitrate (mg/l NO₃) at survey points at Cullen

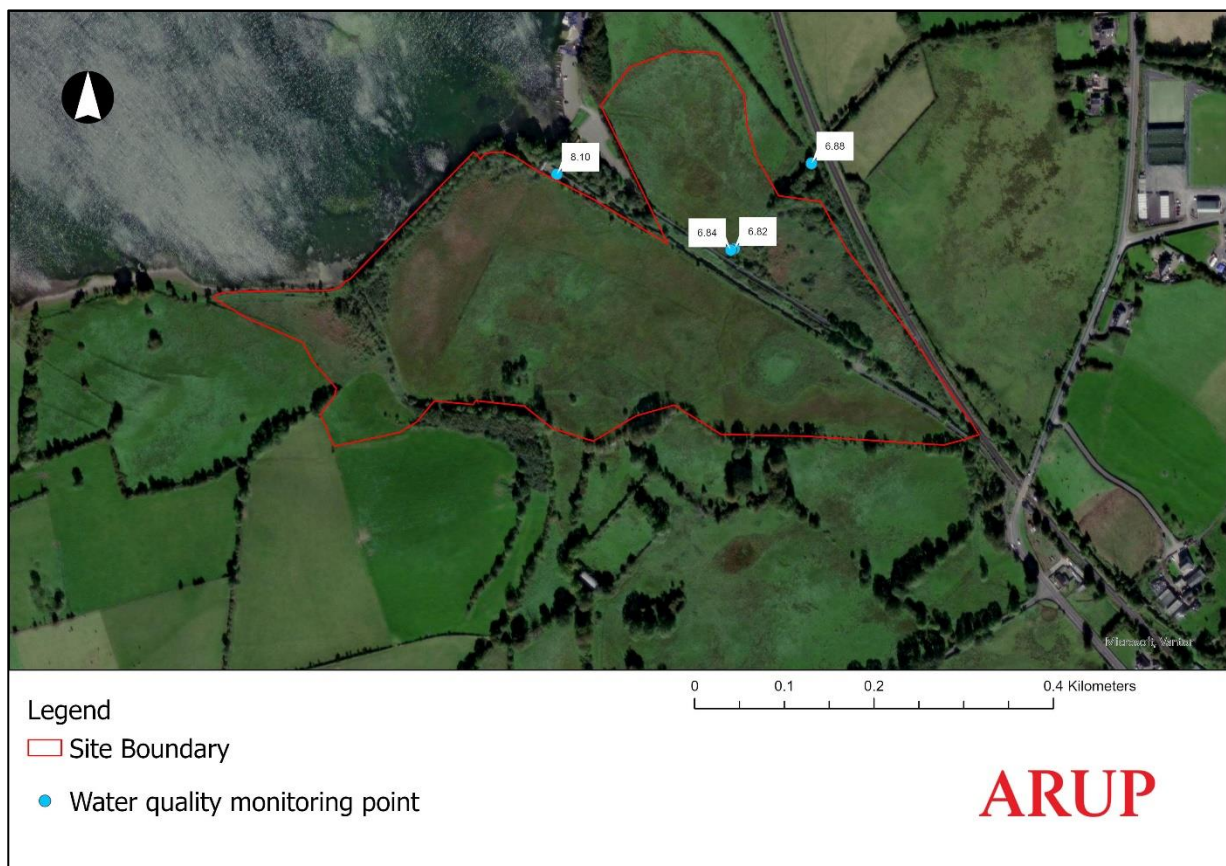


Figure 3-46: pH at survey points at Cullen

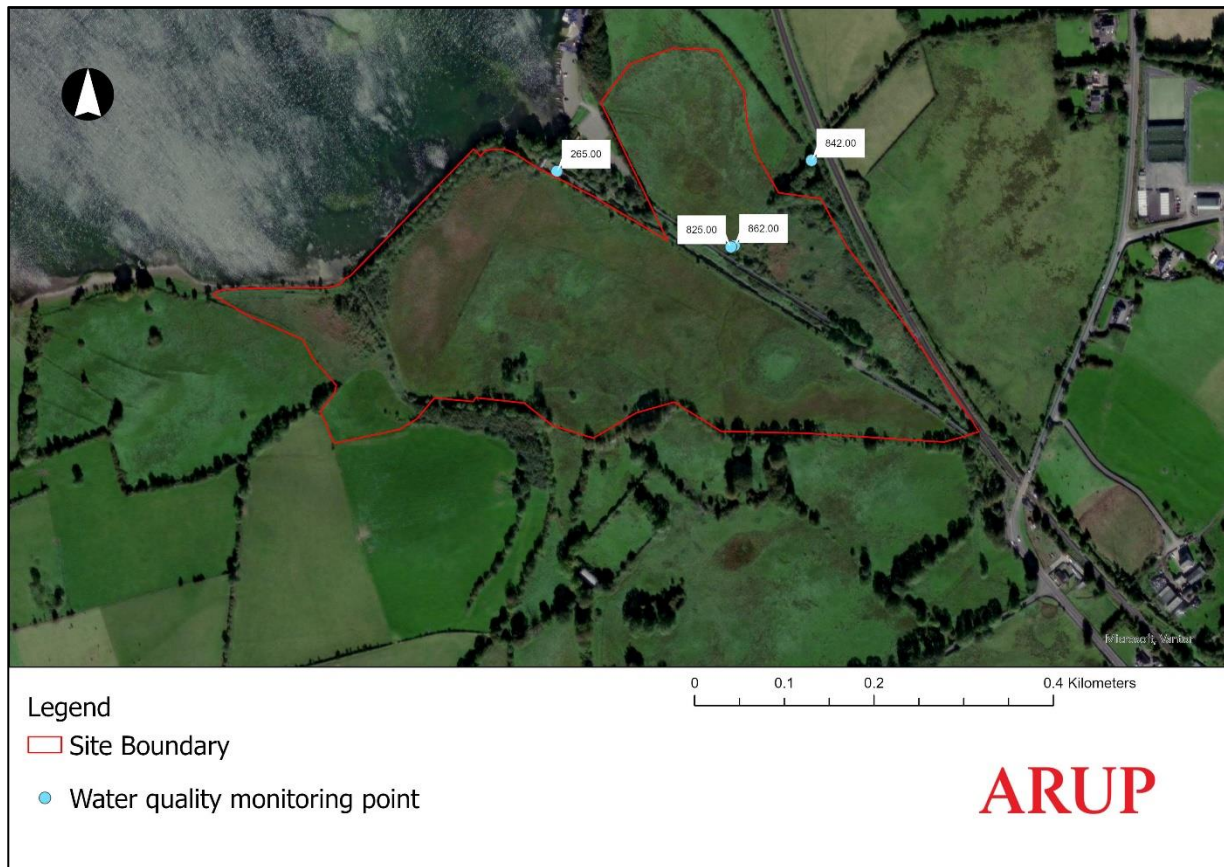


Figure 3-47: Electrical Conductivity (EC) ($\mu\text{S}/\text{cm}$) at survey points at Culleen

3.2.4.3 Ballard

TBD

3.3 Conceptual Site Model

Lough Owel wetlands are classed as being WETMEC 6: Surface water percolation floodplain (O’Neil et al., 2023; Weeler, 2009). A Conceptual Site Model (CSM) has been developed for each of the three sites within the Lough Owel SAC (Figure 3-48; Figure 3-49; Figure 3-50). Each CSM includes information gained from the PFS 2020 (O’Neill et al., 2023) results and from the desktop study.

Table 3-2: Site conditions informing the conceptual site models for Lough Owel

Site	Vegetation	Ground conditions	Drainage
Bunbrosna	There were no Annex 1 fen habitats mapped within the Bunbrosna site. The site mostly consists of wet willow alder-ash woodland, with a localised area of wet grassland to the northeast, a limestone marl lake in the centre, a localised area of wet grass grassland on the	The inferred ground conditions consist of subsoils constituting peat, underlain by till and is overlying a Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones (LI).	Surface discharge from the habitat is towards the west of the site. There is likely groundwater flow between Lough Owel and the habitat depending on the water levels in Lough Owel. Marl lake and

Site	Vegetation	Ground conditions	Drainage
	southeastern margin and a reed and large sedge swamp on the shoreline of Lough Owel.		springs indicate groundwater connection.
Culleen	There were two Annex 1 habitats mapped within the Culleen site, 7230 and 4140 in the western portion of the site. The rest of the site constitutes wet grassland. There appears to be two drains within the site. Flow directions within the drains are currently unknown and are to be confirmed during the site visits.	Ground conditions beneath the site consist of peat subsoils underlain by glacial till. The bedrock is characterised by a Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones (LI).	Surface discharge towards the canal feeder. There is likely groundwater flow between Lough Owel and the habitat depending on the water levels in Lough Owel.
Ballard	The Pilot Fen Survey (20920) mapped a mosaic of habitats within the Ballard site consisting of limestone/ marl lake, wet grassland, wet heath, and reed and large sedge swamps.	Ground conditions beneath the site constitute peat subsoils underlain by glacial till over burden, and bedrock characterised by a Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones (LI).	A fen habitat in the southern portion of the Ballard site with surface water drainage surrounding it. Drainage directions are currently unknown and are yet to be confirmed.

Lough Owel SAC Fen Restoration Plan

Lough Owel: Bunbrosna

Westmeath County

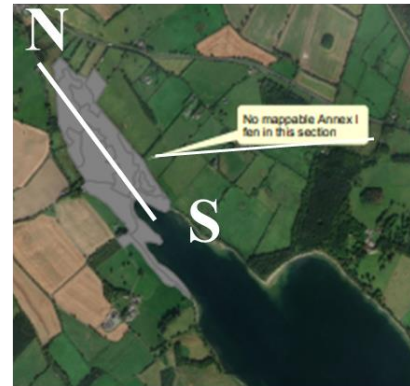
Lower Shannon 25A

WETMEC 6: Surface water percolation floodplain

Key:



Cross section:



Water input/output:

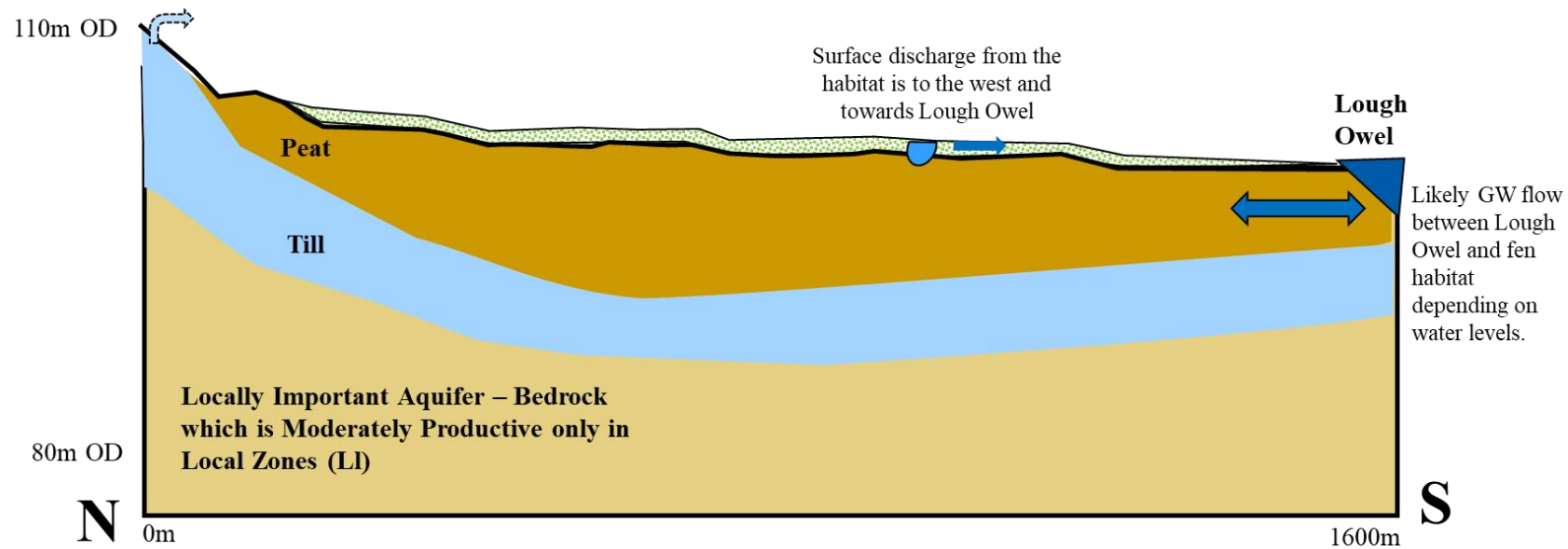


Figure 3-48: Conceptual Site Model for Bunbrosna within the Lough Owel SAC

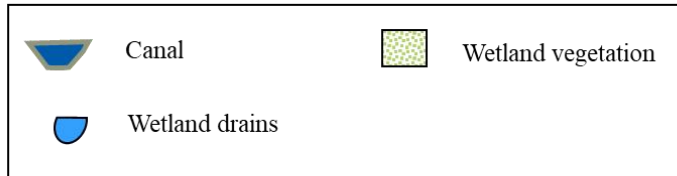
Lough Owel: Culleen

Westmeath County

Lower Shannon 25A

WETMEC 6: Surface water percolation floodplain

Key:



Cross section:

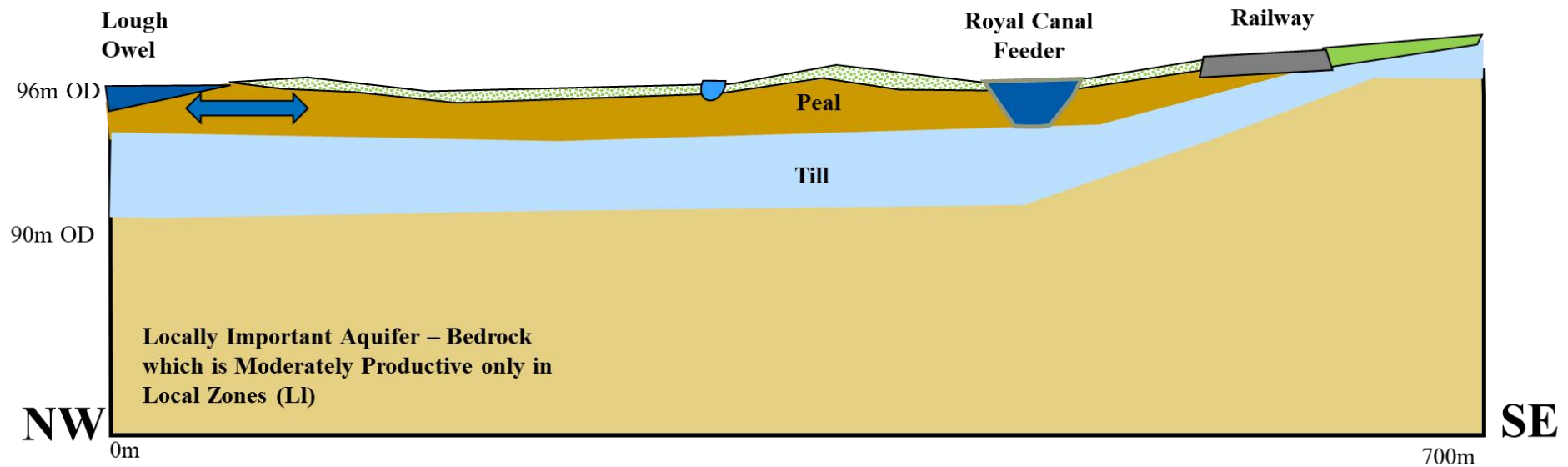


Figure 3-49: Conceptual Site Model for Culleen within the Lough Owel SAC

Lough Owel SAC Fen Restoration Plan

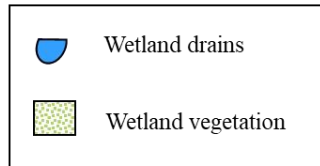
Lough Owel: Ballard

Westmeath County

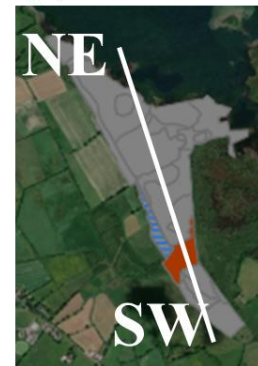
Lower Shannon 25A

WETMEC 6: Surface water percolation floodplain

Key:



Cross section:



Water input/output:

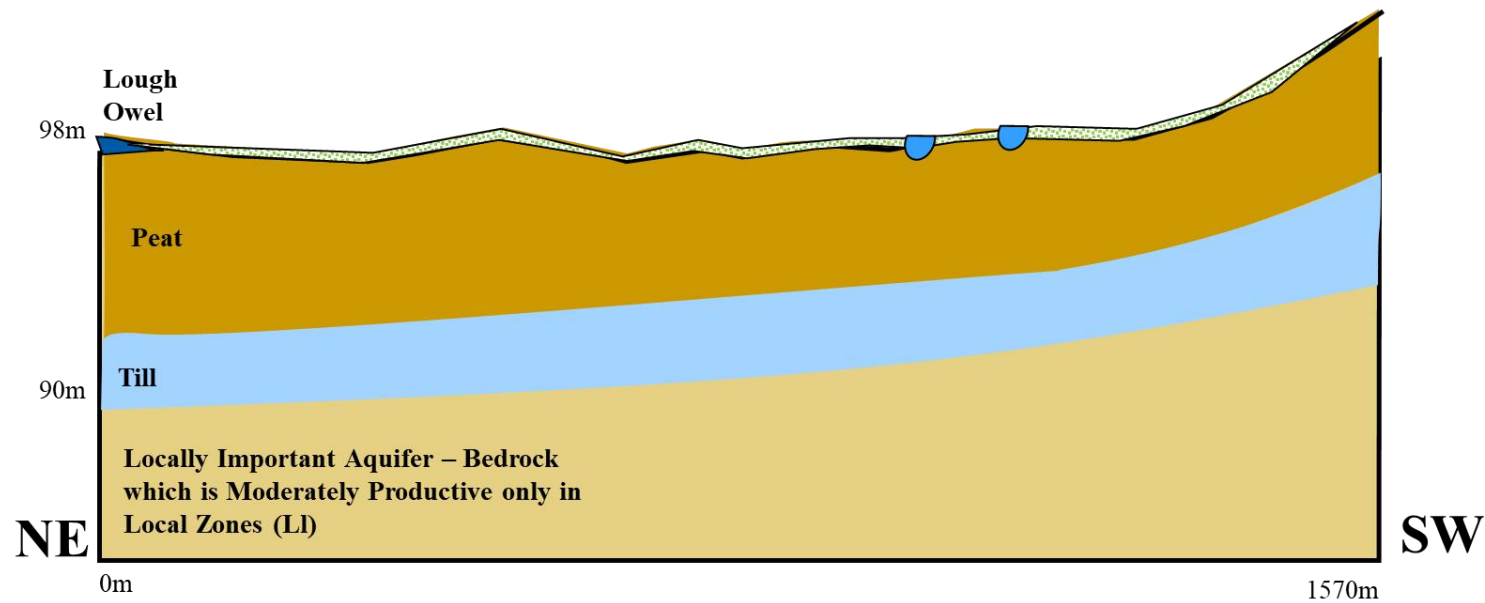
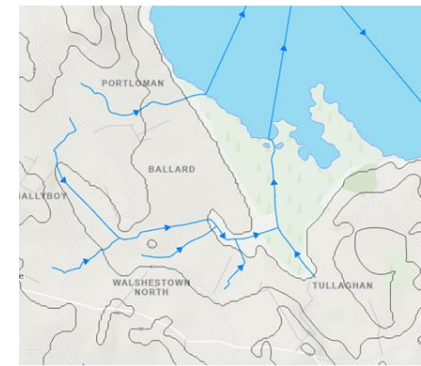


Figure 3-50: Conceptual Site Model for Ballard within the Lough Owel SAC

4 Ecology

4.1 Desk Study

A review of available desktop information on the ecological baseline for Lough Owel SAC was reviewed from the below information sources:

- NPWS Protected Sites – Special Areas of Conservation – Lough Owel SAC;
- NPWS Article 17 habitats distribution datasets;
- Scoping Study and Pilot Survey of Fens (O'Neill, 2023);
- Biodiversity Maps - National Biodiversity Data Centre (NBDC);
- Plant Atlas 2020 website - Botanical Society of Britain & Ireland (BSBI);

The 'Scoping Study and Pilot Survey of Fens' was commissioned to develop and test a standardised methodology for assessing the conservation status of fen habitats across Ireland. As part of this study, Lough Owel SAC in County Offaly was selected as one of the pilot sites for field survey. The site was surveyed in June 2020, with a focus on Annex I fen habitats, specifically 7230 Alkaline fens and 7140 Transition mires. 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.

Lough Owel SAC overlaps with Lough Owel SPA and Lough Owel pNHA.

4.1.1 Habitats

The Scoping Study and Pilot Survey of Lough Owel SAC was conducted over three sections of the site, the northern section near Bunbrosna and Ballinslout, the southeastern section adjacent to the townlands of Ballard and Tullaghan, and a southern section adjacent to Culleen More. The objective was to focus on regions that have historically sustained fen and transitional mire habitats, as well as those areas demonstrating the highest current potential for supporting these environments. The total area of the site surveyed was 104.19 ha.

Refer to Appendix B for maps.

4.1.1.1 Annex Habitats

The following Annex I habitats (which are qualifying features) were identified and mapped:

- **7140 Transition mires and quaking bogs** – The 7140 Transition mires at Lough Owel is limited in area (1.31 ha), mainly in the south-east (Culleen). Key species include *Carex diandra*, *C. nigra*, *C. panicea*, *C. rostrata*, *C. elata*, *Eriophorum angustifolium* and *Menyanthes trifoliata*. In certain sections of the site, the distinction between the 7230 Alkaline fen and the 7140 Transition mires is not clearly defined, owing to the presence of overlapping characteristic species. Fluctuations in water level in addition to scrub encroachment was identified as pressures. There was no mappable annex quality transition mire and quaking bog present within the northern section of the site. The overall conservation status is favourable for structure, function, and future prospects.
- **7230 Alkaline fen** – covering approximately 2.18ha, the annex habitat is spread between the south-east (Ballard) and south-west (Culleen). Key species include *Carex demissa*, *C. leporina*, *C. panicea*, *C. hostiana*, *Campylium stellatum*, *Calliergonella cuspidata*, *Scorpidium cossonii* and *Molinia caerulea*. In some areas the distinction between the 7230 Alkaline fen and 7140 Transition mires is blurred due to the overlapping suite of characteristic species. Fluctuations in water level in addition to scrub encroachment was identified as pressures. The overall conservation status is unfavourable-inadequate, mainly due to structure, function, and future prospects. Both Ballard and Culleen are hydrologically complex, with fen peat soils, moderate to low subsoil permeability, and moderate groundwater vulnerability.

In addition to the two qualifying feature habitats denoted above, additional annex quality habitats were identified through the majority of the site:

- **91E0 Alluvial woodland** – Dominates much of the surveyed site at Lough Owel, especially within Bunbrosna. Whilst not a qualifying interest of Lough Owel SAC, key species such as *Pyrola rotundifolia* and Marsh fritillary butterfly *Euphydryas aurinia* have been identified here, illustrating its ecological function in support of nationally important species.
- **7210 Cladium fen** – covering approximately 0.01ha, this habitat is extremely limited at Lough Owel at the northern section (Bunbrosna). Vegetative composition is characterised by *Phragmites australis*, *Cladium mariscus* (dominant), *Menyanthes trifoliata*, and various sedge species.
- **6410 Molinia meadows** – occurs in patches in both the Culleen and Ballard, especially in fields adjacent to fen habitats (annex and non-annex). Dominated by *Molinia caerulea* there are key species of *Cirsium dissectum*, *Galium uliginosum* and *Crepis paludosa*.

4.1.1.2 Non-Annex/Fossitt habitats

Several non-annex fen and other habitats were also recorded, with mapping using Fossitt¹¹ (2000) classification. These are broken down by the site's subsections (Table 4-1) and are illustrated in Appendix B.

Table 4-1: Species within Lough Owel sites

Habitat Type	Notes
Bunbrosna	
WN6 Wet willow-alder-ash woodland	Predominant in the northern area, this habitat is classified as wet woodland and is characterised by regular deer presence. Several target notes indicate populations of <i>Pyrola rotundifolia</i> . Marsh Fritillary butterflies have also been recorded within the woodland. Management recommendations: Removal of scrub or native trees is not necessary unless their growth becomes excessive
FL3 Limestone marl lake	Described as a <i>cladium</i> swamp adjacent to a hard water lake; <i>Chara hispida</i> var. <i>major</i> observed
GS4 Wet grassland	Found in blocks or patches near fens and woods. Mainly features <i>Molinia caerulea</i> , with <i>Juncus</i> , <i>Phragmites</i> , and other swampy grassland plants
FS1 Reed and Large Sedge Swamps	These were situated along lake margin and within drainage ditches. Representative species include <i>Phragmites</i> , <i>Cladium</i> , <i>Carex elata</i> , and <i>Menyanthes trifoliata</i>
PF1 Rich fen and flush	Found in small patches, sometimes overlapping PF3. Vegetation includes <i>Schoenus</i> , <i>Carex viridula</i> , and <i>Scorpidium</i> species.
HH3 Wet heath	Characterised by <i>Myrica gale</i> heath, accompanied by birch (<i>Betula spp.</i>), willow (<i>Salix spp.</i>), and royal fern (<i>Osmunda regalis</i>).
PF3 Transition Mire and Quaking Bog	Located in multiple parts of the site. The vegetation assemblage includes <i>Schoenus</i> , <i>Carex rostrata</i> , <i>Phragmites</i> , and <i>Menyanthes trifoliata</i>
WL2 Treelines	Associated with 91E0 annex habitat, recorded along the edges of fields and lakes
Ballard	
GS4 Wet grassland	Similar species composition as northern section.
PF3 Transition mire and quaking bog	Corresponds with the 7140 Annex habitat in the site with vegetation including <i>Carex spp.</i> , <i>Eriophorum angustifolium</i> and <i>Menyanthes trifoliata</i>
WL2 Treelines	Indicative of 91E0 wet woodland, mapped along boundaries.
FS1 Reed and large sedge swamps	Found along lake edge and in ditches.
FL3 Limestone marl lake	Mapped in proximity to fen and swamp habitats.
PF1 Rich fen and flush	Present in small areas, sometimes overlapping with PF3.
Culleen	
GS4 Wet grassland	Dominant habitat, mapped in blocks and patches
PF1 Rich fen and flush	Present in small areas, sometimes overlapping with PF3.
PF3 Transition mire and quaking bog	Mapped in several locations, with characteristic vegetation

¹¹ Fossitt habitats refer to the classification system outlined in A Guide to Habitats in Ireland by J.A. Fossitt (2000). It provides a standardised framework for habitat identification and mapping in Ireland, grouping habitats into hierarchical levels based on vegetation, landform, and ecological characteristics.

Habitat Type	Notes
WN6 Wet willow-alder-ash woodland	Present, with similar species and structure as northern section.
FS1 Reed and large sedge swamps	Found along lake edge and in ditches
FL3 Limestone marl lake	Mapped adjacent to fen and swamp habitats
WL2: Treelines	Indicative of wet woodland, mapped along boundaries

Overall, the non-Annex and Fossitt habitats show a high degree of diversity and ecological connectivity, though some areas are impacted by drainage, scrub encroachment, nutrient enrichment, fluctuating water levels, and deer browsing.

Several categories of the Irish Vegetation Classification (IVC) were recorded on site:

- FE1C - *Carex panicea* – *Carex viridula* fen / Carnation sedge-Yellow sedge fen
- FE2A - *Equisetum fluviatile* – *Menyanthes trifoliata* mire / Water horsetail-Bogbean mire
- FE2F - *Menyanthes trifoliata* – *Calliergonella cuspidata* mire / Bogbean – Pointed Spear-moss mire
- FE3A - *Carex nigra* – *Ranunculus flammula* fen / Common sedge-Lesser spearwort fen
- GL1D - *Molinia caerulea* – *Potentilla erecta* – *Agrostis stolonifera* grassland / Purple moor-grass-tormentil-creeping bent grassland

4.1.2 Species

The following subsections outline the presence of species recorded at or within the zone of influence of the Lough Owel site. 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.

Lough Owel SAC is designated for the presence of *Austropotamobius pallipes* (white-clawed crayfish). Historical records from the National Biodiversity Data Centre (NBDC) confirm the presence of this species within the SAC, particularly in freshwater habitats associated with the lake and its tributaries. The white-clawed crayfish is listed as an Annex II species under the EU Habitats Directive and is of significant conservation interest due to its declining status across Europe. However, as white-clawed crayfish is a freshwater species, it sits outside the scope of the Tóchar fen restoration programme, which is focused on fen and wetland habitats.

Other notable species recorded on site include marsh fritillary butterfly, Desmoulin's Whorl Snail (*Vertigo moulinsiana*) in adjacent wet grassland, and round-leaved wintergreen within wet woodland. The site supports a diverse range of wetland and fen flora, including characteristic sedges, rushes, and mosses associated with alkaline fen and transition mire habitats.

4.1.2.1 Species within the site

Recent records from the National Biodiversity Data Centre (NBDC), filtered to the last ten years, demonstrate that Lough Owel SAC supports a diverse assemblage of protected, endangered, and red-listed species across multiple taxonomic groups. Notable records include the white-clawed crayfish, marsh fritillary, red hemp-nettle (*Galeopsis angustifolia*), and round-leaved wintergreen, as well as a range of amphibians, mammals, and invertebrates. The presence of these species highlights the ecological value of the site's wetland, fen, and woodland habitats.

A particularly rich bird community is present, with records for species such as kingfisher (*Alcedo atthis*), great northern diver (*Gavia immer*), white-tailed eagle (*Haliaeetus albicilla*), goldeneye (*Bucephala clangula*), and kestrel (*Falco tinnunculus*), among others. Many of these birds are listed under the EU Birds Directive and appear on national Birds of Conservation Concern Ireland (BOCCI) red or amber lists. The diversity and abundance of waterbirds and wetland-associated species is likely attributable to the fact that Lough Owel is also designated as an SPA. The SPA qualifying interest species, coot (*Fulica atra*) and shoveler (*Spatula clypeata*) are both recorded on site.

Some of the species identified in the NBDC search overlap with those recorded in the Pilot Scoping and Survey of Fens study, reinforcing the importance of Lough Owel SAC for both fen and broader wetland biodiversity. The presence of species protected under the EU Habitats Directive, Flora Protection Order, and Irish Wildlife Acts, as well as those listed as vulnerable or near threatened, underscores the need for ongoing habitat management and monitoring.

Table 4-2: Species records within Lough Owel

Legislative protection	Common name	Latin name
Habitats Directive	Common Frog	<i>Rana temporaria</i>
	White-clawed Crayfish	<i>Austropotamobius pallipes</i>
	Marsh Fritillary	<i>Euphydryas aurinia</i>
	Leisler's Bat	<i>Nyctalus leisleri</i>
	Pipistrelle	<i>Pipistrellus pipistrellus s.l.</i>
	Soprano Pipistrelle	<i>Pipistrellus pygmaeus</i>
	Pine Marten	<i>Martes martes</i>
	Fine Bog-moss	<i>Sphagnum angustifolium</i>
EU Birds Directive	Kingfisher	<i>Alcedo atthis</i>

Legislative protection	Common name	Latin name
	Great Northern Diver	<i>Gavia immer</i>
	White-tailed Eagle	<i>Haliaeetus albicilla</i>
	Coot	<i>Fulica atra</i>
	Goldeneye	<i>Bucephala clangula</i>
	Pochard	<i>Aythya ferina</i>
	Snipe	<i>Gallinago gallinago</i>
Irish Wildlife Act	Badger	<i>Meles meles</i>
	Hedgehog	<i>Erinaceus europaeus</i>
Flora Protection Order (FPO)	Red Hemp-nettle	<i>Galeopsis angustifolia</i>
Irish Red List (Vulnerable)	Marsh Fritillary	<i>Euphydryas aurinia</i>
	Narrow-bordered Five-spot Burnet	<i>Zygaena lonicerae</i>
Irish Red List (Near threatened)	Red-tailed Bumblebee	<i>Bombus lapidarius</i>
	Dark Tussock	<i>Dicallomera fascelina</i>
	Round-leaved Wintergreen	<i>Pyrola rotundifolia</i>
Irish Red List (Amber/Red List)	Kestrel	<i>Falco tinnunculus</i>
	Goldeneye	<i>Bucephala clangula</i>
	Meadow Pipit	<i>Anthus pratensis</i>
	Pochard	<i>Aythya ferina</i>
	Snipe	<i>Gallinago gallinago</i>
	White-tailed Eagle	<i>Haliaeetus albicilla</i>
	Great Northern Diver	<i>Gavia immer</i>
	Kingfisher	<i>Alcedo atthis</i>
	Great Crested Grebe	<i>Podiceps cristatus</i>
	Black-headed Gull	<i>Chroicocephalus ridibundus</i>
	Brambling	<i>Fringilla montifringilla</i>
	Goldcrest	<i>Regulus regulus</i>
	Herring Gull	<i>Larus argentatus</i>
	Lesser Black-backed Gull	<i>Larus fuscus</i>
	Mute Swan	<i>Cygnus olor</i>
	Spotted Flycatcher	<i>Muscicapa striata</i>
	Willow Warbler	<i>Phylloscopus trochilus</i>
No legislative protection	Little Grebe	<i>Tachybaptus ruficollis</i>
	Robin	<i>Erithacus rubecula</i>

4.1.2.2 Species within the Zone of Influence

Lough Owel supports a population of *Vertigo moulinsiana*. The south-eastern section of the site, forming part of the Tóchar fen restoration area at Culleen, was surveyed in 2011 and found to support both optimal and suboptimal habitat for the species, covering approximately 21.54 ha (Moorkens, 2011). The area was subject to mixed grazing, and the population, habitat, and future prospects of *V. moulinsiana* were assessed as favourable at that time.

V. moulinsiana is a highly specialised wetland snail that inhabits living and dead stems and leaves of tall plants in saturated conditions. It requires a stable hydrogeological regime, with the water table at or slightly above ground level for most of the year. Seasonal flooding must

be of low amplitude to maintain suitable conditions. The species exhibits seasonal behavioural shifts: climbing tall vegetation in summer and autumn, aestivating on lower leaves during extremes, and descending to the litter layer in winter.

Within optimal habitat, *V. moulinsiana* can persist across large areas (typically around 50% of the habitat), characterised by a good distribution of tall *Carex* species, often interspersed with *Schoenus nigricans* and *Phragmites australis*. The ground is sufficiently wet that water rises around the surveyor's boot under light pressure.

Suboptimal habitat supports the species in patches (around 10% of the habitat), where conditions are generally unsuitable but include tussocks or low-growing *Schoenus* that allow the snail to spread. These areas may be too wet (open water) or too dry (damp ground without water rise under pressure) but still contribute to the population's viability.

Unsuitable habitat is defined by vegetation and hydrological conditions outside the snail's tolerance range, such as areas with shallow bedrock, excessive vegetation cutting, or burning. These conditions prevent the establishment or persistence of *V. moulinsiana*.

4.2 Field Survey Data

Following a comprehensive review of available desktop data, a targeted follow-up ecological survey was undertaken on the site in August 2025 and November 2025. 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.

Three survey forms were created to collect data relevant to:

- Monitoring data
- Pressures and threats

4.2.1 Monitoring points

To inform the restoration strategy for Lough Owel, a targeted walkover survey was undertaken at Bunbrosna and Culleen. This was a focused assessment designed to gather site-specific data at pre-identified locations. The walkover was designed to assess ecological condition throughout the site and paid particular focus to 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 surveys focused on three key components:

- Target Notes: Qualitative observations at each monitoring point, capturing site condition, vegetation structure, hydrological features, and legacy management.
- Pressures and Threats Identification: Systematic recording of anthropogenic and natural pressures affecting each location.

The surveys confirmed the presence of a variety of habitats across the three site areas, as denoted in Table 4-3.

Table 4-3: Presence of Annex habitats recorded at Lough Owel during 2025 Ecological Walkover

Site	7210 <i>Cladium</i> fen	7230 Alkaline fen	Fossit
Bunbrosna	The habitat was not identified during the 2025 ecological walkover. Given that the survey was targeted and did not encompass the entire site parcel, there remains a possibility that this habitat occurs within the area.	The habitat was not identified during the 2025 ecological walkover. Given that the survey was targeted and did not encompass the entire site parcel, there remains a possibility that this habitat occurs within the area.	WN6 Alluvial woodland was noted as the primary habitat at Bunbrosna. This woodland habitat is considered Annex quality 91E0 Alluvial Woodland.
Culleen	Present at Culleen supported by good water flow. The location of the <i>Cladium</i> fen corresponded with suitable habitat for <i>Vertigo moulinsiana</i> .	Found adjacent to the 7210 <i>Cladium</i> fen. Supported by indicator species of <i>Carex lepidocarpa</i> , <i>Carex rostrata</i> , <i>Juncus subnodulosus</i> , <i>Campylium stellatum</i> , <i>Menyanthes trifoliata</i> , <i>Carex panicea</i> , <i>Calliergon giganteum</i> and <i>Potamogeton coloratus</i> .	WL1 hedgerows, WL2 treelines, GS1 dry calcareous and neutral grassland, GS4 wet grassland, FW4 drainage ditches, FS2 tall-herb swamp, PF1 rich fen and flush, GA1 improved agricultural grassland and WS1 scrub.
Ballard	Access limitations prevented survey of this part of the site during the 2025 ecological assessments. Therefore, the habitats documented in PFS are taken as the baseline for this parcel	Access limitations prevented survey of this part of the site during the 2025 ecological assessments. Therefore, the habitats documented in the PFS are taken as the baseline for this parcel	Access limitations prevented survey of this part of the site during the 2025 ecological assessments. Therefore, the habitats documented in the PFS are taken as the baseline for this parcel

4.2.2 Pressure and threats

This section outlines the historical and current pressures and threats affecting fen habitats at Lough Owel, with emphasis on Annex I habitats 7210 *Cladium* fen and 7230 Alkaline Fen. The analysis draws on baseline data from the PFS and recent ecological walkovers.

4.2.2.1 7140 Transition mire and quaking bogs

Historical Pressures

The PFS identified two key pressures historically affecting transition mire and quaking bog at the site:

- **Scrub encroachment:** Identified as a pressure on fen habitats, including 7140 Transition mires. Excessive scrub should be removed, but complete clearance of native trees is not required.
- **Water level fluctuations:** Lough Owel is used as a water supply reservoir, and fluctuating water levels are likely to negatively impact fen habitats, including transition mire areas. The extent of this impact requires further investigation.

Current observations

- **Scrub encroachment:** Identified as an ongoing pressure, in particular in Bunbrosna. Access issues prevented survey of Ballard; however, aerial photography would suggest that scrub/conifers are an ongoing issue.

4.2.2.2 7230 Alkaline fens

Historical Pressures:

The PFS identified three key pressures historically affecting alkaline fens at the site:

- **Scrub encroachment:** Same issue as above, specifically noted for alkaline fen areas. Monitoring and selective removal recommended.
- **Nutrient enrichment:** Evidence of nutrient input was observed in fen areas, including a smell of sewage effluent along the path to the south-east section and a small patch of algae.
- **Poor drain maintenance:** Many drains are infilled with vegetation, reducing water movement and potentially altering fen hydrology.

Current observations

- **Scrub encroachment:** In line with the historical pressure.

- **Drainage:** Still present within or adjacent to alkaline fen habitats.

4.2.3 Other Site Observations

4.2.3.1 91E0 Alluvial Woodland

Historical Pressures

- **Deer activity:** Recorded throughout wet woodland areas, which may affect regeneration and structure.
- **Hydrological changes:** While not explicitly detailed for woodland, overall site-level water fluctuations could influence wet woodland conditions.

Current Pressures

Observations during the 2025 ecological walkovers indicated that scrub encroachment by non-native species such as sycamore and beech is currently at levels that do not pose a significant pressure on the habitat, although without ongoing monitoring it could become problematic in the future.

4.3 Site Conservation Priority Matrix for Lough Owel Site

Refer to Table 4-4 for the Site Conservation Priority Matrix for the sites at Lough Owel.

Table 4-4: Site Conservation Priority Matrix for Lough Owel

Level	Feature Type	Feature Name	Extent/ Population	Pressure/Threat affecting it	Restoration Measure On-Site	Restoration Measure Off- Site
1a	SAC Habitat	7140 Transition mires and quaking bog	1.31ha	Fluctuations in water levels (drainage) Scrub encroachment	Vegetation monitoring Hydrological monitoring	
		7230 Alkaline fens	2.18ha	Fluctuations in water levels (drainage) Scrub encroachment	Vegetation monitoring Hydrological monitoring	
		3140 Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	N/A	N/A	N/A	N/A
1b	Annex Quality Habitat	91E0 Alluvial woodland	Present Bunbrosna	Invasive Alien Species Ash dieback	Vegetation monitoring Hydrological monitoring	
		7210 <i>Cladium</i> fen	0.01ha	Fluctuations in water levels (drainage) Scrub encroachment	Vegetation monitoring Hydrological monitoring	
		6410 <i>Molinia</i> Meadows	Present Cullen & Ballard	Unknown	Vegetation monitoring Hydrological monitoring	
2	SPA Habitat	A999 Wetlands	1118.64ha (entire site)	For the wetland habitats of fen and transition mire – fluctuations in water levels and scrub encroachment	Vegetation monitoring Hydrological monitoring	
3	pNHA Habitat	N/A	N/A	N/A	N/A	N/A

Lough Owel SAC Fen Restoration Plan

Level	Feature Type	Feature Name	Extent/ Population	Pressure/Threat affecting it	Restoration Measure On-Site	Restoration Measure Off- Site
4	European Priority Species	White clawed crayfish, marsh fritillary, Leisler's bat, pipistrelle, soprano pipistrelle, pine marten, fine bog-moss, birds: kingfisher, great northern diver, white-tailed eagle, coot, goldeneye, pochard, snipe.	Present	Scrub encroachment and fluctuations in water levels to habitats (Fen and transition mire) in which the species depend.	Vegetation monitoring Hydrological monitoring	
5	Nationally important species	All species listed in Table 4-2	Present	Scrub encroachment and fluctuations in water levels to habitats (Fen and transition mire) in which the species depend.	Vegetation monitoring Hydrological monitoring	
6	Habitats and species of local interest	Fossitt habitats listed in Section 4.1.1.2 and species listed in Section 4.1.2	Present	As above	Vegetation monitoring Hydrological monitoring	

4.4 *Impact Assessment Notes*

Restoration actions proposed for Lough Owel SAC aim to improve the ecological condition of sensitive fen habitats, particularly Annex I habitats 7140 Transition mires and 7230 Alkaline fens. These actions are designed to support favourable conservation status and enhance habitat resilience. However, potential impacts, both direct and indirect, must be carefully assessed to ensure compliance with Article 6(3) of the Habitats Directive.

The restoration measures proposed for Lough Owel are directly connected to the management of the SAC and inherently connected with maintaining the favourable conservation status of the 7140 Transition mires and 7230 Alkaline fens.

Potential Impacts

- **Habitat loss** – low risk - Restoration actions (e.g. drain blocking, scrub removal) are designed to enhance existing habitats rather than remove them. However, minor loss of degraded habitat may occur during scrub clearance or fencing installation. Where these are required, targeted removal/placement will be mapped to ensure minimal areas are impacted.
- **Habitat fragmentation** – low risk - Installation of fencing for targeted grazing could introduce physical barriers. However, if sensitively placed, this can be avoided.
- **Habitat degradation** – moderate risk - Potential degradation could occur if restoration measures are poorly implemented or monitored. This could occur where the control of overgrazing in eastern zones if fencing is ineffective. Where scrub removal without follow-up could lead to erosion or colonisation by invasive species or where drain blocking may alter hydrology in unintended ways if not based on robust baseline data.
- **Species disturbance** – low risk – Lough Owel supports a variety of bird species given its joint classification as an SPA site. Where proposed restoration works overlap with the breeding bird season of the qualifying features and other Annex I birds, there is the potential that minor disturbance impacts could arise from the operation of machinery and the movement of personnel.
- **Accidental pollution release** – very low risk - No chemical inputs are proposed. However, machinery use (if any) could pose a risk of fuel/oil leaks. This is mitigated by avoiding machinery in sensitive areas and using hand tools where possible. Furthermore, measures such as refuelling will be undertaken within designated areas of hardstanding outside of the SAC where any potential spill can be managed with a spill kit and avoid accidental release of pollutants into the ground.
- **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.

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 4-5 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 4-5: 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	All vehicles should undergo stream cleaning before site entry. Identified buffers on Invasive Alien Species (IAS) should be avoided during site preparation and restoration implementation. Consideration should be given to noting the presence of any IAS e.g. <i>Rhododendron</i> infestation, extent along with ecological oversight regarding works proximal to larger infestations.
Protection of European Sites	Any required mitigation measures to avoid potentially adverse effects on European Sites should be incorporated into an Environmental Management Plan or Checklist of Environmental Commitments. A suitably qualified ecologist should oversee implementation.
Protection of Sensitive Habitats	High sensitivity habitats should be protected from long term damage by the use of low-pressure vehicles. 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.

5 Key Pressures

The FRP considers pressures on Lough Owel SAC 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.

The Pilot Fen Survey (O'Neill et al., 2023) undertook a site evaluation and ranking which determined the conservation value of the three sites within the Lough Owel SAC: Bunbrosna, Culleen, and Ballard. The evaluation considered 15 criteria as outlined which included naturalness, uniqueness, 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 were subsequently used to guide the overall assessment of conservation status.

The conservation status assessment results for Lough Owel are summarised in Table 5-1.

Table 5-1: Conservation Status Assessment as per PFS 2020 (O'Neil et al., 2023)

OVERALL CONSERVATION STATUS ASSESSMENT				
Annex I habitat	Area	Structure & functions	Future prospects	Overall Conservation Status
7140	Favourable	Favourable	Favourable	Favourable
7210	Favourable	Not assessed	Not assessed	Not assessed
7230	Favourable	Unfavourable - Inadequate	Unfavourable - Inadequate	Unfavourable - Inadequate

The main pressures have previously been reported across the site in the Pilot Fen Survey (O'Neill et al., 2023). Table 5-2 shows the main pressures identified in each site, related to diffuse pollution, scrub encroachment, groundwater abstraction and drainage.

Table 5-2: Assessment of impacts of pressures on 7140 and 7210 Fen at Lough Owel SAC

Pressure Code	Pressure [sub-category]	Influence
A26	Agricultural activities generating diffuse pollution to surface or ground waters - Nutrient enrichment - smell of sewage effluent along the path leading to southeastern section of the site (i.e. Culleen). Small area of algae cover in southeastern area.	Negative
L02	Natural succession resulting in species composition change – scrub encroachment.	Negative

Pressure Code	Pressure [sub-category]	Influence
K01	Abstraction from groundwater, surface water or mixed water: Flooding (natural). Increasing level of water supply to Mullingar.	Negative
K02	Several historical drains exist on the three sites which appear not maintained and are infilled with vegetation.	Negative

5.1 *Field surveys of key pressures*

Following 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 in-situ walkovers is summarised below.

5.2.1 *Hydrology Pressures*

The following hydrological pressures were identified for Lough Owel sites (Table 5-3).

Table 5-3: Hydrology pressures for Lough Owel

Site	Hydrology pressure
Bunbrosna	Surface water levels at the Bunbrosna site are currently not maintained for the optimum water levels needed to sustain the habitats present.
Culleen	Drainage has been identified as a pressure affecting fen hydrology across the site. Where drains occur within the habitats and show localised effects, they have been flagged as pressures requiring targeted action.
Ballard	Surface water levels at the Ballard site are currently not maintained for the optimum water levels needed to sustain the habitats present.

5.2.2 *Nutrient Pressures*

The following nutrient pressures were identified within Bunbrosna, Culleen, and Ballard in Lough Owel (Table 5-4).

Table 5-4: Nutrient pressures for Lough Owel

Site	Nutrient pressure
Bunbrosna	Desktop and site visits confirm Nitrate pressure.
Culleen	No pressure identified in desktop study.
Ballard	Desktop indicates Nitrate and Phosphorus pressure from the western catchment.

5.2.3 Flora and fauna pressures

The following pressures are listed in order of their intensity and impact on the ecological receptors of Lough Owel SAC. These were determined from the review of historical information (PFS) and gathered from observations made along the Monitoring points carried out as part of this project.

- Drainage – evident by both historical drains and actively managed drains in Bunbrosna and Culleen. Drainage features alter water tables and disrupt flow, shifting fen vegetation patterns and promoting grass dominance. While some drains are infilled with vegetation, the influence upon the on-site hydrology remains.
- Scrub encroachment – evident by beech, birch and sycamore regeneration at various points throughout Bunbrosna and within Ballard. Given the proximity of commercial plantations to the site at Ballard, there is likelihood that conifer saplings present a threat for scrub encroachment.
- Absence of appropriate grazing management – At Culleen, rank grasses and scrub are replacing the open fen vegetation, leading to a shift in habitat structure and species composition. Undergrazing is leading to conditions where the fen specific flora is suppressed, hindering the regeneration of the open fen habitat.

Historical pressures, which were not evidenced during site walkover in 2025 are outlined below. It is important to note that whilst these pressures were not observed during site walkover, it does not necessarily mean they are not present and as such should be considered as potentially current.

- Pollution – As noted within the PFS at Culleen, a small area of algae was observed during site visit. No other signs of eutrophication or pollution was noted throughout the site.



Figure 5-1: Flora & Fauna Pressures mapped within Bunbrosna



Figure 5-2: Flora & Fauna Pressures mapped within Ballard and Cullen

6 Restoration Measures

6.1 Introduction

The restoration actions proposed by the FRP will help to maintain or improve the quality of existing areas of fens and improve the conditions that will allow an expansion of the area of fen. In some areas it must be recognised that restoration to fen 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 6.4, with detailed mapping of proposed measures illustrated in the maps provided in Appendix C.

The key pressures that were identified in Section 5 highlight a different focus of on-site restoration measures for each of the three sites within the Lough Owel SAC, namely drainage for the Culleen site, and monitoring for the Bunbrosna and Ballard sites.

6.2 Hydrology Measures

The primary aim of the hydrology restoration measures is to modify water levels closer to the surface and increase the duration and frequency of saturation across the wetland, without causing inundation. The restoration measures will be undertaken as part of the Tóchar Fen Restoration Project, and the follow-on long-term monitoring will be the responsibility of the NPWS.

6.2.1 On-site Hydrology Measures

6.2.1.1 Hydrological monitoring and analysis

Due to the competing water use at Lough Owel any reduction of flow will need to be quantified through a detailed hydrological analysis. Although the wetlands will benefit from reduced drainage, these measures will require further monitoring and engagement with wider stakeholders.

Hydrological analysis of the catchment

A longitudinal profile of Lough Owel to Lough Ennell will assist in nesting the wetlands within the wider catchment context.

A temporal and spatial analysis of the change in lake levels of Lough Owel, and its relationship with rainfall will assist in assessing the influence of lake levels and rainfall in the wider catchment.

Hydrological monitoring within wetlands

The hydrological analysis of each wetland will require a digital elevation model to identify drains. Once these have been defined then monitoring can target the surface water outflow to quantify the surface water inputs into Lough Owel from the sites and the downstream feeder canal.

Surface flow into/within the Bunbrosna site will need to be monitored at targeted drains (i.e. western perimeter drain). Groundwater levels will need to be monitored using piezometers within the wetland at targeted locations for habitat restoration.

Surface flow into/within/out of the Culleen site will need to be monitored at targeted drains (i.e. western drain that discharge into the canal feeder). Groundwater levels will need to be monitored using piezometers within the wetland at targeted locations for habitat restoration.

Monitoring Progress

Ongoing hydrogeological monitoring is proposed site-wide for Bunbrosna, Culleen, and Ballard. Monitoring requirements are detailed below.

- Groundwater, surface water and lake level monitoring in a network of piezometers at key locations within the site to monitor changes to water levels as a result of drainage management (if these measures are actioned).
- Rainfall and evaporation monitoring using site-specific or nearby stations

6.2.1.2 Installation of drain management measures

Bunbrosna:

The largest drain in the site is the boundary drain along the southwest margin of the wetland. It is wide and deep and is likely drying out the site. The target habitat for hydrological measures is alkaline fen. From an ecological point of view, it would be beneficial to block the southwestern drain to increase the target alkaline fen habitat within the site. Blocking this drain could have neutral to positive effects within the site. Positive effects of rewetting include reducing the abundance of species that benefit from drainage such as bramble and *Myrica*, it could restrict opportunities for the spread of beech and other non-native species, and it could increase the heterogeneity of vegetation on site, which is currently fairly uniform.

Culleen:

There is a drain identified from site visits and the LIDAR drainage analysis in the Northeastern drainage section of the site, running perpendicular to the Royal Canal feeder (NE-SW), and flowing into Lough Owel. Blocking this drain could rewet the Eastern section of Culleen and increase the Fen habitat in this area.

Ballard:

The Ballard site was not visited due to access issues. Therefore, the drain management is to be confirmed.

6.2.2 Off-site Hydrology Measures

6.2.2.1 Catchment management for Lough Owel

Under the Lough Ennell Catchment Management Plan, it was indicated that Lough Owel be included as an extension of the Lough Ennell Catchment as it is an important surface water contributor. It is recommended that this is formalised with stakeholders and that the Lough Owel catchments and fens be included within the Lough Ennell Catchment Management Implementation Plan.

6.2.2.2 Recommend engagement with Coillte

It is recommended to engage with Coillte on their management of the site adjacent to Ballard, in particular a focus on blocking the forestry drains within their site. Ideally, the forestry site would be restored to a wetland habitat following the end of the forestry's lifespan.

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. For water quality the target is to maintain, or where necessary restore, appropriate water quality, particularly pH and nutrient levels, to support the natural structure and functioning of fen habitat.

6.3.1 Water quality monitoring

Refer to water quality monitoring points identified for Bunbronsna, Culleen and Ballard.

On-site nutrient measures include the monitoring of water quality within the site to assess the effectiveness of proposed off-site nutrient measures and identify any changes in water quality within the site which may require a modification of measures.

Monitoring of habitats and drainage channels for water quality parameters including nutrients (nitrate and phosphate), electrical conductivity and pH is proposed. Locations are to include the main surface water inputs upstream and downstream of the sites.

6.3.2 On-site Fen Nutrient Measures

Continued engagement with landowner at Culleen to ensure land use does not change to more intensive agriculture than the current organic farming and nutrients are not introduced.

6.3.3 Off-site Nutrient Measures

6.3.3.1 Catchment nutrient management

Targeted nutrient control measures should be implemented across the catchment to address both phosphate and nitrogen pathways. PIP maps and field water quality data suggest that

Phosphorus runoff may be an issue in Ballard. Therefore, measures to address phosphate runoff should consider the western catchment and overland flow pathways in the site.

Nitrate is a greater concern in Bunbrosna and Ballard sites where the ground conditions are characterised by freely draining soils and the farming activity is more intensive. Nitrate is likely to enter the fen through groundwater pathways. Measures proposed to address excess nitrate entering the habitat should focus on the groundwater catchment providing flow to the west of Bunbrosna and Ballard sites.

Measures outlined under the Farming for Water EIP¹² or novel approaches under NPWS Farm Plans¹³ are categorised depending on if they address the source, pathway or receptor. Suitable measures for Lough Owel may include:

- **Source control measures:**
Farmer Training Course for farmers in the fen catchments.
Nutrient Management Plan to support optimal slurry application and nutrient uptake, avoiding overapplication for Bunbrosna and Ballard groundwater and surface water catchments.
- **Pathway interception measures:**
Linear Riparian Buffer Zones (grassland), potentially appropriate along the south-western part of Ballard to prevent phosphate runoff.

6.4 Vegetation Measures

6.4.1 On-site Vegetation Measures

Proposed measures to address the identified pressures and threats are:

Priority	Measure	Description	Responsibility
1	Drainage management	Drainage management will benefit the fen vegetation. Appropriately placed drain blocking measures will increase the overall water table to a defined area. This is anticipated to encourage the growth of fen and mire vegetation species. The locations of any future drain	NPWS Outside the Tóchar fen restoration programme

¹² The "[Farming for Water](#)" project provides funding to help farmers implement 43 measures designed to protect water quality by reducing pollution from nitrates, phosphorus, sediment, and pesticides. The project is an initiative that aims to reduce pollution from farming practices in Ireland

¹³ The [NPWS Farm Plan Scheme](#) trials novel approaches to farming for the environment, to safeguard particular sites, habitats and species, and to work towards meeting conservation measures required under the EU Birds and Habitats Directives. Role players are the NPWS through the Agri-Ecology Unit, the regional staff of the NPWS and the farm participant.

Priority	Measure	Description	Responsibility
		blocks will first be informed by the proposed hydrological and ecological monitoring.	
2	Conservation grazing	For Culleen, the ecological monitoring, post drain blocking will determine whether light grazing is necessary on-site. For habitat areas where drain blocking has not occurred, these may not experience a shift in hydrological condition that combats the succession of grass species. As such light conservation grazing by cattle breeds suitable for wetland habitats (e.g. Kerry Blue, Irish Moiled or Belted Galloway) would be most suitable. Species choice should be made following review of the ecological monitoring data and following consultation with Department of Agriculture, Food and The Marine (DAFM) or Teagasc officials and the landowner. Conservation grazing is not yet recommended for Bunbrosna or Ballard.	NPWS Outside the Tóchar fen restoration programme
3	Scrub removal	For application in Culleen and Bunbrosna, scrub removal may be necessary following on-going monitoring of the ecological condition of habitats on site, post drain blocking (should it occur). It may be necessary to carry out the removal of some unfavourable species (e.g. beech sapling regeneration in Bunbrosna) via mechanical or hand-tool means. Ecological monitoring results will inform the most suitable method and type and its applicability.	NPWS Outside the Tóchar fen restoration programme

7 Additional consideration

7.1 Drainage Management Plan

Lough Owel is part of the Brosna Arterial Drainage Scheme managed by OPW. Consultation is required with OPW on the maintenance and function of the C45(1) canal of the East Region Brosna Scheme.

The preliminary drainage management plan for Lough Owel 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.

Fen sites are typically located on relatively flat slopes at the base of catchments, which are lower risk than Blanket Bogs which occur at higher elevations including steep slopes and higher rainfall.

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 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.

7.2.1 GSI Landslide Susceptibility Mapping

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 results from this landslide susceptibility map for Lough Owel SAC are presented in Figure 7-1. This highlights that there are no known historical landslides within the SAC; however, there are known landslides in the surrounding area, most notably to the north of the SAC boundary (as illustrated in Figure 7-1). While the data from the GSI is indicative only, it highlights that there is moderate to moderately high risk of a landslide within several areas outside Lough Owel SAC pointing to the need for site-specific assessments.

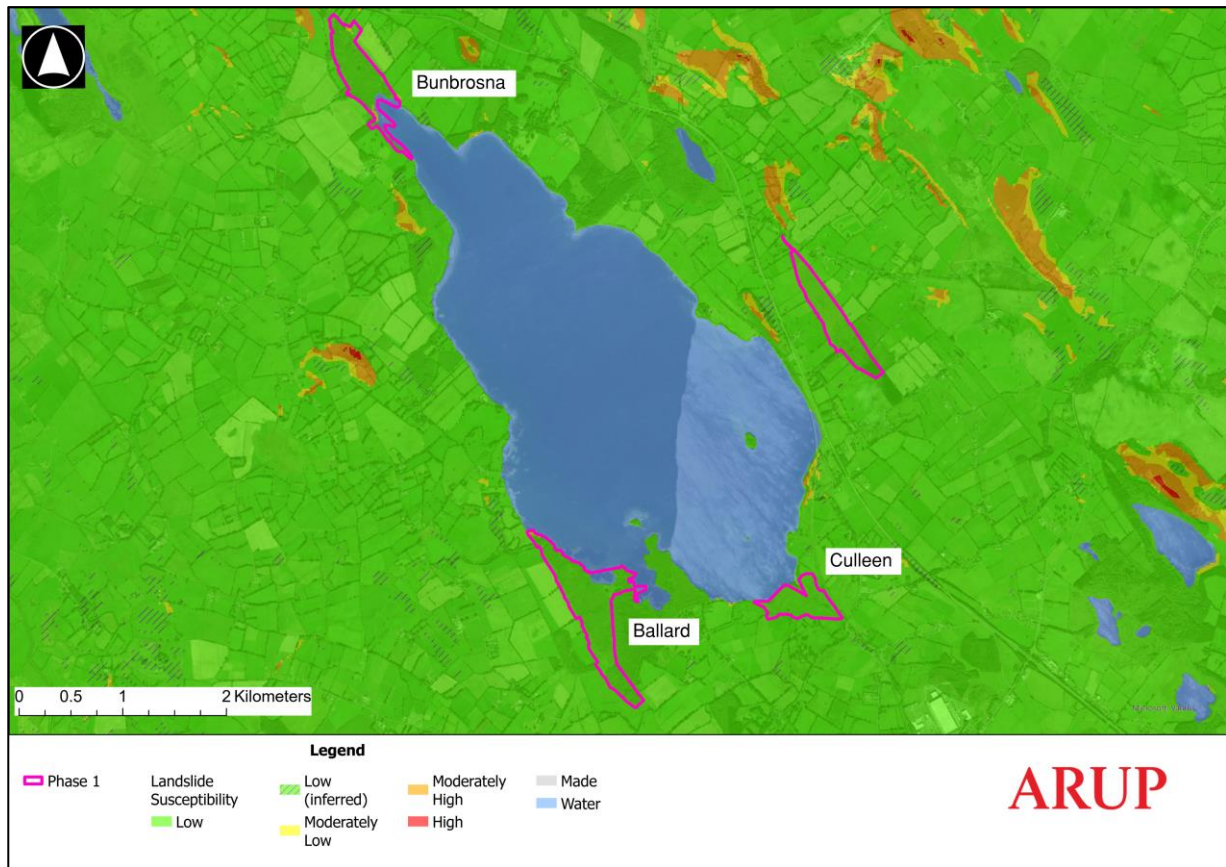


Figure 7-1: Geological Survey of Ireland Landslide Susceptibility mapping for Lough Owel SAC

7.3 Archaeology

For Bunbrosna there are no historical monuments within the site (Figure 7-2). However, there are several Ringforts to the northeast and east of the site. For Culleen there are two Fulacht fias located within the site, one is within the transition mire habitat (Figure 7-3). To the northeast of the site there are two Ringforts located along the train line. For Ballard there are standing stones located to the north of the site and a Ringfort is located west of the site (Figure 7-4). There are no historical monuments located within the site



Figure 7-2: Archaeological sites at Bunbrosna (NMS, 2025)

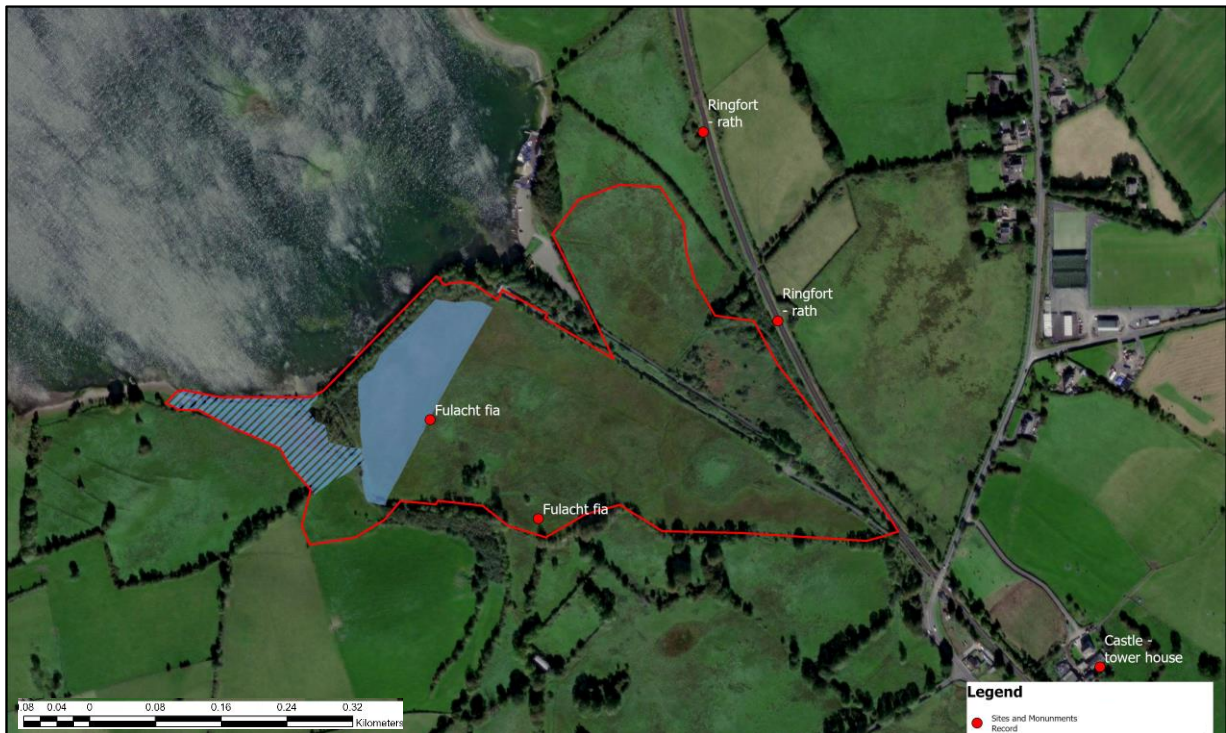


Figure 7-3: Archaeological sites at Culleen (NMS, 2025)



Figure 7-4: Archaeological sites at Ballard (NMS, 2025)

8 Summary of Fen Restoration Plan Actions

Prior to proceeding with the implementation of the restoration actions outlined in the FRP, consultation with landowners and key stakeholders with an interest in the site is essential (Figure 7-1). 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	Site	Stakeholder		Description
On-site	All sites	Other	Landowners	Bunbrosna; Culleen; Ballard
	All sites	National	Uisce Éireann	Service lines within 1km of site.
	Culleen, Bun Brosna	National	ESB	Electricity lines within 1km of site.
	Culleen	National	National Monument Services / CC	Archaeology
Off-site	Bun Brosna	National	OPW	Sites are part of the Brosna Arterial Drainage Scheme
	Ballard	National	Coillte	Forestry to the east of site.
	Culleen	National	Waterways Ireland (Royal Canal)	Canal from the site connects to the Royal Canal.
	Culleen	National	Irish Railway	Railway line within 1km of site.
	Culleen	Local	Fish farm	Fish farm water abstraction downstream of Culleen
	All sites	Local	LAWPRO	Lough Owel not a priority for LAWPRO targeted measures.
	All sites	National	Uisce Éireann	Lough Owel used for drinking water under the Mullingar Water Supply Scheme.
Capacity building	All sites	National	NPWS	NPWS engaging in community education and events
	All sites	Local	LAWPRO	LAWPRO team engages with farmers through Farming for Water EIP.

This section provides the summary of the Fen Restoration Plan Actions for Lough Owel (Table 8-2).

Table 8-2: Implementation plan for Lough Owel Fen Restoration

	Activity	Location	Monitoring indicator	Timeframe	Key role player			Possible funding source
					National/Regional	Local	Other	
1	Required preliminary actions							
1.1	Screening for Appropriate Assessment report.							
	This report must outline all restoration measures that shall be undertaken as part of the project at Lough Owel SAC. The Screening for AA must conclude whether a likely significant effect is anticipated to arise from the implementation of the project.	Sitewide	Screening report	Pre-restoration	NPWS	Westmeath C.C		NPWS
1.2	Drainage management plan							
	Consultation with OPW on the drainage management plan is required to ensure compliance with legislation and authority objectives.	Sitewide	Drainage management plan	Pre-restoration	NPWS OPW		Arup	Within Tochar project scope
	Consultation with stakeholders on competing water uses such as abstraction.	Sitewide	Drainage management plan	Pre-restoration	NPWS Uisce Eireann Waterways Ireland		Arup	Within Tochar project scope
1.3	Archaeological assessment							
	Consultation with Westmeath County Council on the archaeology is required to ensure	Sitewide	Archaeological assessment report	Pre-restoration	NPWS	Westmeath C.C	Arup	Within Tochar project scope

Lough Owel SAC Fen Restoration Plan

	Activity	Location	Monitoring indicator	Timeframe	Key role player			Possible funding source
					National/Regional	Local	Other	
	compliance with legislation and local authority objectives.							
1.4	Topographical assessment							
	All three sites require a Lidar survey to help identify drainage on site.	Sitewide	Lidar survey complete	Pre-restoration	NPWS		Surveyor	Within Tochar project scope
2	Enabling Works							
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. Surveys should also include identifying habitats for <i>Vertigo geyeri</i> which are within the areas for restoration measures. Where <i>Vertigo geyeri</i> habitats overlap with areas for restoration, alternative measures will be discussed with the project team.	Sitewide	ECoW Report	Pre-restoration	NPWS		Arup	Within Tochar project scope
2.2	Implementation of Mitigation Measures							
	Ecological Impact Assessment Considerations – identification of necessary mitigation measures. Such measures may include, but are not limited to, the utilisation of bog mats for machinery to access in and out of the site to avoid soil compaction, soil impacts, risk of siltation.	Sitewide	ECoW Report	Pre-restoration			Arup	Within Tochar project scope

Lough Owel SAC Fen Restoration Plan

[illegible]

Lough Owel SAC Fen Restoration Plan

	Activity	Location	Monitoring indicator	Timeframe	Key role player			Possible funding source
					National/Regional	Local	Other	
	Installation of drain blockers The drain from the western perimeter of the wetland could be blocked to slow water loss.	Bunbrosna - Drain Locations TBC	Site installation records	Long-term	NPWS to facilitate site access Waterways Ireland Uisce Eireann	Landowner		Future funding
	Installation of drain blockers The drain from the eastern part of the wetland could be blocked to slow water loss.	Culleen - Drain Locations TBC	Site installation records	Long-term	NPWS to facilitate site access Waterways Ireland Uisce Eireann	Landowner		Future funding
3.3	Vegetation measures							
	Vegetation monitoring shall include ecological surveys at fixed points throughout the site to identify habitats, vegetation communities, pressures and threats.	Culleen Ballard Bunbrosna	Vegetation surveys	Long-term	NPWS	NPWS	Arup	Year 1: Within Tóchar project scope Year 2+: NPWS funding.
	Proposed measures to address scrub encroachment include: - Removal of scrub (birch etc.,) via hand tools (chainsaw); - Carrying out scrub clearance following ecological monitoring post drain blocking; and	Culleen	Site records / habitat surveys	Restoration 2026	NPWS to facilitate site access		Arup / Contractor	Within Tóchar project scope

Lough Owel SAC Fen Restoration Plan

	Activity	Location	Monitoring indicator	Timeframe	Key role player			Possible funding source
					National/Regional	Local	Other	
	3. Implementing conservation grazing measures on site following ecological monitoring post drain blocking							
4	Off-Site Restoration measures							
4.1	Hydrology measures							
	Catchment management for Lough Owel Ensure that the Lough Owel catchments and fens are included within the Lough Ennell Catchment Management Implementation Plan.	Lough Owel and Lough Ennell catchments	Fens included in Lough Ennell CMP	Long-term	NPWS, UE, LAWPRO			NPWS
	Avoid creating new drains Ensure FRP is included in the planning for the forestry land (zoned as a forest for nature) that will need to be restored. Ensure drains are managed and no new drains are dug.	Coillte land near Ballard	Coillte land managed with fen in mind	Long-term	NPWS, Coillte			Coillte
4.2	Nutrient measures							
	Catchment nutrient management Targeted nutrient control measures should be implemented for Bun Brosna Measures may include source control measures (Farmer Training Course for farmers in the fen	Surrounding landowners for Bunbrosna	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

Lough Owel SAC Fen Restoration Plan

	Activity	Location	Monitoring indicator	Timeframe	Key role player			Possible funding source
					National/Regional	Local	Other	
	catchment; Nutrient Management Plan; Nitrogen Surplus) and pathway interception measures (Linear Riparian Buffer Zones: Grassland).							
	Catchment nutrient management Targeted nutrient control measures for Ballard. Measures may include source control measures (Farmer Training Course for farmers in the fen catchment; Nutrient Management Plan; Nitrogen Surplus) and pathway interception measures (Linear Riparian Buffer Zones: Grassland).	Surrounding landowners for Ballard	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							
	Rainfall and evaporation monitoring using site-specific or nearby stations. Align with Uisce Eireann.	All sites – Mullingar weather station	Rainfall and evaporation levels	Long-term	Uisce Eireann			NPWS
	Lake level monitoring through GSI.	Lough Owel	Water level	Long-term	GSI, UE			NPWS
	Site specific groundwater and surface water monitoring in a network of piezometers and standpipes at key locations within the site to monitor changes to water levels.	Brunbosna	Water level	Long-term	NPWS to facilitate site access		Landowners	NPWS

Lough Owel SAC Fen Restoration Plan

	Activity	Location	Monitoring indicator	Timeframe	Key role player			Possible funding source
					National/Regional	Local	Other	
	Site specific groundwater and surface water monitoring in a network of piezometers and standpipes at key locations within the site to monitor changes to water levels.	Culleen	Water level	Long-term	NPWS to facilitate site access		Landowners	NPWS
	Site specific groundwater and surface water monitoring in a network of piezometers and standpipes at key locations within the site to monitor changes to water levels.	Ballard	Water level	Long-term	NPWS to facilitate site access		Landowners	NPWS
5.2	Nutrient monitoring							
	Ongoing monitoring of habitats and drainage channels for water quality parameters.	Bunbrosna	Nutrients (Nitrate and phosphate), electrical conductivity and pH	Long-term	NPWS			NPWS
	Ongoing monitoring of habitats and drainage channels for water quality parameters.	Ballard	Nutrients (Nitrate and phosphate), electrical conductivity and pH	Long-term	NPWS			NPWS
5.3	Vegetation monitoring							
	Habitat condition assessments will be included to track restoration progress.	Culleen	Habitat condition	Long-term	NPWS			NPWS
	Habitat condition assessments will be included to track restoration progress.	Bunbrosna	Habitat condition	Long-term	NPWS			NPWS

Lough Owel SAC Fen Restoration Plan

	Activity	Location	Monitoring indicator	Timeframe	Key role player			Possible funding source
					National/Regional	Local	Other	
	Habitat condition assessments will be included to track restoration progress.	Ballard	Habitat condition	Long-term	NPWS			NPWS
6	Capacity building and training							
	Public meeting: To engage stakeholders on developments and results from the restoration measures.			Long-term	NPWS			NPWS
	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

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Appendix A – Non-Technical Summary

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan Non-Technical Summary			
Site Name	Lough Owel	NFS site no.	1005
County	Westmeath	Designations	
Fen habitats present (area)	Cladium fen [7210] Alkaline Fen [7230]	Species of note	White-clawed crayfish, marsh fritillary red hemp-nettle (<i>Galeopsis angustifolia</i>), and round-leaved wintergreen.
Site Description			
Lough Owel SAC is located 4 km north-west of Mullingar, Co. Westmeath. The site is a Special Area of Conservation (SAC) for the Hard water lake [3140], Transition mires [7140], Alkaline fens [7230], and the White-clawed crayfish (<i>Austropotamobius pallipes</i>) species [1092], as listed on Annex I/II of the E.U Habitats Directive. For the purpose of this study, Lough Owel has been distributed into three sites, namely Bunbrosna in the northwest, Culleen in the southeast, and Ballard in the southwest. There were no Annex 1 fen habitats mapped within the Bunbrosna site. The site mostly consists of wet willow alder-ash woodland, with a localised area of wet grassland to the northeast, a small limestone marl lake in the centre, a localised area of wet grass grassland on the southeastern margin and a reed and large sedge swamp on the shoreline of Lough Owel. There were two Annex 1 habitats mapped within the Culleen site, 7230 and 4140 in the western portion of the site. The rest of the site constitutes wet grassland. The Pilot Fen Survey mapped a mosaic of habitats within the Ballard site consisting of limestone/ marl lake, wet grassland, wet heath, and reed and large sedge swamps. The habitat maps are presented in Figure 1.			
Conceptual Site Model (CSM)			
The elevation at the site ranges from 95 mOD to 105 mOD, and the topography is characterized by drumlins oriented in a northwest to southeast direction surrounding Lough Owel with topography gently sloping towards the Lough. The inferred ground conditions consist of subsoils constituting peat, underlain by till and is overlying a Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones (LI). The CSMs are presented in Figure 2.			
Key Pressures			
Hydrology Pressures	Surface water levels at the Bunbrosna and Ballard sites are currently not maintained for the optimum water levels needed to sustain the habitats present. Drainage has been identified as a pressure affecting fen hydrology across the Culleen site.		

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan Non-Technical Summary	
Nutrient Pressures	Desktop and site visits confirm Nitrate pressure for Bunbrosna. Desktop indicates Nitrate and Phosphorus pressure from the western catchment for Ballard.
Ecology Pressures	Scrub encroachment – evident by beech, birch and sycamore regeneration at various points throughout Bunbrosna and within Ballard. Given the proximity of commercial plantations to the site at Ballard, there is likelihood that conifer saplings present a threat for scrub encroachment. Absence of appropriate grazing management – At Culleen, rank grasses and scrub are replacing the open fen vegetation, leading to a shift in habitat structure and species composition. Undergrazing is leading to conditions where the fen specific flora is suppressed, hindering the regeneration of the open fen habitat. As noted within the PFS at Culleen, a small area of algae was observed during site visit. No other signs of eutrophication or pollution was noted throughout the site.
Objective of Restoration Plan	
The objective of the Lough Owel Fen Restoration Plan is to maintain or improve the quality of existing areas of fens and improve the conditions that will allow an expansion of the area of fen. In some areas it must be recognised that restoration to fen habitat will not be possible or preferable, and the objective is to improve the habitat condition. While full-scale hydrological restoration aimed at re-establishing the site's former lake levels would offer potential ecological gains for aquatic species, this would result in the loss of existing fen areas.	
Restoration Measures	
Hydrology Measures	On site measures: - Hydrological monitoring and analysis of catchment and wetlands - Installation of drain management measures (to be determined) Off-site measures: - Catchment management for Lough Owel - Engagement with Coillte for Ballard site
Nutrient Measures	On site measures: - Water quality monitoring - Continued sustainable land practices within Culleen site Off-site measures:

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan Non-Technical Summary	
	Catchment nutrient management
Ecology Measures	On site measures: - Conservation grazing - Scrub removal
Monitoring	
Hydrology Monitoring	Groundwater and surface water monitoring within the fen as well as lake level and rainfall monitoring.
Nutrient Monitoring	Ongoing monitoring of habitats and drainage channels at Bunbrosna and Ballard for water quality parameters within the fen.
Ecology Monitoring	Habitat condition assessments to track restoration progress.
More information	
Fen Restoration Plan Report (provide url) Tóchar website: https://www.tocharwetlands.ie/fen-restoration/	

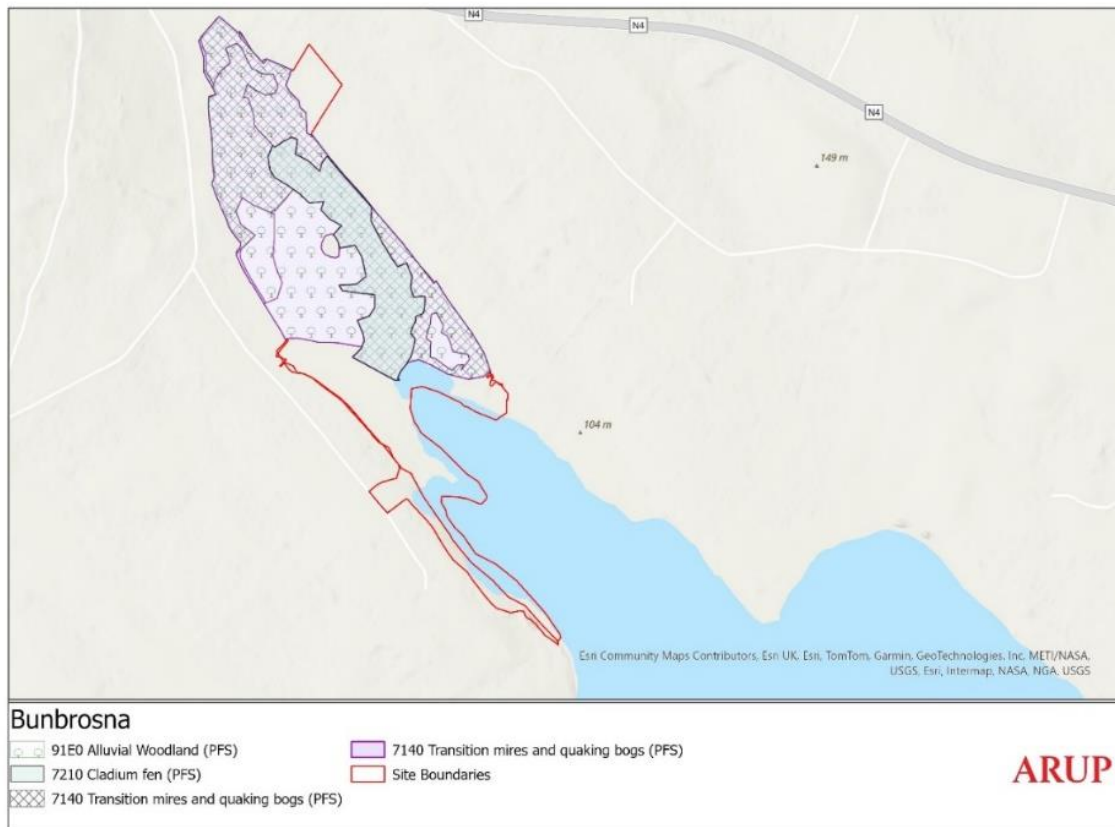


Figure 1a: Site Habitat Map for Bunbrosna

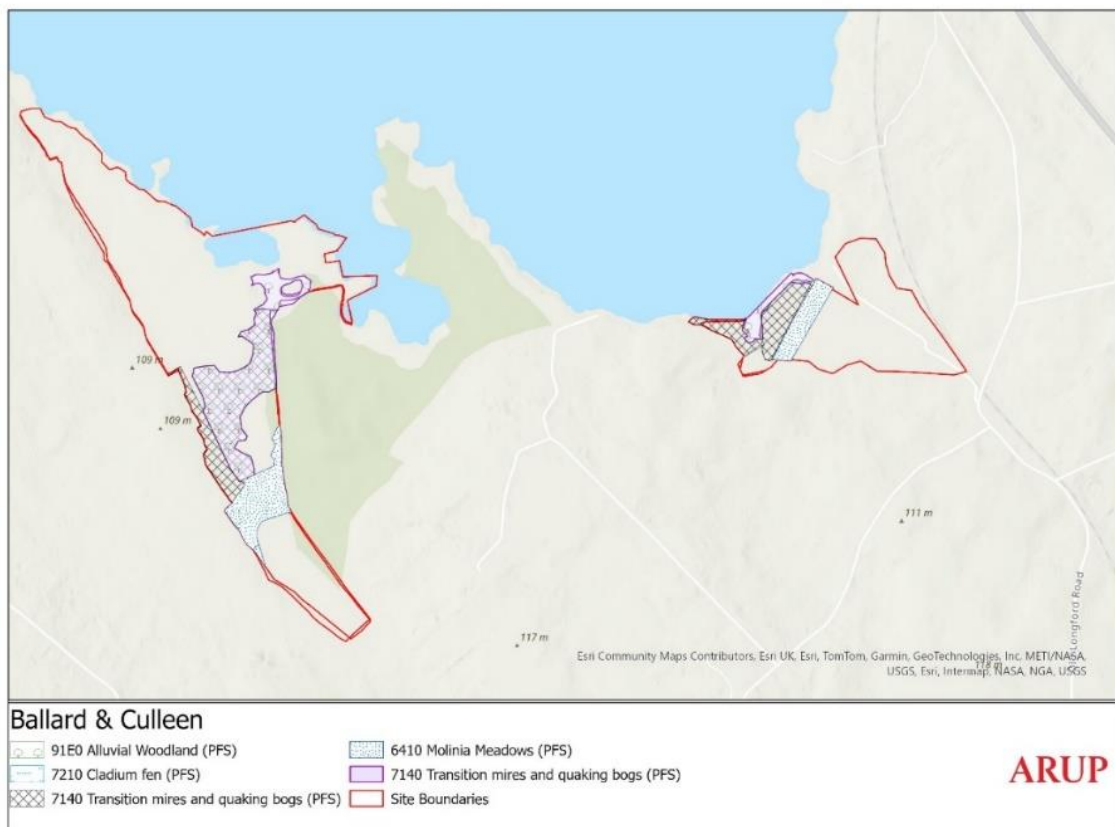


Figure 1b: Site Habitat Map for Culleen and Ballard

Lough Owel: Bunbrosna

Westmeath County

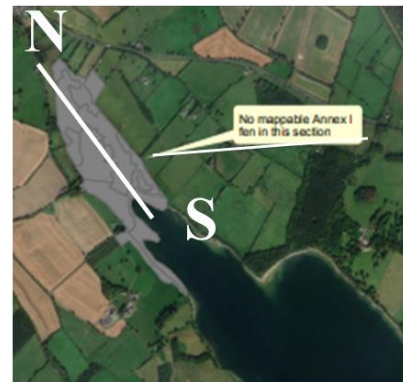
Lower Shannon 25A

WETMEC 6: Surface water percolation floodplain

Key:

	Wetland drains		Wetland vegetation
	Spring		

Cross section:



Water input/output:

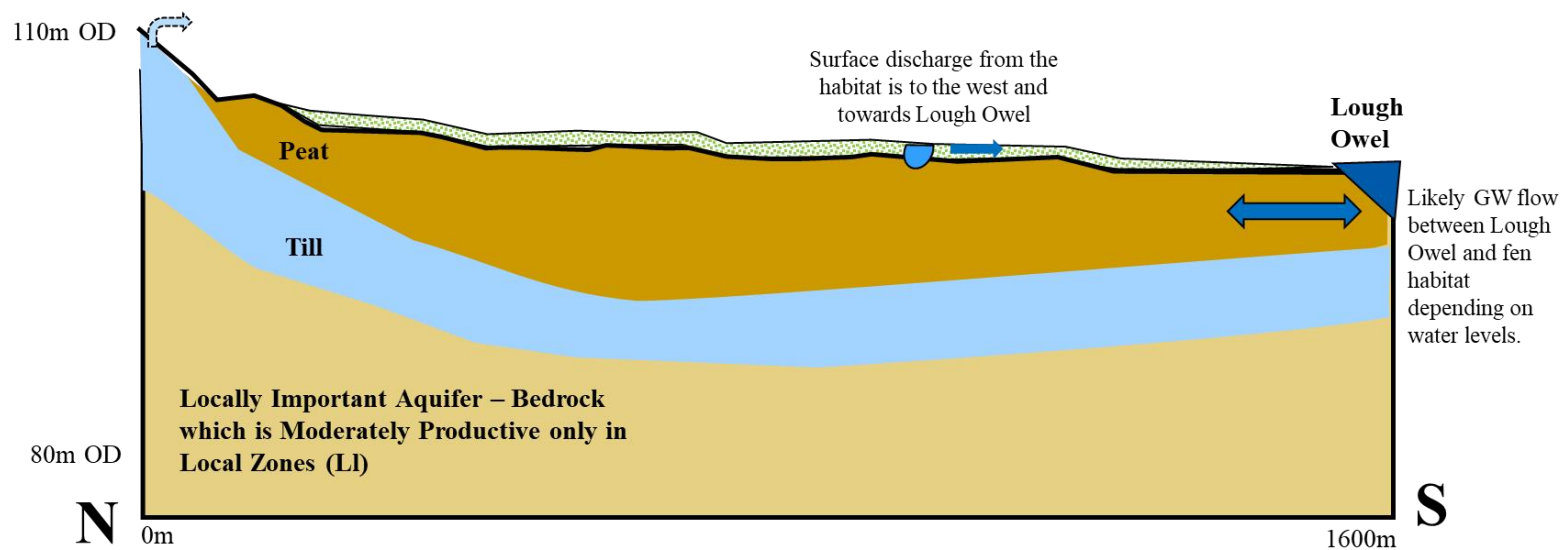
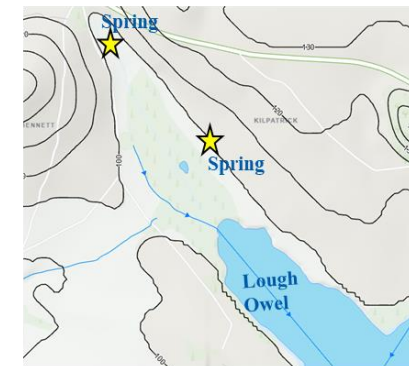


Figure 2a: Conceptual Site Model for Bunbrosna

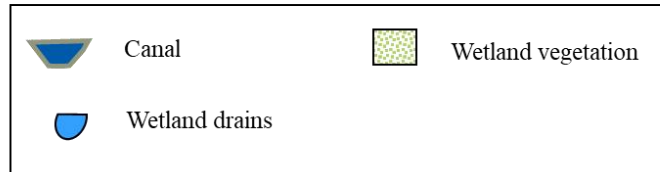
Lough Owel: Culleen

Westmeath County

Lower Shannon 25A

WETMEC 6: Surface water percolation floodplain

Key:



Cross section:

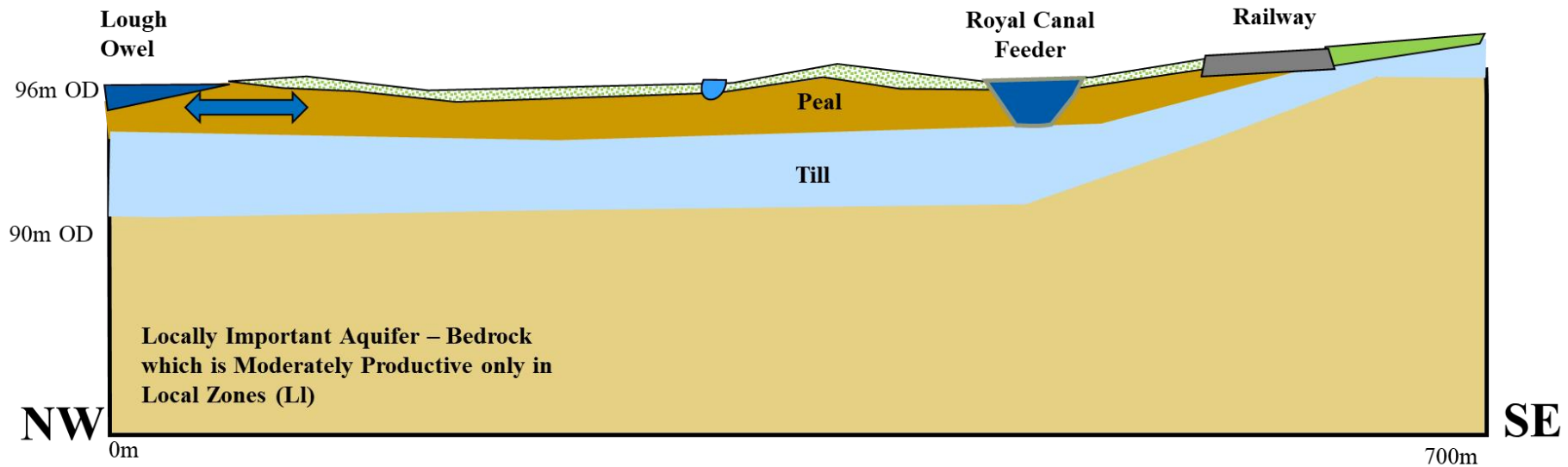


Figure 2b: Conceptual Site Model for Culleen

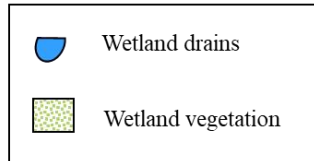
Lough Owel: Ballard

Westmeath County

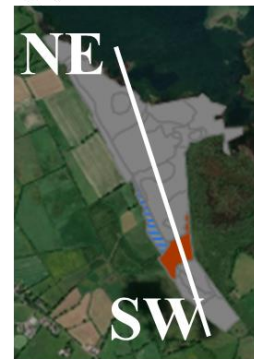
Lower Shannon 25A

WETMEC 6: Surface water percolation floodplain

Key:



Cross section:



Water input/output:

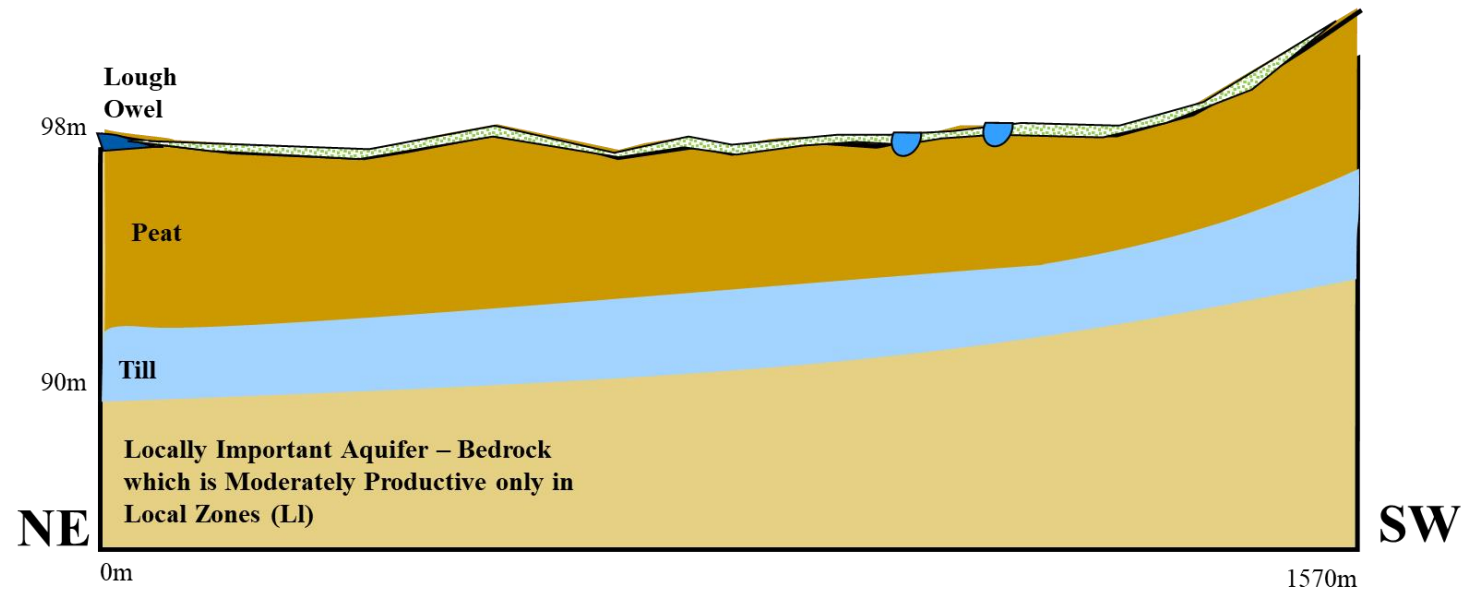
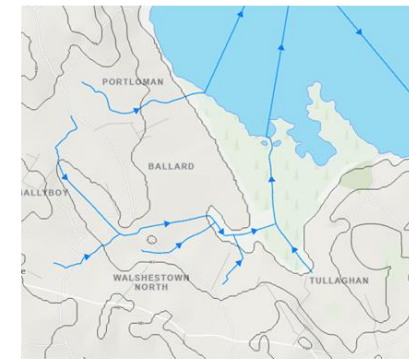


Figure 2c: Conceptual Site Model for Ballard

Appendix B – Ecological Survey Maps

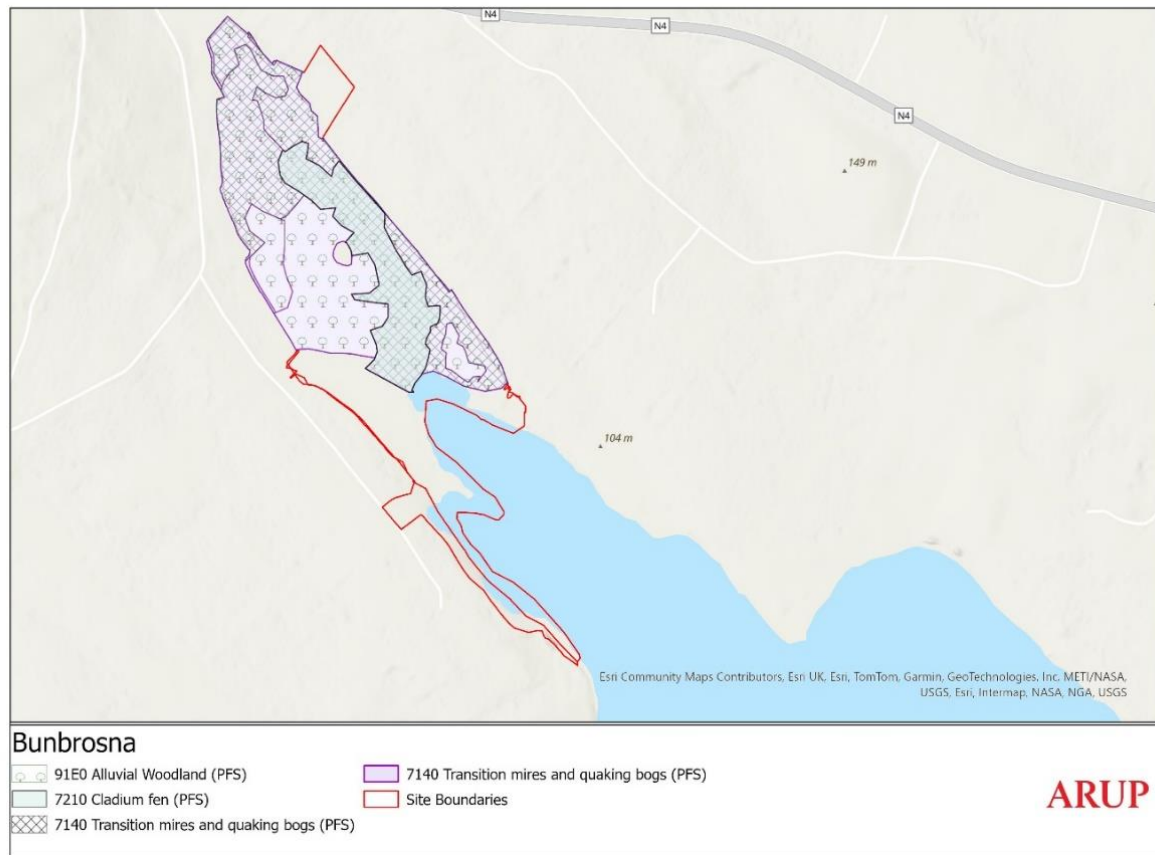


Figure B-1: Annex I Habitats recorded during the PFS present at Bunbrosna

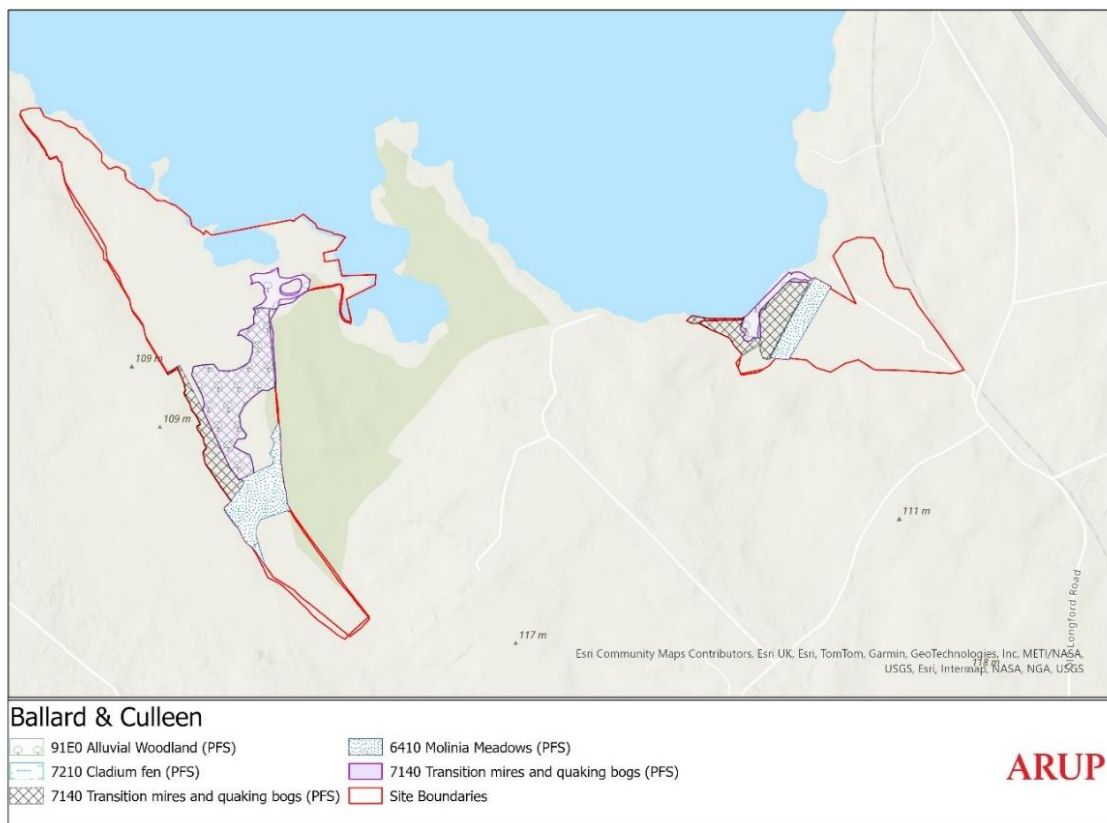


Figure B-2: Annex I Habitats recorded during the PFS present at Ballard (West) and Culleen (East)

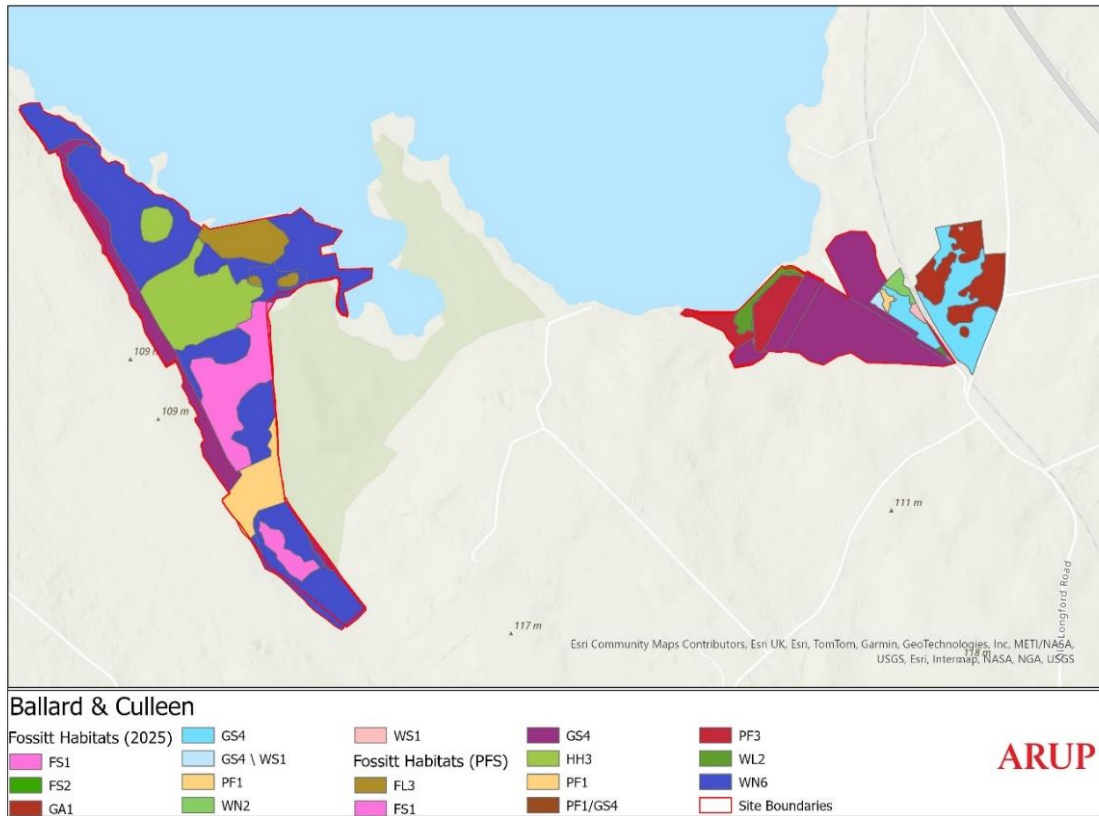


Figure B-3: Fossitt Habitats recorded during the PFS and 2025 Ecological walkover (Culleen only) at Ballard (West) and Culleen (East).

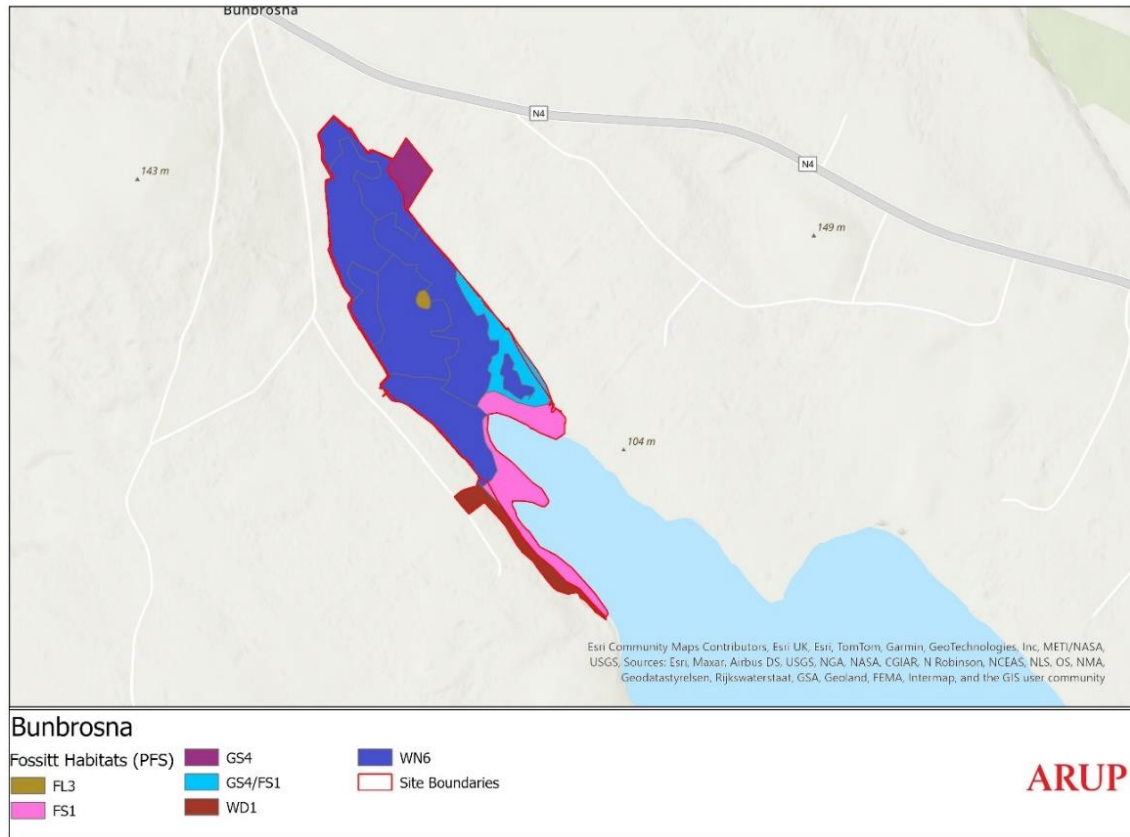


Figure B-4: Fossitt habitats recorded during the PFS at Bunbrosna

Appendix C – Restoration and Monitoring Map**Table C1: Long-term monitoring points for fen restoration at Bunbrosna**

Point	Measure	Objective	Timeframe	Frequency of monitoring	Monitoring indicator
Gw_1	Hydrological	Monitoring groundwater levels and quality	Long-term	Quarterly I ¹⁴ for year 1 Annual for year 2-5	Groundwater level near western drain
Gw_2					Groundwater level near western drain
Gw_3					Groundwater level near lake
Sw_1		Monitoring of surface water levels and quality	Long-term	Quarterly for year 1 Annual for year 2-5	Water level and quality at western drain
Sw_2					Water level and quality at western drain

Table C2: Long-term monitoring points for fen restoration at Culleen

Point	Measure	Objective	Timeframe	Frequency of monitoring	Monitoring indicator
Gw_1	Hydrological	Monitoring groundwater levels and quality	Long-term	Quarterly for year 1 Annual for year 2-5	Groundwater level near edge of lake
Gw_2					Groundwater level near central wetland
Gw_3					Groundwater level near eastern wetland
Sw_1		Monitoring of surface water levels and quality	Long-term	Quarterly for year 1 Annual for year 2-5	Water level and quality at canal
Sw_2					Water level and quality at small drain

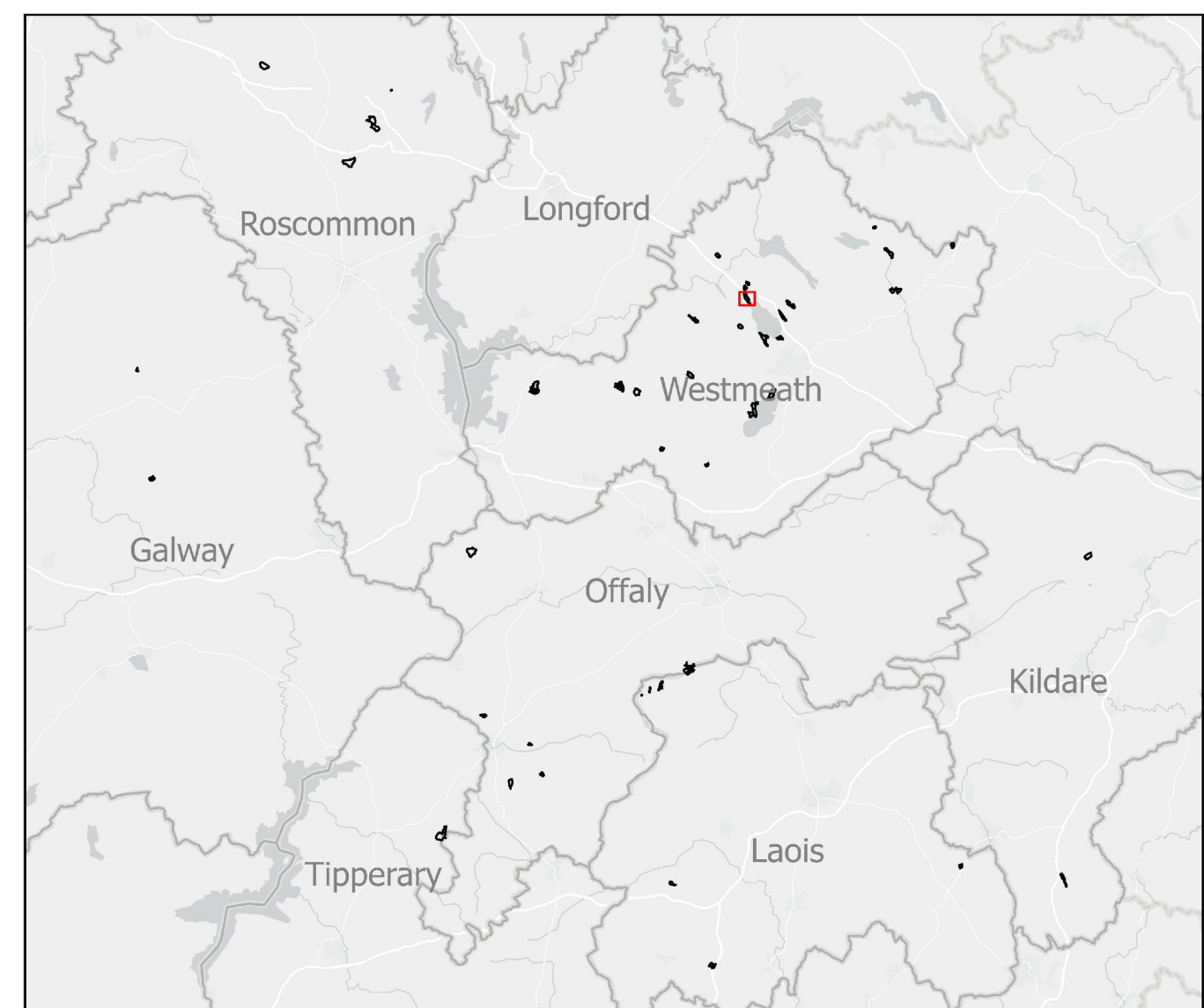
¹⁴ Seasonal: once in winter and once in summer to represent a hydrological year

Point	Measure	Objective	Timeframe	Frequency of monitoring	Monitoring indicator
					entering canal on the east

Table C1: Long-term monitoring points for fen restoration at Ballard

Point	Measure	Objective	Timeframe	Frequency of monitoring	Monitoring indicator
Gw_1	Hydrological	Monitoring groundwater levels and quality	Long-term	Quarterly for year 1 Annual for year 2-5	Groundwater level within fen habitat
Gw_2					Groundwater level near northern wetland
Gw_3					Groundwater level near central wetland
Sw_1		Monitoring of surface water levels and quality	Long-term	Quarterly for year 1 Annual for year 2-5	Water level and quality at Ballard stream
Sw_2					Water level and quality at drain
Sw_3					Water level and quality at Farrow stream
Sw_4					Water level and quality at Walshestown stream

Fen Restoration - Lough Owel (North West) Bunbrosna - Phase 1



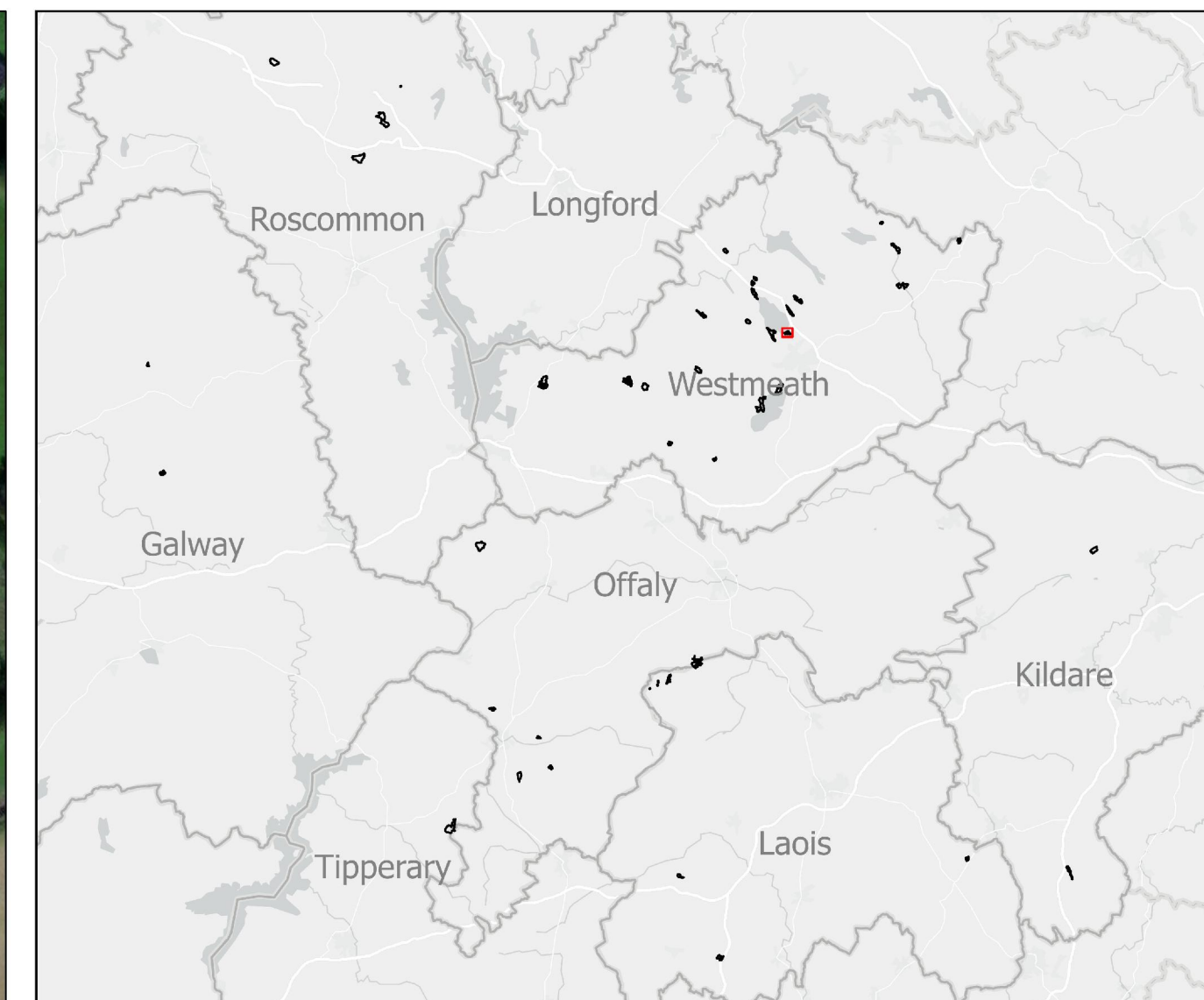
- Legend**
- Site Boundary
 - Drains
 - Water River Network (OSI)
 - Land Parcels
- Monitoring**
- Ecology monitoring
 - Groundwater monitoring
 - Surfacewater monitoring

0 50 100 Meters

Scale: 1:3,000 | Page Size: A3
Date: 22/04/2026

Map Credits: Microsoft, Vantor, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Fen Restoration - Lough Owel (South East) Culleen - Phase 1



Legend

- Site Boundary
 - Drains
 - Water River Network (OSI)
 - Land Parcels
- ## Monitoring
- Ecology monitoring
 - Groundwater monitoring
 - Surfacewater monitoring
- ## Restoration
- Potential Conservation Grazing

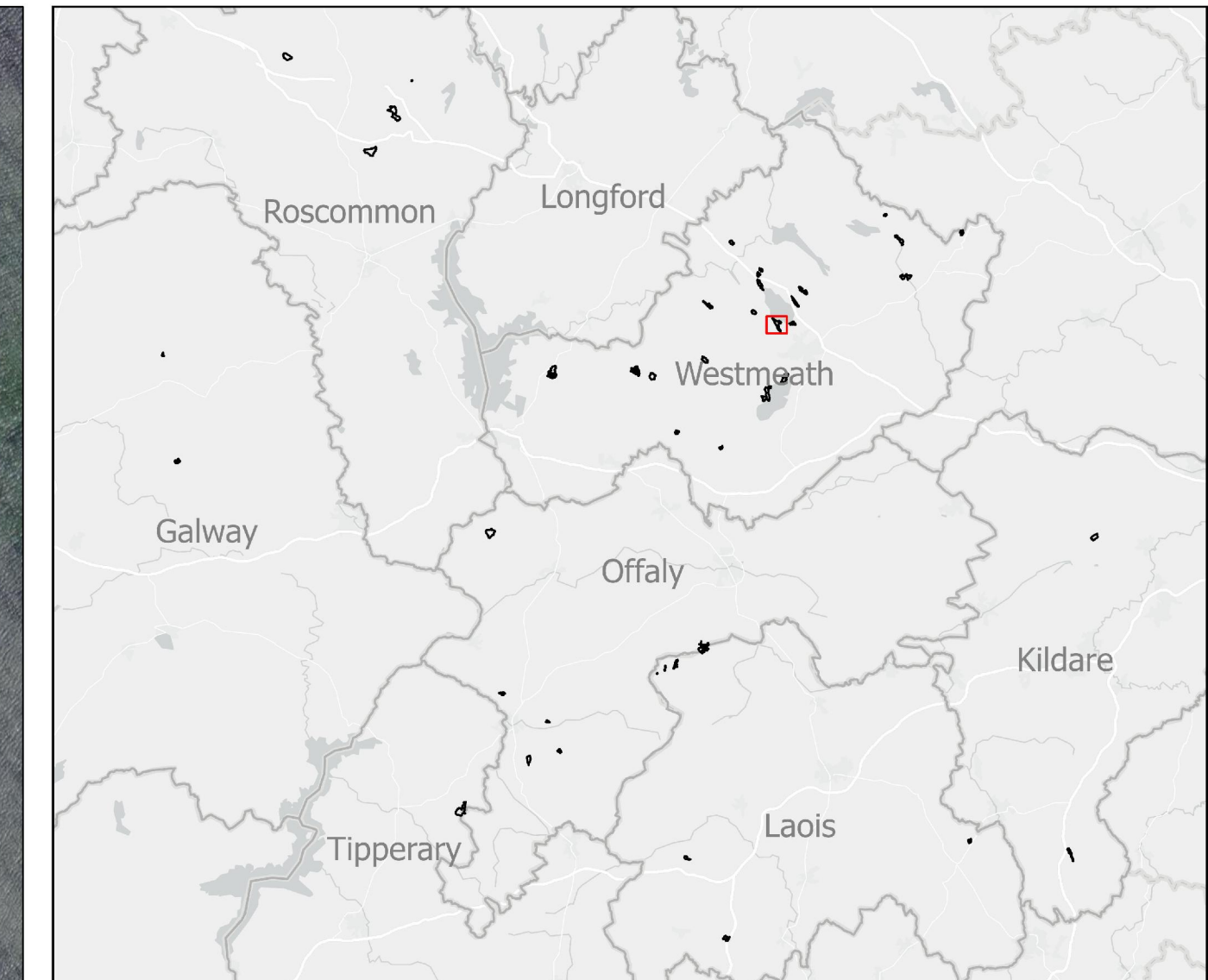
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Date: 22/04/2026

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Fen Restoration - Lough Owel (South West) Ballard - Phase 1



- Legend**
- Site Boundary
 - Drains
 - Water River Network (OSI)
 - Land Parcels
- Monitoring**
- Groundwater monitoring
 - Surfacewater monitoring

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Scale: 1:4,000 | Page Size: A3
Date: 22/04/2026

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Appendix D – Drainage Management Plan

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan: Drainage Management Plan			
Site name	Lough Owel		
County	Westmeath	NFS site No.	1005
Catchment overview:			
The site is positioned at approximately 100 mOD and is relatively flat. The topography is characterized by drumlins oriented in a northwest to southeast direction surrounding Lough Owel with topography gently sloping towards the Lough.			
WFD catchment	25A Lower Shannon	WFD Sub-catchment	River Brosna
Drainage Area	No	Drainage District	No
Arterial Drainage Scheme	Brosna Arterial Drainage Scheme	Channel	C45(1)
Responsible authority	OPW	Maintenance date	TBD
Surrounding landowners	Landowners, Coillte		
The three sites are located within the WFD catchment: 25A Lower Shannon, WFD sub-catchment: River Brosna and WFD sub-basin: Brosna_010. Brosna_010 catchment area is 41.78 km². The lake itself is made up of a WFD lake Lough Owel main as well as a WFD Lake Lough Owel Southeast Part for a small part of the lake separated by a railway line. The main lake is about 10 km². Although historically the lake levels would have been higher, with overflow also being directed to Lough Iron in the north-west, currently flow is towards the south into the feeder canal for the Brosna and Royal Canal. The catchment feeding Lough Owel is relatively small (32.2km²) compared to the size of the lake (10.2km²) with limited contributing runoff from the catchment. Lough Owel is primarily a spring fed lake and therefore sensitive to groundwater recharge within the catchment.			
Wetland drainage for Bunbrosna (refer to Site Restoration Maps):			
The topography within the Bunbrosna site ranges from approximately 102m OD to 96m OD at the lakeshore. The surrounding catchment is bound by the turn off from the N4 in the north at approximately 104m OD; the N4 to the east at approximately 135m OD; and a rural road to the west at approximately 105m OD. There is a connecting drain to the west towards Lough Iron, but this does not seem to be active, as observed during the NFS site visits (O'Neill et al., 2023). There is evidence of historical internal drains within the wetland and on the western perimeter. Arup site visits in 2025 noted unmapped drains perpendicular to the eastern boundary of the site in the surrounding farmland, flowing downslope towards the southwest and then towards Lough Owel once it reaches the site. A small marl lake is present on the eastern section of the site which may be connected to the eastern boundary drain as observed during site visits.			
Surface water inflow	Seasonal drains along the perimeter	Surface water outflow	Lough Owel
Groundwater inflow	There is a small (marl) lake within the site which may be in hydraulic connection with the water table via part of the karst limestone hydrogeology. Further investigation is required understand the dynamics of this system and the groundwater surface water interactions		
Internal drains	Mostly dry	Perimeter drains	Western perimeter drain has most flow.
On site hydrology measures (refer Site Restoration Maps):			
On-site measure 1	Drain blocking (tbc)	Role player	Landowner, Uisce Eireann, Waterways Ireland

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan: Drainage Management Plan					
The drain from the western perimeter of the wetland could be blocked to slow water loss however further monitoring data is required to determine any potential impact on the lake hydrological in advance of installation of any such measures.					
Off-site hydrology measures:					
Off-site measure 1	Catchment management for Lough Owel		Role player	NPWS, LAWPRO	
Lough Owel catchments and fens can be included within a Catchment Management Implementation Plan.					
Water Monitoring					
Rainfall and evaporation monitoring is completed at the Mullingar Met Eireann station. Lake level monitoring is completed by OPW.					
Site specific groundwater and surface water monitoring in a network of piezometers and standpipes at key locations within the site to monitor changes to water levels.					
Indicator	Rainfall and evaporation levels; Water level	Location	Mullingar weather station, Lough Owel	Role players	Uisce Eireann, GSI, NPWS
Wetland drainage for Culleen (refer to Site Restoration Maps):					
The topography within the Culleen site ranges from approximately 100m OD to 91m OD at the lakeshore. The wetland is divided by the feeder canal to the Royal canal through its centre, isolating the drainage of the site into an eastern and western portion. For the western part of the wetland, the surrounding catchment is bound to the north at approximately 109m OD. The centre of the western part of the wetland has a similar elevation as the lake at approximately 95m OD.					
At the lakeshore the elevation is raised, the extent of which can be identified as a prominent line in aerial imagery. This corresponds with the boundary of the SAC and is likely associated with a fence. This isolates two surface flow areas in the western portion of the wetland. There is a deep channel next to the canal feeder channel, which collects water from both of these portions of the wetland and discharges into the canal feeder.					
For the eastern part of the wetland, the surrounding catchment is bound to the north-east by a rural road at approximately 112m OD and a railway track at approximately 99m OD. The centre of the eastern part of the wetland has a similar elevation as the lake at approximately 96m OD. Towards the lakeshore and near the railway the elevation is raised which has confined the surface flow within the eastern portion of the wetland. A drain extends through this portion of wetland from the railway and discharges into the royal canal.					
Surface water inflow	TBC		Surface water outflow	Canal feeder	
Groundwater inflow	TBC				
Internal drains	TBC		Perimeter drains	TBC	
On site hydrology measures:					
On-site measure 1	Drain blocking (tbc)		Role player	Landowner, Uisce Eireann, Waterways Ireland	
The drain from the eastern part of the wetland could be blocked to slow water loss, however further monitoring data is required to determine any potential impact on the lake hydrological in advance of installation of any such measures.					

NPWS Tóchar Midlands Wetland Restoration Scheme Fen Restoration Plan: Drainage Management Plan					
Off-site hydrology measures:					
Off-site measure 1	Catchment management for Lough Owel	Role player	NPWS, LAWPRO		
Lough Owel catchments and fens can be included within a Catchment Management Implementation Plan.					
Water Monitoring					
Rainfall and evaporation monitoring is completed at the Mullingar Met Eireann station. Lake level monitoring is completed by OPW.					
Site specific groundwater and surface water monitoring in a network of piezometers and standpipes at key locations within the site to monitor changes to water levels.					
Indicator	Rainfall and evaporation levels; Water level	Location	Mullingar weather station, Lough Owel, Site	Role players	Uisce Eireann, GSI, NPWS
Wetland drainage for Ballard (refer to Figure 1c):					
The topography for Ballard is characterised by drumlins within the site rising to approximately 107m OD to approximately 96m OD at the lake. There are three main drainage areas within the wetland: the south, south-west and north. For the southern part of the wetland the surrounding catchment is bound to the south at approximately 126m OD. The eastern part of the wetland is bound by the elevated slopes which are currently under forestry land use. The western part of the wetland has surface water inputs from surrounding farmland. For the south-western part of the wetland the surrounding catchment is bound to the south-east at approximately 133m OD. There is a stream (Farrow) that flows along the perimeter of the fen and joins a stream (Walshestown_26) which discharges into the lake. For the northern part of the wetland the surrounding catchment is bound to the north at approximately 137m OD. There is a stream (Ballard_26) discharging into the lake.					
Surface water inflow	Ballard_26, Farrow and Walshestown 26	Surface water outflow	Lough Owel		
Groundwater inflow	TBC				
Internal drains	TBC	Perimeter drains	TBC		
On site hydrology measures:					
On-site measure 1	Drain blocking (tbc)	Role player	Coillte, Landowners		
TBC.					
Off-site hydrology measures:					
Off-site measure 1	Catchment management for Lough Owel	Role player	NPWS, LAWPRO		
Lough Owel catchments and fens can be included within a Catchment Management Implementation Plan.					
Off-site measure 2	Avoid creating new drains	Role players	Coillte		
Ensure FRP is included in the planning for the forestry land (zoned as a forest for nature) that will need to be restored. Ensure drains are managed and no new drains are dug.					
Water Monitoring					

NPWS Tóchar Midlands Wetland Restoration Scheme
Fen Restoration Plan: Drainage Management Plan

Rainfall and evaporation monitoring is completed at the Mullingar Met Eireann station. Lake level monitoring is completed by OPW.

Site specific groundwater and surface water monitoring in a network of piezometers and standpipes at key locations within the site to monitor changes to water levels.

Indicator	Rainfall and evaporation levels; Water level	Location	Mullingar weather station, Lough Owel, Site	Role players	Uisce Eireann, GSI, NPWS
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