PETRIFYING SPRING SURVEY AND ASSESSMENT
MOY ESTUARY, CO. MAYO

December 2021

Tufa dam in stream in Belleek Woods (North), Co. Mayo (photograph by Joanne Denyer)

ACKNOWLEDGEMENTS

This report was produced by Denyer Ecology for 'River Moy Search and Rescue Ballina'.

The following stakeholders funded this work:

- The main funder was the Community Water Development Fund 2021 (operated by the Local Authority Waters Programme (LAWPRO). https://lawaters.ie)
- Water chemistry samples analysed by the Environmental Protection Agency
- Additional funding by Ballina Municipal Council
- Additional funding by National Parks and Wildlife Services

Inland Fisheries Ireland (IFI) provided information on a number of the spring sites.

'River Moy Search and Rescue Ballina' are supported on an ongoing basis in conservation of water projects by North East Mayo LEADER Limited, Moy Valley Resources, Bord Iascaigh Mhara (Inland Fisheries Ireland) and The River Moy Trust.

EXECUTIVE SUMMARY

- Denyer Ecology was commissioned by River Moy Search and Rescue Ballina to undertake petrifying springs **surveys** and **Conservation Status Assessment** of a section of the River Moy Estuary.
- The **objectives** of this project were to map the springs in this area and to assess the current conservation status of any recorded petrifying (tufa-forming) spring or seepages.
- A **detailed survey** of the petrifying springs and seepages within the study area was undertaken in August 2021. Survey methodology followed standard *Monitoring Guidelines for the Assessment of Petrifying Springs in Irelan*d (Lyons & Kelly, 2016) and '*Guidelines for the assessment of Annex I priority petrifying springs in Ireland*' (Denyer, In prep.). The spring vegetation communities were classified using Lyons and Kelly (2017). The ecological condition and conservation score of each spring/ seepage was assessed.
- An overview of the **hydrological context of the site** was undertaken. It is likely that most of the springs are point discharges from the underlying karst limestone system. There is one spring in the south-east of the study area, which lies at a higher elevation from the other springs, which may in part derive from limestone gravels.
- **Thirty-two springs/ seepages with tufa formation were recorded**. These include springs and streams flowing into the estuary; seepages from the banks of the estuary; roadside streams; springs, streams and seepages within woodland and a pond outflow into the estuary.
- **Twenty-three** of the recorded springs, seepages and streams are examples of the **Annex I priority habitat** 'Petrifying springs' [7220].
- **Ten detailed relevé plots** were undertaken. The vegetation in the springs correspond to the **vegetation communities**: Group 1 *Eucladium verticillatum-Pellia endiviifolia* Tufa Cascades vegetation community; Group 2 *Palustriella commutata - Geranium robertianum* vegetation community*;* Group 3 *Brachythecium rivulare-Platyhypnidium riparioides* tufaceous streams and flushes vegetation community and Group 4 *Palustriella commutata-Agrostis stolonifera* springhead vegetation community (Lyons & Kelly, 2017). Average **species richness** of the springs ranged from 6 to 21. The **condition assessment** criteria were met for 8 of the 10 plots. One plot failed on the cover of positive indicator species & phosphate levels and one plot failed on the cover of negative indicator species. **Future prospects** were considered 'Unfavourable-Inadequate' for four springs, due to water pollution and/ or natural succession.
- **Recommendations** were made on: a) the inclusion of petrifying springs as a Qualifying Interest of Killala Bay/Moy Estuary SAC [000458]; b) potential management actions for the spring at the Quay House; c) consideration of the petrifying springs within Belleek Woods south in relation to potential works to reduce nutrients inputs to the downstream pond; and, d) assessment of the potential of the springs to support rare/ protected snail species.

CONTENTS

2 INTRODUCTION

2.1 Background

Denyer Ecology was commissioned by River Moy Search and Rescue Ballina to petrifying springs surveys and Conservation Status Assessment of a section of the River Moy Estuary. A number of streams with tufa deposits had been recorded from this area. These have the potential to correspond to the Annex I Priority Habitat Petrifying springs with tufa formation (*Cratoneurion*) [7220].

2.2 Project aims

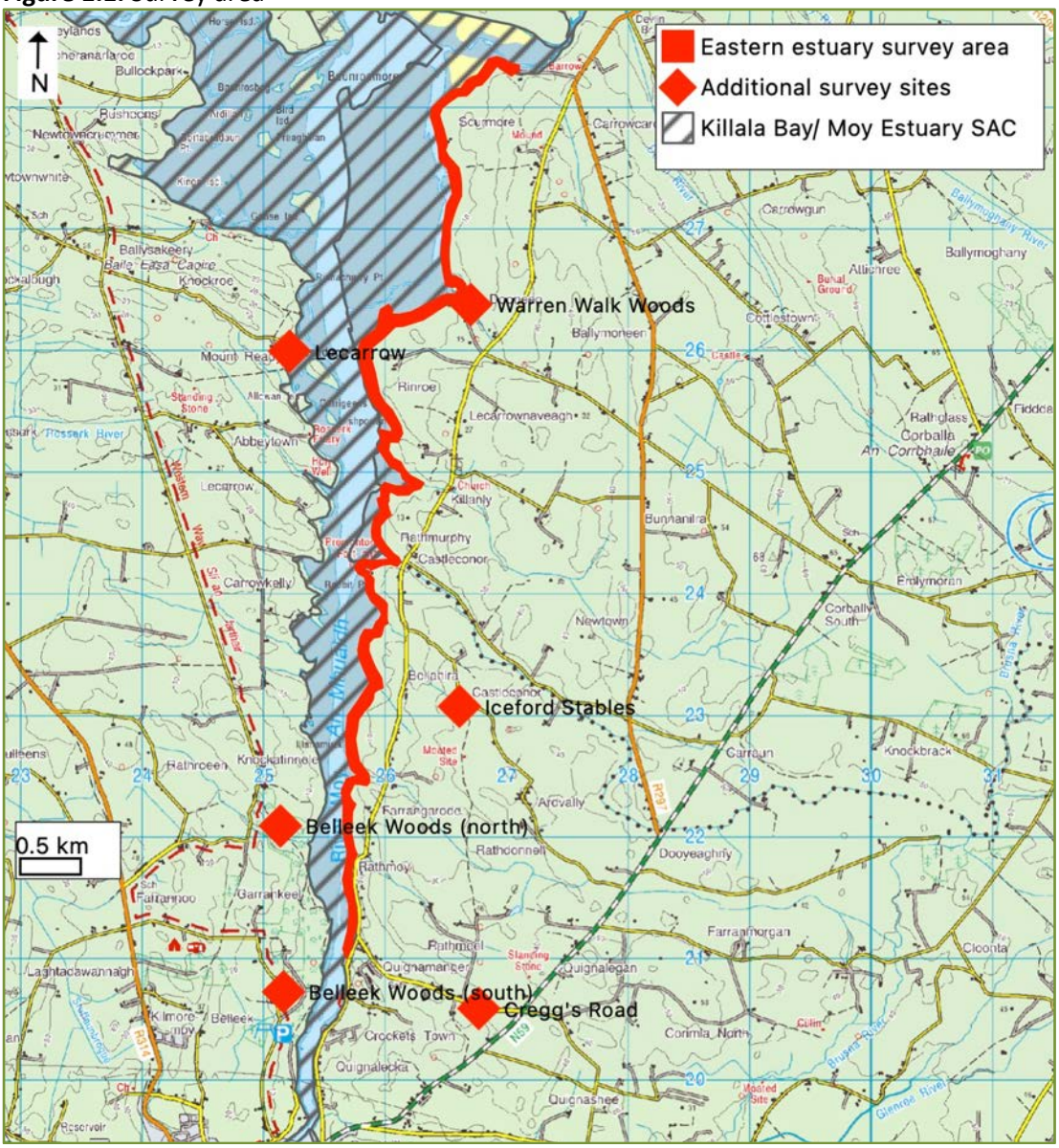
The objectives of this project were to identify the location and assess the conservation status of any petrifying (tufa-forming) spring or seepage found within the survey area (Figure 1.1).

2.3 Site

The project site (Figure 1.1) is located within/ adjacent to Killala Bay/Moy Estuary SAC [000458]. The survey area included:

- The length of riverbank surveyed comprises the eastern riverbank from a building referred to as a 'pump house/ station' at Cregg's Road, Ballina in the south to Scurmore House, Enniscrone in the north.
- Springs/ streams near or crossing the Warren Walk/ Way (east of the estuary).
- Springs/ streams with Belleek Woods (north and south) (west of the estuary).
- Seepage/ spring at Lecarrow (west of the estuary).
- Roadside stream at Iceford Stables (east of the estuary).
- Roadside stream along Cregg's Road (east of the estuary).

Figure 1.1. Survey area



2.4 Relevant expertise

Dr Joanne Denyer (Denyer Ecology)

Dr Joanne Denyer was the lead surveyor for the survey work and undertook the Conservation Status Assessment and reporting. She is a highly experienced botanist and bryologist with 20 years' experience of ecological survey and research. She is experienced in the identification of all plant groups, including difficult groups such as aquatic macrophytes, charophytes and bryophytes. She received the National Biodiversity Data Centre 'Distinguished Recorder Award' in 2014 in recognition of outstanding contribution to bryological recording in Ireland. She regularly provides botanical and bryological training courses for amateurs and professionals and leads training meetings for the British Bryological Society (Irish group), Dublin Naturalist Field Club and the Botanical Society of the British Isles. Training courses provided include grass, sedge and rush identification, bryophyte and *Sphagnum* identification and using bryophytes as habitat indicators. She also lectures on bryophyte ecology and identification to undergraduates at University College Dublin and Trinity College Dublin.

Dr Denyer specialises in wetland habitats and including Annex I habitat priority petrifying springs and has worked on a wide range of projects and sites in relation to this habitat. This includes detailed

survey, assessment and monitoring, Ecological Impact Assessment and acting as an expert witness on calcareous springs at Oral Hearing. She provides advice on this habitat to County Councils and National Parks and Wildlife Service (NPWS). In 2018 she assisted NPWS in the latest Article 17 reporting (national Conservation Status Assessment) on Petrifying springs to the European Commission (under Article 11 of the Habitats Directive, each member state must report every 6 years on the conservation status of Annex I habitats). Dr Denyer is currently preparing updated '*Guidelines for the assessment of Annex I priority petrifying springs in Ireland*' for NPWS (Denyer, In prep.). She undertook detailed petrifying spring survey work at Ballyman Glen in 2014 for Irish Water.

Hannah Mulcahy (JBA Consulting)
Hannah Mulcahy assisted in the field survey work. She is a botanist experienced in detailed vegetation surveys and habitat assessment across Ireland. She is joint Botanical Society of the British and Ireland (BSBI) Vice County Recorder for County Clare (H9).

Alex Jones (JBA Consulting)
Alex undertook the hydrogeology assessment. He is a hydrogeologist and chartered geologist with over 10 years of professional experience in geo- environmental consultancy. Alex has particular expertise in wetland eco-hydrology, restoration and creation schemes. He is highly experienced in the assessment of petrifying spring hydrogeology.

3 METHODOLOGY

3.1 Desktop data

Desktop data accessed in this assessment includes the following data sources:

- NPWS records of rare and protected bryophytes.
- Rare and Threatened bryophytes of Ireland (Lockhart et al., 2012).
- British Bryological Society Atlas dataset.
- Aerial photography and OSI mapping.
- Water quality data from Lyons (2015).
- Additional literature and resources as relevant (referenced in text).

3.2 Hydrological assessment

An overview of the hydrological context of the site was undertaken by a hydrogeologist with specialist petrifying springs experience.

3.3 Field survey

3.3.1 Site walk-over

- All accessible areas of the study area (Figure 1.1) were walked over by an experienced botanist and bryologist.
- The location of any base-rich seepages/ petrifying springs/ tufa formation was mapped using a GPS.
- General notes of the vegetation (vascular plants and bryophytes) of any springs were made and representative photographs taken.

3.3.2 Detailed spring survey

- Detailed survey was undertaken of a representative section of each petrifying spring/ stream/ base-rich seepage to determine a) if it is an example of the Annex I priority habitat 7220; b) to evaluate its quality and condition; and, c) assign a conservation score and ranking.
- Data collected included habitat and plot photographs; plot location(s) (GPS); recording of percentage cover of all vascular plant and bryophyte species (including positive and negative indicator species); shading; tufa type and extent; and, impacting activities (such as grazing, invasive species, changes to water quality and/ or quality, trampling and dumping).

- The plot sampling methodology follows Lyons, M.D. & Kelly, D.L. (2016). Monitoring guidelines for the assessment of petrifying springs in Ireland. *Irish Wildlife Manuals*, No. 94. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland
- Updated NPWS (draft) survey and assessment guidance was also be taken into account: Denyer, J. (In press). Guidelines for the Assessment of Annex I Priority Petrifying Springs in Ireland. *Irish Wildlife Manuals*, No. XXX. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.
- Petrifying spring/ stream vegetation communities were classified using Lyons, M.D. & Kelly, D.L. (2017). Plant community ecology of petrifying springs (*Cratoneurion*) – a priority habitat. *Phytocoenologia* 47 (1): 13-32.

3.3.3 Condition assessment

- The ecological condition of the springs was assessed using the '*Monitoring Guidelines for the Assessment of Petrifying Springs in Ireland*' (Lyons & Kelly, 2016) and the updated *Guidelines for the Assessment of Annex I Priority Petrifying Springs in Ireland* (Denyer, In press). Criteria include positive and negative indicator species (frequency and cover), woody species cover, vegetation height and disturbance.

3.3.4 Conservation score

- The 'Conservation Score' of the petrifying springs was assessed using the '*Monitoring Guidelines for the Assessment of Petrifying Springs in Ireland*' (Lyons & Kelly, 2016 and the updated *Guidelines for the Assessment of Annex I Priority Petrifying Springs in Ireland* (Denyer, In press). Criteria such as species diversity, High Quality indicator species, tufa-forming capacity and other positive characteristics are used to calculate the 'Conservation Score' for each spring. This score is then be used to rank the quality of the spring at a national level (Lyons & Kelly, 2016; Denyer, In press).

3.4 Water chemistry

Where there was flowing water, the pH and conductivity of the spring water from each plot was measured using a handheld pH meter (which was calibrated prior to use in the field). Detailed water chemistry was also collected separately from 13 springs. This was frozen before being sent for analysis to an EPA approved laboratory. These were analysed for a number of parameters of which pH, conductivity, nitrates and phosphates were used in the condition assessment (Appendix A).

3.5 Plant species nomenclature

Vascular plant nomenclature follows that of the *New Flora of the British Isles*. 4th Edition (Stace, 2019). Bryophyte nomenclature follows Blockeel et al. (2021).

4 GEOLOGY AND HYDROGEOLOGY

The following section provides a geological and hydrogeological baseline for the area. The main units of the area and their properties are presented in Table 3.1.

Table 3.1. Hydrogeological Units

Deposit	Lithology	Teagasc Soil Description	Estimated Thickness (m)	Location relative to site	Hydrogeological Properties
Cut of Raised Peat	Peat	Cut Peat	0-2m	Headwaters of the streams	Low permeability
Alluvium	Silts, sands and gravels	Mineral alluvium	0-2m	Narrow bands along the valley floors of the streams	Variable
Gravels derived from Limestone	Glaciofluvial Sands and Gravels	Renzinas, Lithosols Shallow well-drained mineral (Mainly basic)	Unknown		High Permeability, intergranular flow dominated aquifer
Till Derived from Limestone	Limestone derived clays, sands, gravels	Grey Brown Podzolics, Brown Earths(medium-high base status) Deep well-drained mineral	Unknown - likely variable. Thin in areas surrounding bedrock outcrops	Widespread across the area	Low to moderate permeability deposit
Upper Ballina Limestone Formation	Grey limestone, thin shale	Renzinas, Lithosols Derived from mainly calcareous parent materials Shallow well-drained mineral (Mainly basic	South of the Area	To depth in south, wedges out to the centre	High permeability fracture and karst flow dominated
Lower Ballina Limestone Formation	Dark fine-grained limestone & shale		Centre and North of the Area	To depth	High permeability fracture and karst flow dominated

Source - Geological Survey Ireland Spatial Resources available at https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228

4.1 Quaternary Deposits

The distribution of quaternary deposits is shown in Figure 3.1. Limestone derived till is widespread across the area. The distribution of bedrock outcrops in the area suggests that in general the till is relatively thin. On the hills above the streams are cut-over raised peat deposits resting on the till and a large pocket of glacial fluvial gravels derived from limestone. Along the valley floors are narrow bands of alluvium.

4.2 Bedrock

Two main bedrock units cover the area (Figure 3.2). The Upper Ballina Limestone occupies the south of the study area and wedges out further north. The Upper Ballina Limestone is underlain by the Lower Ballina Limestone, which outcrops (or subcrops) through the middle and north of the site.

4.3 Hydrogeology

The streams in the area are feed by two broad groundwater systems in the area: a shallow groundwater system through the quaternary deposits and the Ballina Limestones system. The groundwater vulnerability mapping of the area (Figure 3.3) and the Teagasc soil description (see Table 3.1) show that the till in the area is relatively free draining. The headwater of the streams in the south may also be feed by intergranular flow within the gravel deposits. Both of these deposits are derived

from limestone and will be a source of calcium carbonate-rich water. However, flow through these units will be relatively shallow and have shorter flow paths.

The Ballina Limestone formation is dominated by fracture and karst flow. The Geological Survey Ireland (GSI) karst features dataset records no Karst features in the study area, but they are recorded elsewhere in the Ballina Limestone. Groundwater from this system will discharge to the surface mainly via springs along the watercourse. The residence time of the groundwater within the limestone will vary significantly.

4.4 Distribution of the Tufa Springs

Figure 3.3 shows that the majority of the springs lie in areas of extreme vulnerability, which suggests that the overlying till where present is thin. It therefore appears that the majority of the springs are likely point discharges from the underlying karst limestone system.

Figure 3.1 shows that there is one spring in the south-east of the study area that like on the junction of the edge of the gravels derived from limestone. This spring lies at a higher elevation that the majority of the other springs and possibly the water from this spring is in part derived from flows from the gravels.

Figure 3.1. Quaternary Geology

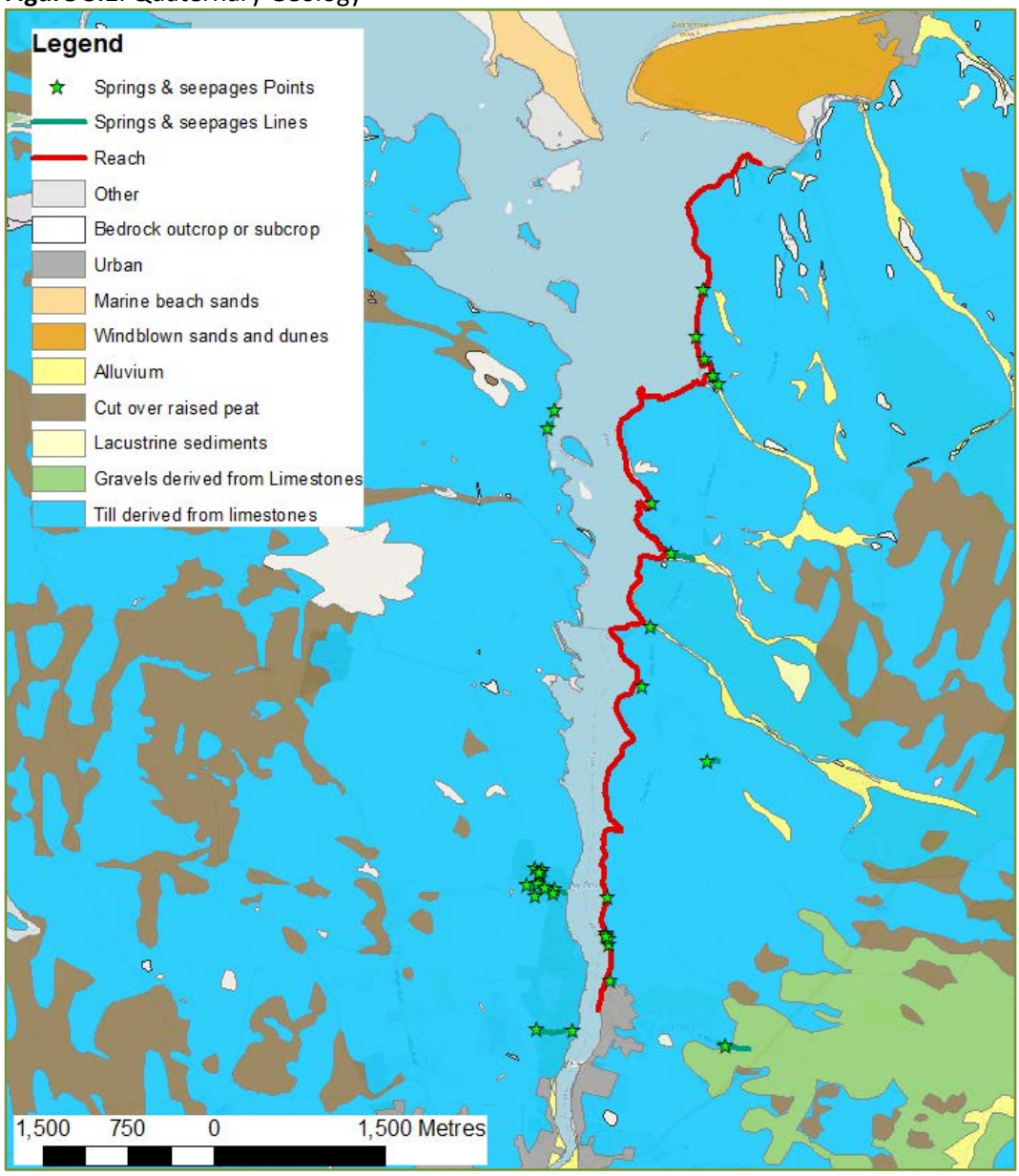


Figure 3.2. Bedrock Geology

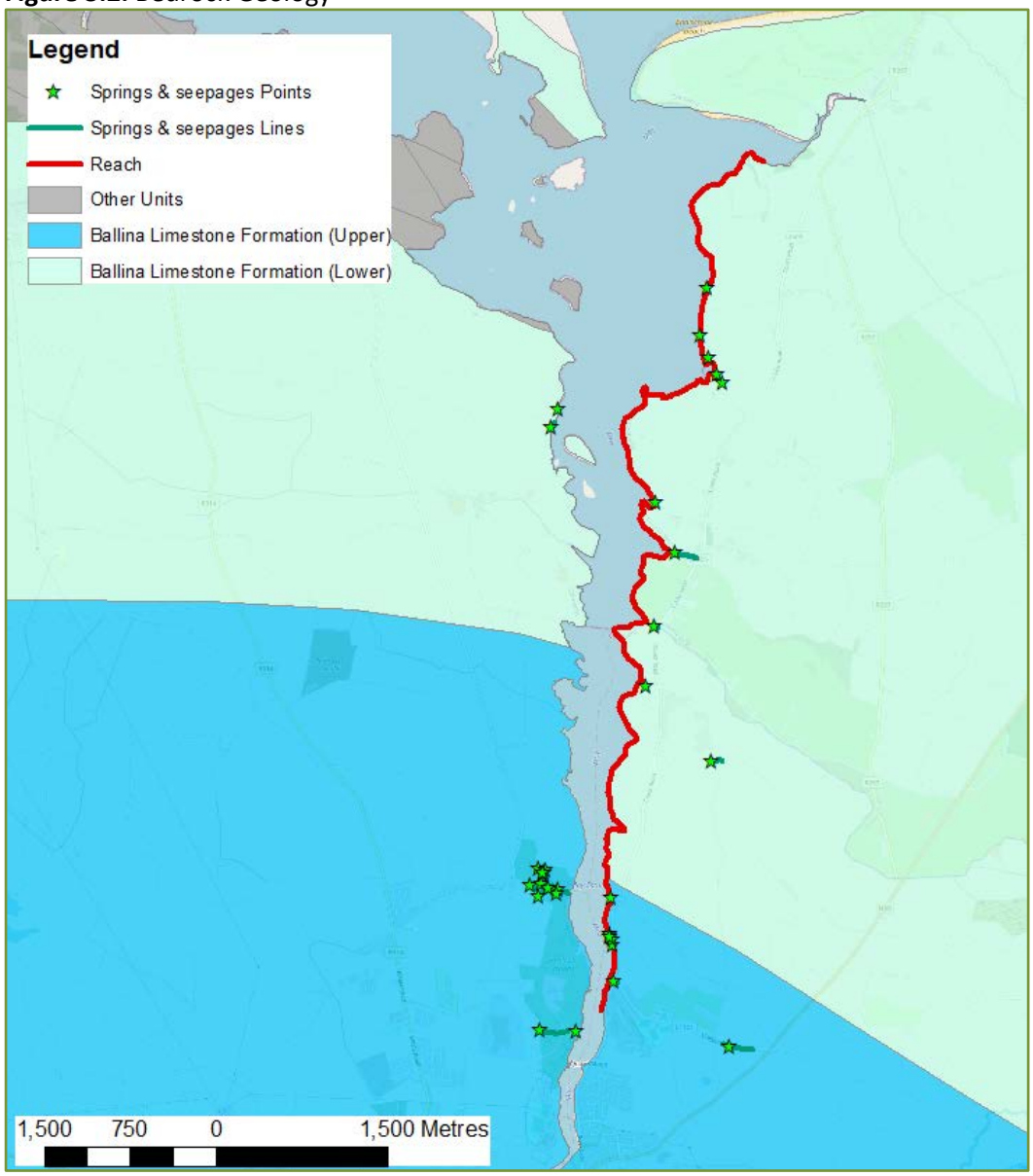
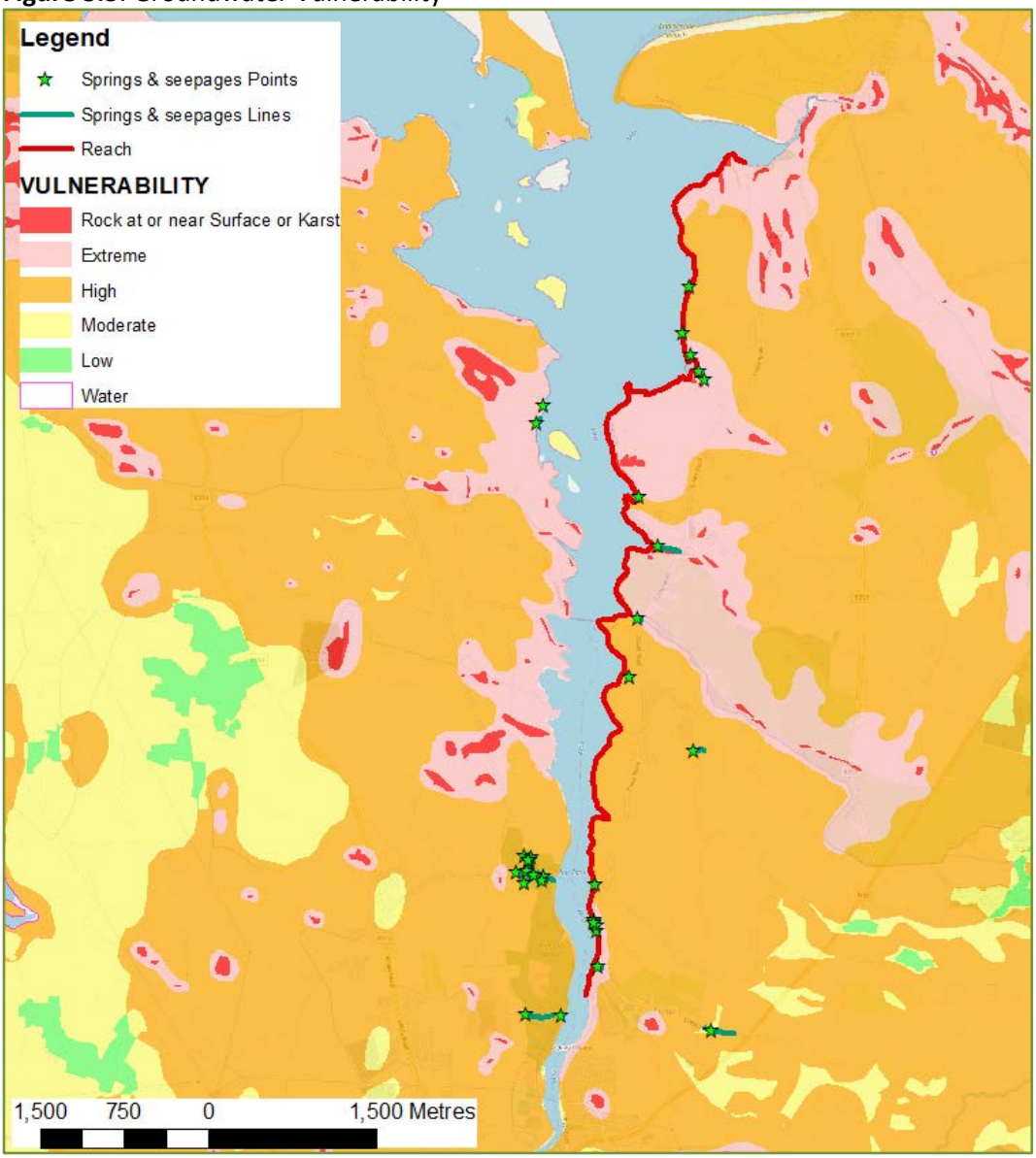


Figure 3.3: Groundwater Vulnerability



5 SPRING SURVEY RESULTS AND EVALUATION

5.1 Walk-over survey

Thirty-two springs/ seepages with tufa formation were recorded (Figures 4.1a-c, Table 4.1). These include springs and streams flowing into the estuary; seepages from the banks of the estuary; roadside streams; springs, streams and seepages within woodland and a pond outflow into the estuary. Twenty-three of the recorded springs, seepages and streams, were considered to be examples of Annex I petrifying spring habitat (Table 4.1). Photographs and a summary description of each spring/ stream/ seepage area are shown in Table 4.2 and a summary of key water chemistry data is shown in Table 4.3 (full water chemistry data is included in Appendix A).

Figure 4.1a. Petrifying spring/ stream/ seepage areas recorded within the northern survey area

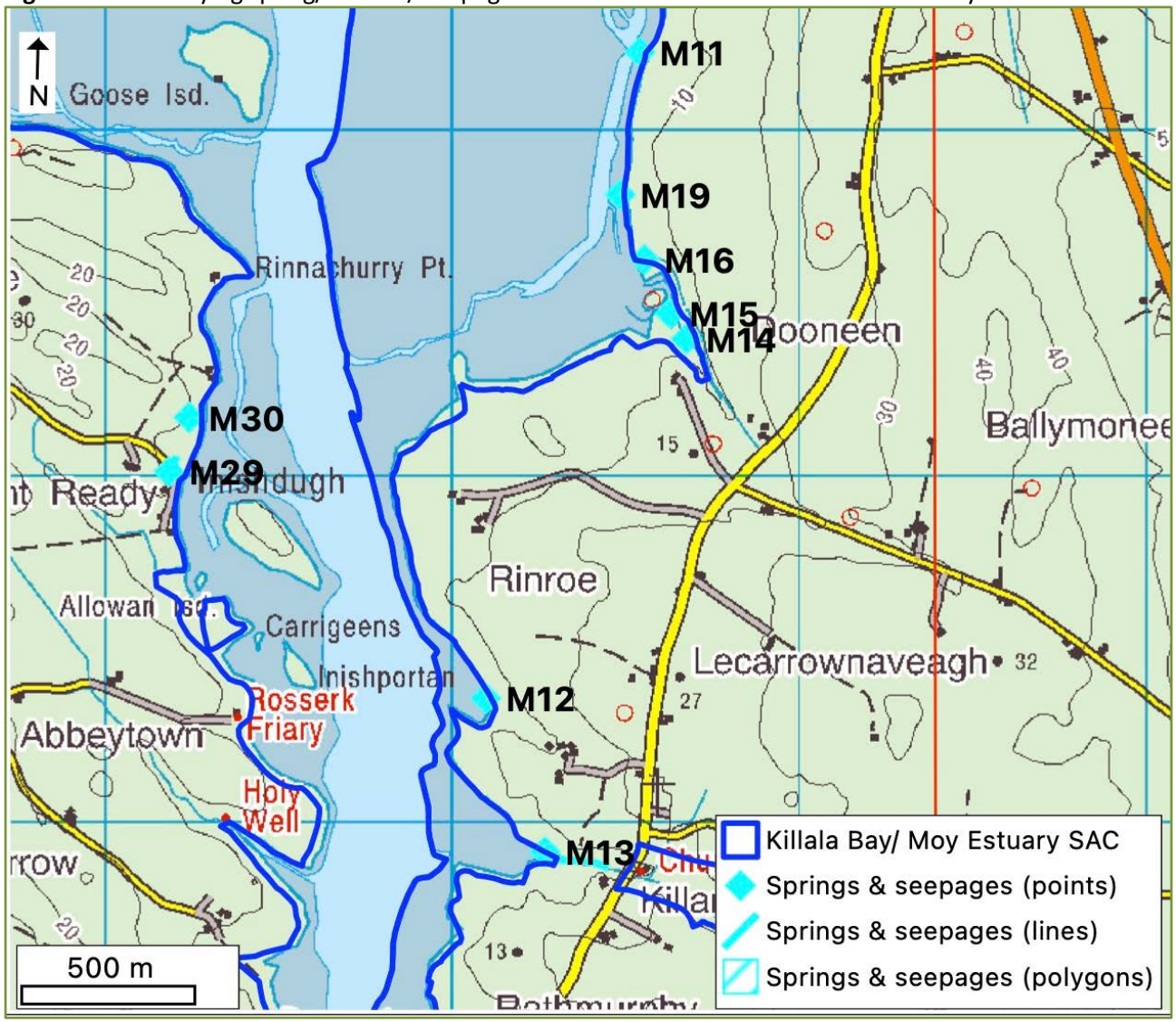


Figure 4.1b. Petrifying spring/ stream/ seepage areas recorded within the central survey area

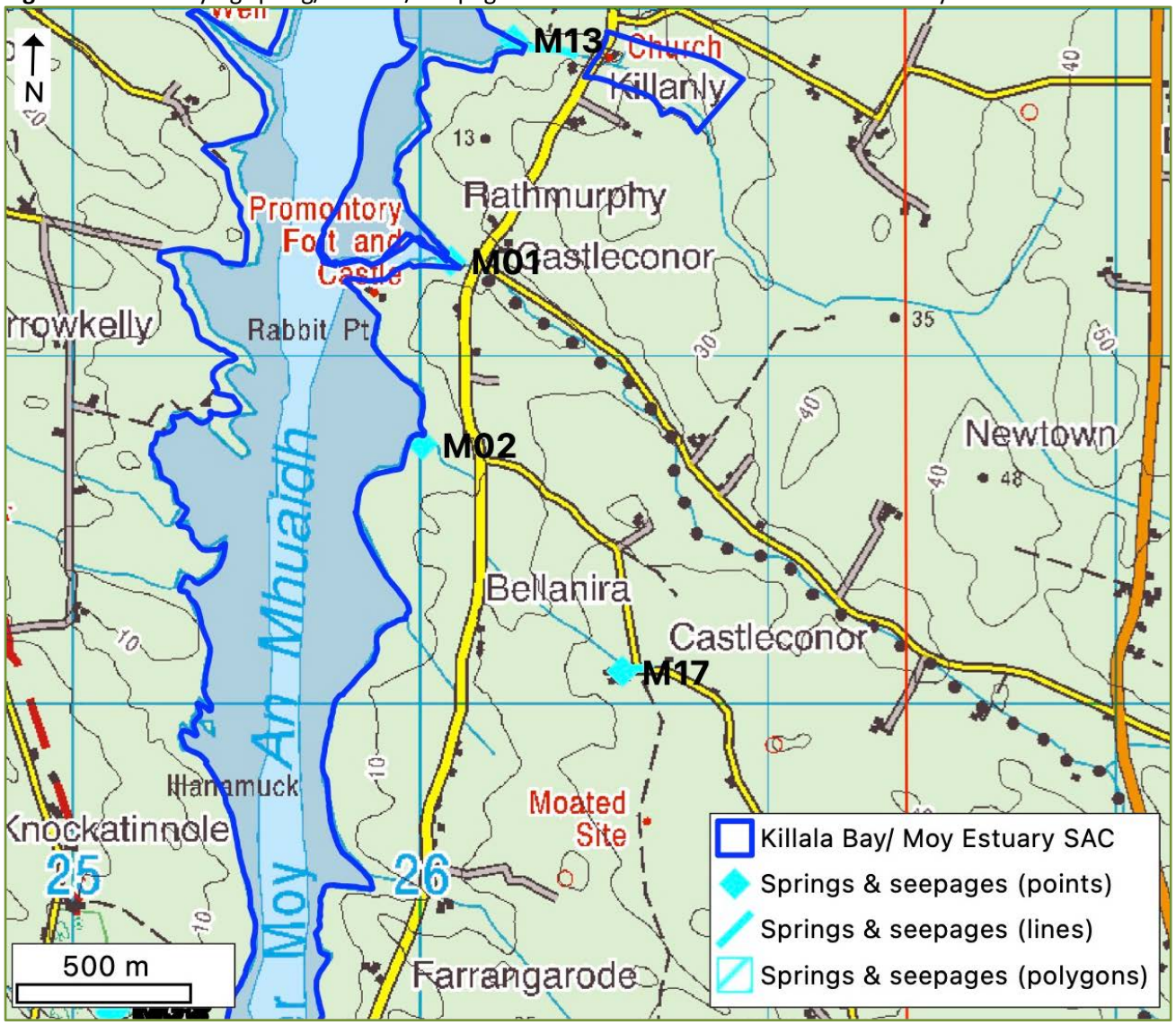


Figure 4.1c. Petrifying spring/ stream/ seepage areas recorded within the southern survey area

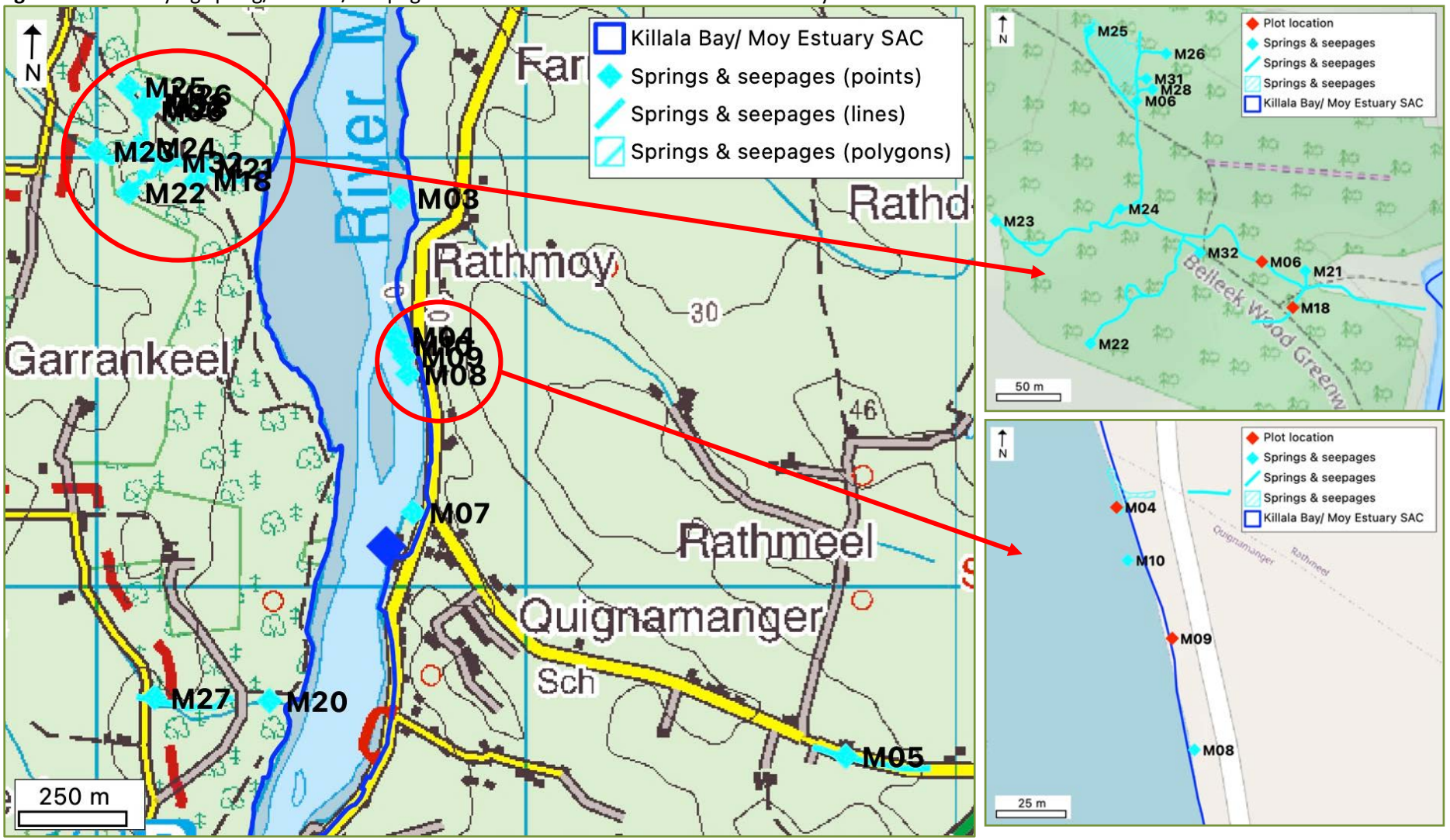


Table 4.1. Summary of petrifying springs/ streams/ seepages recorded in 2021 survey

Spring ID	Location	Spring type	Within SAC	Grid reference (IG)	Tufa present	*7220 Indicator spp.	Detailed plot	Water sample	*7220 habitat
M01	Castleconner	Stream flowing into estuary	On boundary, discharges to SAC	G2612924265	Yes	2	**MR01**	**M01**	Yes
M02	Castleconner to Quay House	Stream flowing into estuary	Adjacent (*c.* 30m to E). discharges to SAC	G2605123738	Yes (high)	0	No	No	No
M03	Castleconner to Quay House	Stream flowing into estuary	Yes	G2571221900	Yes	1	No	No	No
M04	Quay House	Spring flowing into estuary	On boundary, discharges to SAC	G2573321569	Yes (high)	5	**MR02**	**M04**	Yes
M05	Cregg's Road	Roadside stream	>1km to E, possibly discharges to SAC	G2678220600	Yes	1	No	No	Yes
M06	Belleek Woods (north)	Stream within woodland	Arises *c.* 300m to W, discharges to SAC	G2525821965	Yes	3	**MR03**	**M06 & M182**	Yes
M07	Quignamanger (Cregg's Road/ Quay Road junction)	Small roadside stream	Adjacent (*c.* 15m to E). discharges to SAC	G2577521169	Yes	4	**MR04**	**M07**	Yes
M08	Quay House to Pump House	Seepage from under road into estuary	On boundary, discharges to SAC	G2576121482	Yes	0	No	**M08**	No
M09	Quay House to Pump House	Spring seeping from wooded bank into estuary	On boundary, discharges to SAC	G2575321522	Yes	9	**MR05**	**M09**	Yes
M10	Quay House to Pump House	Spring flowing into estuary	On boundary, discharges to SAC	G2573721550	Yes	0	No	No	No
M11	Estuary bank section to S of Scurmore House	Spring flowing into estuary	On boundary, discharges to SAC	G2658327216	Yes	3	No	**M11**	Yes
M12	Knockroe, N Castleconner	Spring flowing into estuary	On boundary, discharges to SAC	G2613825348	Yes	3	**MR06**	**M12**	Yes
M13	1st inlet N of Castleconner	Stream flowing into estuary	On boundary, discharges to SAC	G2630924904	Yes	0	No	No	No
M14	Warren Walk Woods	Spring flowing under path	Yes	G2671726387	Yes	3	**MR07**	**M14**	Yes
M15	Warren Walk Woods	Spring flowing under path	Yes	G2667026461	Yes	1	No	No	No
M16	Warren Walk Woods	Seepage over path	Yes	G2659626617	Yes (low)	1	No	No	No
M17	Iceford Stables	Roadside stream	*c.* 700m to E, possibly discharges to SAC	G2663723072	Yes	1	No	**M17**	No
M18	Belleek Woods (north)	Stream within woodland	Arises *c.* 150m to W, discharges to SAC	G2527121941	Yes	4	**MR08**	**M186**	Yes

Spring ID	Location	Spring type	Within SAC	Grid reference (IG)	Tufa present	*7220 Indicator spp.	Detailed plot	Water sample	*7220 habitat
M19	Between Scurmore to Dooneen	Seepage from bank with tufa	On boundary, discharges to SAC	G2653426797	Yes	0	No	No	No
M20	Belleek Woods south	Outflow to pond into estuary	On boundary, discharges to SAC	G2538321924	Yes	3	No	No	Yes
M21	Belleek Woods (north)	Stream within woodland	Arises *c.* 95m to W, discharges to SAC	G2528521955	Yes	0	No	No	Yes
M22	Belleek Woods (north)	Stream within woodland	Arises *c.* 280m to W, discharges to SAC	G2511721898	Yes (high)	3+	No	No	Yes
M23	Belleek Woods (north)	Stream within woodland	Arises *c.* 340m to W, discharges to SAC	G2504321994	Yes (high)	3+	No	No	Yes
M24	Belleek Woods (north)	Stream within woodland	Arises *c.* 260m to W, discharges to SAC	G2514122004	Yes (high)	3+	No	No	Yes
M25	Belleek Woods (north)	Stream within woodland	Arises *c.* 330m to W, discharges to SAC	G2511722143	Yes	3+	No	No	Yes
M26	Belleek Woods (north)	Stream within woodland	Arises *c.* 270m to W, discharges to SAC	G2517722126	Yes	3+	No	No	Yes
M27	Belleek Woods (south)	Stream within woodland	Arises *c.* 310m to W, discharges to SAC	G2518220721	Yes	5	**MR09**	**M24**	Yes
M28	Belleek Woods (north)	Stream within woodland	Arises *c.* 280m to W, discharges to SAC	G2516622098	Yes	0	No	No	Yes
M29	Lecarrow	Seepage from estuary bank with tufa	On boundary, discharges to SAC	G2522825996	Yes	3	No	No	Yes
M30	Lecarrow	Seepage from estuary bank with tufa	On boundary, discharges to SAC	G2528726159	Yes	6	**MR10**	No	Yes
M31	Belleek Woods (north)	Stream within woodland	Arises *c.* 280m to W, discharges to SAC	G2516122106	Yes	0	No	No	Yes
M32	Belleek Woods (north)	Stream within woodland	Arises *c.* 180m to W, discharges to SAC	G2520332969	Yes	1	No	No	Yes

Table 4.2. Summary description and photograph of petrifying springs/ streams/ seepages recorded

Spring ID	Comment	Photograph
M01	Stream flowing into the estuary with tufa in the main channel, and some paludal tufa and oncoids and ooids. Only 2 positive indicator species were recorded, but the habitat is typical of *7220 overall.	
M02	Highly tufa forming stream flowing into the estuary. Filamentous algae were frequent, but no *7220 positive indicator species were present. The stream was brackish in the lower section.	
M03	Tufa producing stream with the *7220 positive indicator species *Palustriella commutata* occasional. No other positive indicator species recorded and given the low cover of *Palustriella commutata*, the stream is not considered to be *7220 habitat.	
M04	Large extensive tufa mound/ complex associated with a spring which arises to the east of the Quay/ coast road. It discharges into the estuary. The main tufa formation is cascade tufa but there is also significant stream crust tufa in the main spring channel and some paludal tufa. The tufa mound extends approximately 20m along the shoreline. Where the spring joins the estuary, the tufa cascades are algal covered. Much of the main tufa mound is dominated by trees and scrub.	

Spring ID	Comment	Photograph
M05	This roadside stream has high cover of *Pellia endiviifolia* and good tufa cover. Only 1 positive indicator is present. However, downstream (M07) supports *7220 vegetation and so M05 is considered to be part of this *7220 system.	
M06	This is the main stream flowing through Belleek Woods (north). Tufa is in the form of extensive areas of stream crust, cascade tufa and occasional oncoids/ ooids. *7220 positive indicator species are locally frequent. There are many tributaries which feed into this main stream and most also have extensive tufa formation.	
M07	Section of roadside stream along Cregg's Lane, downstream from M05. This section is located just to the east of the coast/ Quay road. Despite the channel having been modified, tufa cascades and *7220 positive indicator species are frequent in this section of the stream.	
M08	This spring seeps from the roadside bank into the estuary. It extends *ca.* 10m along the shore. There are small tufa cascades at the estuary edge which are algal covered. No *7220 positive indicator species were present.	

Spring ID	Comment	Photograph
M09	Seepage area arising from the eastern estuary bank. There was a small water flow at the time of survey but the whole spring area was damp. There is cascade tufa formed at the base of the bank with species-rich bryophyte vegetation and some vascular plants. This plot had the highest number (9) of positive indicator species within the Moy Estuary survey area, of which 8 were bryophytes. The spring flows into the estuary and there is filamentous algae in the brackish zone below the relevé plot location.	
M10	This is part of the seepage spring area along the estuary from the Quay House to Pump House. Tufa cascades with algae are present at the estuary edge. However, as with M08 there were no *7220 positive indicator species recorded.	
M11	This is a small spring which discharges from the estuary bank. It had a fast flow. Tufa (cascade, paludal and oncoids and ooids) was restricted to the area around the outflow from the bank. The area was too small for a plot but had three positive indicator species present (*Eucladium verticillatum, Didymodon tophaceus* and *Pellia endiviifolia*) and is *7220 habitat.	
M12	This is a spring which discharges from the northern bank of a small inlet. Where the spring arises from the bank, it has formed a large tufa mound over 1m in height and several metres in diameter. This is covered in grass (*Agrostis stolonifera*) which has reduced species diversity. Where grass cover is lower (eastern side of mound), *7220 bryophyte species are locally frequent.	

Spring ID	Comment	Photograph
M13	This stream has high stream crust and cascade tufa formation but no *7220 positive indicator species were recorded. The only bryophyte present was *Cratoneuron filicinum*. The stream may be brackish or have highly variable flow, reducing its suitability for *7220 species.	
M14	Spring which arises in Warren Way woods on the eastern side of the estuary. It flows under the path through the woods and into an area of wet woodland downstream. The tufa formation is mainly cascade tufa, with some paludal tufa and oncoids and ooids. The vegetation has equal proportions of woodland and wetland vascular plants.	
M15	A spring which flows under the path in Warren Way woods. The springhead is just above the path. Tufa is frequent but the only *7220 species present is *Pellia endiviifolia*. There was flow at the time of survey but it may vary seasonally.	
M16	A seepage area over the path in Warren Way woods. It was damp at the time of survey but may have higher flow in winter. There is tufa on the path and some *7220 species are present, there are not enough species/ cover for *7220 habitat.	

Spring ID	Comment	Photograph
M17	This is a small roadside stream with frequent tufa formation. The only *7220 species present is *Pellia endiviifolia*. Cyanobacteria sp. (bluish colour) is locally frequent.	
M18	This is a tributary to M06 in Belleek Woods (north). This stream section in spring M18 had lower tufa than the downstream section, but higher cover of petrifying spring species. In-stream bryophytes include abundant *Palustriella commutata* and *Pellia endiviifolia* and frequent *Fissidens adianthoides* (all *7220 positive indicator species).	
M19	This is a seepage spring from the eastern estuary bank. Tufa is present but there are no *7220 positive indicator species.	
M20	This is the outflow to the pond in Belleek Woods (south). There is a large tufa cascade beneath the outflows. Some *7220 species are present but the outflow was not accessible for detailed survey. There is a high cover of algae and it is likely that nutrient levels are high (as there is significant algae cover in the pond feeding the outflows).	

Spring ID	Comment	Photograph
M21	This is part of the Belleek Woods (north) spring system. It was dry at time of survey, but tufa was present in the channel and it is linked to *7220 habitat downstream.	n/a
M22	This is part of the Belleek Woods (north) spring system. It had water flow and there were extensive cascade and stream crust tufa throughout most of the stream. *7220 positive indicator species are locally frequent.	
M23	This is part of the Belleek Woods (north) spring system. The stream channel is up to 3m wide in places. Cascade and stream crust tufa are very extensive in some areas and *7220 positive indicator species frequent.	
M24	This is part of the Belleek Woods (north) spring system. Extensive cascade and stream crust tufa are present. The streams are adjacent for a section and then join to the west. *7220 positive indicator species frequent.	
M25	This is part of the Belleek Woods (north) spring system. The small stream runs through wet woodland with iron staining springs frequent in adjacent areas. *7220 positive indicator species are frequent with *Fissidens adianthoides* is locally abundant.	

Spring ID	Comment	Photograph
M26	This is part of the Belleek Woods (north) spring system. The stream was dry to east, but wet where it joins the main channel to the west. Tufa was mainly oncoids and ooids.	
M27	Unlike the stream/ spring system in Belleek Woods (north), this appears to be the only petrifying stream in Belleek Woods south. The tufa in the stream is largely confined to a series of dams, which potentially are artificial in origin but now have cascade tufa on them. The stream flows into a pond (man-made) and then discharges to the estuary from two discharge points with cascade tufa formation. The stream is larger than the streams in Belleek Woods (north) and has less bryophyte cover in the main channel. There are seepages from the riverbanks in the western (upstream) section of the stream.	
M28	This is part of the Belleek Woods (north) spring system. This is a small stream with good flow at time of survey and frequent tufa.	n/a
M29	This is a section of the western estuary shoreline with spring seepage and tufa formation. At the time of survey there was no flow, but the tufa areas were damp. There are two main areas of tufa formation: M29 (ca. 20m of shoreline and 2m in height) and M30 (ca. 20m of shoreline and 2m in height). The tufa is both active and inactive and it is likely that the seepage areas have changed slightly over time. The tufa is cascade formation on mainly vertical slopes on the rocky shoreline. Bryophytes dominate the tufa.	
M30	This is a section of the western estuary shoreline with spring seepage and tufa formation. At the time of survey there was no flow, but the tufa areas were damp. There are two main areas of tufa formation: M29 (ca. 20m of shoreline and 2m in height) and M30 (ca. 20m of shoreline and 2m in height). The tufa is both active and inactive and it is likely that the seepage areas have changed slightly over time. The tufa is cascade formation on mainly vertical slopes on the rocky shoreline. Bryophytes dominate the tufa.	

Spring ID	Comment	Photograph
M31	This is part of the Belleek Woods (north) spring system. The stream was dry to the east, but there was flow where it joins the main stream (M06). Tufa is occasional.	n/a
M32	This is part of the Belleek Woods (north) spring system. This is a small section of stream which joins stream M22 just upstream of where M22 joins M06. Oncoids and ooids (tufa formation around stones and debris – shown in photo to right) were abundant in the channel.	

Table 4.3. Summary of water chemistry results

Spring ID	Location	pH (lab)	pH (field)	Alkalinity mg/l CaCO3	Conductivity @25'C µS/cm	Hardness mg/l CaCO3	Nitrate mg/l N	Ortho-Phosphate µg/l P
M01	Castleconner	7.7	7.8	303	626	303	0.32	20
M02	Castleconner to Quay House	-	8.27	-	-	-	-	-
M04	Quay House	7.7	8.1	359	750	378	1.7	<10
M06	Belleek Woods (north)	7.9	-	158	381	177	0.89	<10
M06	Belleek Woods (north)	7.1	8.1	161	395	180	0.52	<10
M07	Quignamanger (Cregg's Road/ Quay Road junction)	7.0	8.4	166	426	194	1.1	<10
M08	Quay House to Pump House	7.2	8.5	143	396	185	0.43	<10
M09	Quay House to Pump House	6.8	7.9	153	414	183	0.91	<10
M11	Estuary bank section to S of Scurmore House	6.8	8.1	181	506	217	2.2	<10
M12	Knockroe, N Castleconner	6.8	8.2	186	453	208	1.1	<10
M13	1st inlet N of Castleconner	-	8.51	-	-	-	-	-
M14	Warren Walk Woods	6.5	8.0	181	431	198	0.51	<10
M15	Warren Walk Woods	-	8.2	-	-	-	-	-
M17	Iceford Stables	7.0	7.6	175	409	187	0.62	<10
M18	Belleek Woods (north)	7.1	7.9	134	476	215	0.3	<10
M27	Belleek Woods (south)	7.0	8.1	185	586	262	0.65	<10

5.2 Detailed plot survey and condition assessment

5.2.1 Detailed spring survey summary

Ten plots were undertaken (MR01-MR10, Figure 4.2a-b). A summary of the results is shown in Tables 4.4 and 4.5. and the full results of the plot survey and condition assessment are shown in Appendix B.

Figure 4.2a. Petrifying spring plot survey locations within the northern survey area

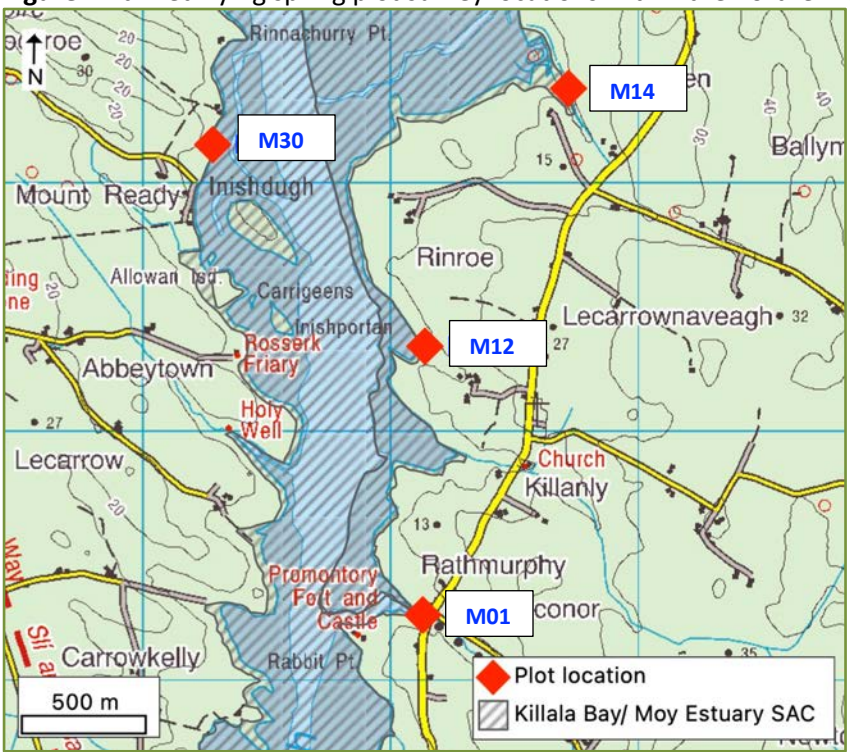


Figure 4.2b. Petrifying spring plot survey locations within the southern survey area

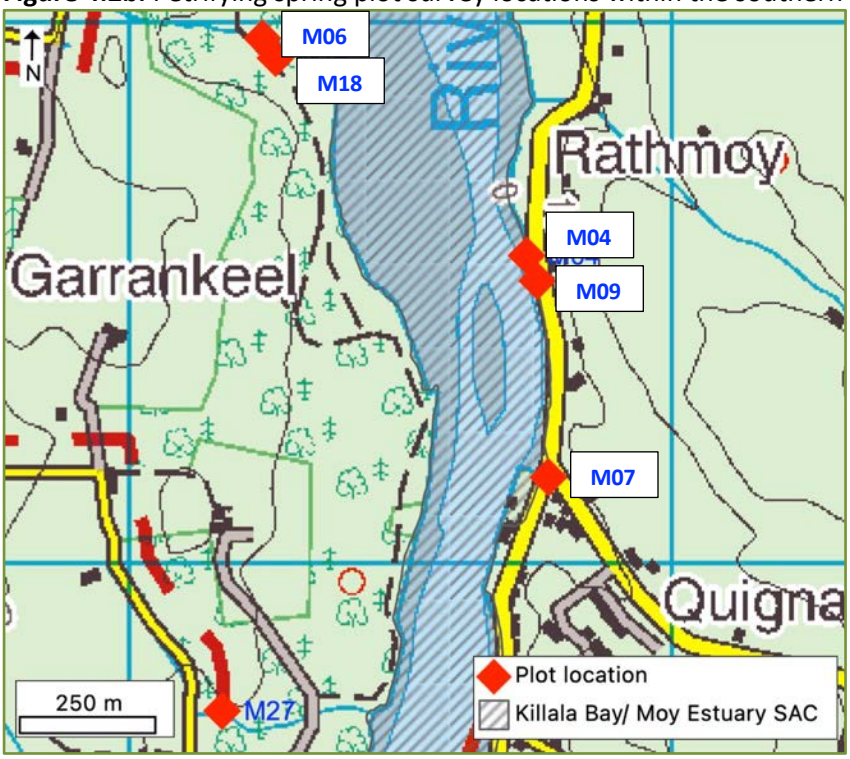


Table 4.4 Main tufa formation, vegetation type and species richness in each plot

Spring ID	Plot no.	Vegetation community[1]	Total tufa cover	Main tufa formation	Plot sp. richness	Average plot sp. richness for vegetation community[2]
M01	MR01	Group 3	50%	Cascade	6	13.8
M04	MR02	Group 4	100%	Cascade	15	19.7
M06	MR03	Group 2	95%	Stream crust	17	14.1
M07	MR04	Group 1	45%	Cascade	17	8.7
M09	MR05	Group 2	80%	Cascade	21	14.1
M12	MR06	Group 4	90%	Cascade	9	19.7
M14	MR07	Group 4	60%	Cascade	13	19.7
M18	MR08	Group 2	30%	Oncoids/ ooids	21	14.1
M27	MR09	Group 4	65%	Cascade	11	19.7
M30	MR010	Group 1	80%	Cascade	12	8.7

[1]Lyons & Kelly (2017)
[2]Lyons (2015)

Table 4.5. Conservation score, ranking and condition assessment summary for each plot

Spring no.	Plot no.	Annex I spring	Within SAC	Conservation score	Conservation ranking	Condition assessment result	Future Prospects	Recommendations
M01	MR01	Yes	On boundary, discharges to SAC	5	High	UNFAVOURABLE-INADEQUATE Fails on cover of positive indicator species & phosphate levels	UNFAVOURABLE-INADEQUATE Water pollution	Monitor nutrients in water. Investigate source of nutrients and possibility of reducing nutrient source in spring catchment.
M04	MR02	Yes	On boundary, discharges to SAC	7	**Very High**	FAVOURABLE Passes all criteria	UNFAVOURABLE-INADEQUATE Natural succession	Vegetation clearance (under supervision of a suitably experienced ecologist)
M06	MR03	Yes	Arises *c.* 300m to W, discharges to SAC	7	**Very High**	FAVOURABLE Passes all criteria	FAVOURABLE No negative activities	n/a
M07	MR04	Yes	Adjacent (*c.* 15m to E). discharges to SAC	5	High	FAVOURABLE One minor fail (woody cover) only	UNFAVOURABLE-INADEQUATE Natural succession	Vegetation clearance (under supervision of a suitably experienced ecologist)
M09	MR05	Yes	On boundary, discharges to SAC	5	High	FAVOURABLE Passes all criteria	FAVOURABLE No negative activities	n/a
M12	MR06	Yes	On boundary, discharges to SAC	6	High	FAVOURABLE Passes all criteria	UNFAVOURABLE-INADEQUATE Natural succession	Vegetation clearance (under supervision of a suitably experienced ecologist)
M14	MR07	Yes	Yes	5	High	FAVOURABLE Passes all criteria	FAVOURABLE No negative activities	n/a
M18	MR08	Yes	Arises *c.* 150m to W, discharges to SAC	6	High	FAVOURABLE Passes all criteria	FAVOURABLE No negative activities	n/a
M27	MR09	Yes	Arises *c.* 310m to W, discharges to SAC	5	High	UNFAVOURABLE-INADEQUATE Fails on cover of negative indicator species	UNFAVOURABLE-INADEQUATE Water pollution	Monitor nutrients in water. Investigate source of nutrients and possibility of reducing nutrient source in spring catchment.
M30	MR010	Yes	On boundary, discharges to SAC	6	High	FAVOURABLE Passes all criteria	FAVOURABLE No negative activities	n/a

All ten petrifying springs/ streams seepages are examples of the Annex I priority habitat 'Petrifying springs' due to the presence of typical tufa vegetation with tufa formation. Plots MR02-MR10 passed the water quality condition assessment criteria: below 10 mg/l for nitrate and below 15 µg/l for phosphate (Appendices A and B). However, plot MR01 exceeded the phosphate threshold (Tables 3.3 and 3.5) as 20 µg/l was recorded. Plot MR01 also failed the condition assessment criteria for positive indicator species (only 2 recorded). Plot MR09 failed the condition assessment criteria for negative indicator species (the bryophyte *Rhynchostegium riparioides* was abundant). This plot passed the water quality criteria, but it is likely that nutrients have been elevated historically (or intermittently) and so this spring is given an 'Unfavourable-Inadequate' score for Future Prospects. Three springs (MR02, MR04 and MR06) were given an 'Unfavourable-Inadequate' score for Future Prospects due to natural succession and invasion of these non-wooded springs by woody species.

5.3 Recommendations

- Thirty-two springs/ seepages/ streams with tufa formation were recorded of which twenty-three are examples of Annex I priority habitat 'Petrifying springs' [7220]. These springs/ streams and seepages are located either within/ adjacent to **Killala Bay/Moy Estuary SAC** [000458], or discharge into the SAC. Petrifying springs are not currently a Qualifying Interest (QI) for this SAC. Given the frequency of petrifying springs associated with for Killala Bay/Moy Estuary SAC, it should be considered whether this priority habitat should be added as a QI for this SAC.
- M04 (by the **Quay House**) is becoming overgrown with trees and scrub and would benefit from sensitive clearance of woody shrubs (in consultation with NPWS and under supervision by an ecologist).
- There are proposals for works to reduce nutrient inputs into to the pond in **Belleek Woods south.** This may involve works on the stream which flows into this pond. The stream has frequent cascade tufa and seepages along the riverbanks and this must be taken into account when assessing potential pond restoration options. It is highly likely that the pond was created in a calcareous wetland and therefore wetland vegetation within the pond could be encouraged as a proposal to reduce nutrient impacts. Any proposed works to the stream/ pond should be assessed by a petrifying springs ecologist.
- Petrifying springs can support **rare/ protected snail species** such as *Vertigo* spp. It would be useful to assess the potential of the springs recorded from the Moy Estuary to support rare/ protected snail species. It is recommended that a suitability experienced snail expert reviews the spring details in this report to assess whether field surveys would be worth undertaking.
- Where suitable, in consultation with NPWS and the relevant landowner, erect information boards to educate the public over the value of the petrifying springs at the site. Belleek Woods would be particularly suitable for this.

REFERENCES

Blockeel, T.L., Bell, N.E., Hill, M.O., Hodgetts, N.G., Long, D.G., Pilkington, S.L. and Rothero, S.L. (2021): A new checklist of the bryophytes of Britain and Ireland, 2020, Journal of Bryology, DOI: 10.1080/03736687.2020.1860866

Denyer (In Prep.). *Guidelines for the assessment of Annex I priority petrifying springs in Ireland*. Report for National Parks and Wildlife Service.

Fossitt, J.A. (2000). *A guide to habitats in Ireland.* Heritage Council.

Lyons, M.D. & Kelly, D.L. (2017). Plant community ecology of petrifying springs (*Cratoneurion*) – a priority habitat. *Phytocoenologia* 47 (1): 13-32.

Lyons, M.D. & Kelly, D.L. (2016) *Monitoring guidelines for the assessment of petrifying springs in Ireland*. Irish Wildlife Manuals, No. 94. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland.

Lyons, M.D. (2015). *The Flora and Conservation Status of Petrifying Springs in Ireland.* Unpublished phD thesis, Trinity College Dublin.

Stace, C.A. (2019). *New Flora of the British Isles.* 4th Edition. C&M Floristics, Stowmarket, UK.

EPA Laboratory Test Report

EPA Regional Inspectorate Castlebar
John Moore Road
Castlebar
Co. Mayo

Final

Report To: Internal Customer

Project: EPA-21-01373
Report Number : 6050
Entity: MISC
Location/Site: MISC
Site Visit Number:

Sample Number: 21-13137
Sampling Point: MISC
Description: M01 Castleconnor

Sample Condition: Normal

Sampled Date: 05/08/2021 11:00:00
Sampled By: J Denyer
Replicate / Split: None
Grab/Composite: Grab
Received in Lab: 06/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	303	mg/l CaCO3		19%	06/08/2021	CB	EPA_W17 *
Ammonia	0.023	mg/l N		22%	06/08/2021	CB	EPA_W07 *
Chloride	20.6	mg/l		16%	06/08/2021	CB	EPA_W07 *
Conductivity @25'C	626	µS/cm		15%	06/08/2021	CB	EPA_W08 *
Hardness	303	mg/l CaCO3		16%	06/08/2021	CB	EPA_W16 *
Nitrate	0.32	mg/l N		22%	09/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	06/08/2021	CB	EPA_W07 *
o-Phosphate	0.020	mg/l P		21%	06/08/2021	CB	EPA_W07 *
pH	7.7	pH units		0.2 pH units	06/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	0.32	mg/l N		25%	06/08/2021	CB	EPA_W07 *
Aluminium	24	µg/l		17%	17/08/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	17/08/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	17/08/2021	DB	EPA_W05 *
Barium	33	µg/l		10%	17/08/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	17/08/2021	DB	EPA_W05 *
Boron	20	µg/l		14%	17/08/2021	DB	EPA_W05 *
Cadmium	0.050	µg/l		10%	17/08/2021	DB	EPA_W05 *
Calcium	120	mg/l		14%	17/08/2021	DB	EPA_W05 *
Chromium	1.6	µg/l		13%	17/08/2021	DB	EPA_W05 *

Cobalt	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Copper	1.2	µg/l	8%	17/08/2021	DB	EPA_W05 *
Iron	340	µg/l	15%	17/08/2021	DB	EPA_W05 *
Lead	<0.2	µg/l	10%	17/08/2021	DB	EPA_W05 *
Magnesium	7.2	mg/l	15%	17/08/2021	DB	EPA_W05 *
Manganese	50	µg/l	20%	17/08/2021	DB	EPA_W05 *
Molybdenum	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Nickel	2.9	µg/l	9%	17/08/2021	DB	EPA_W05 *
Potassium	3.3	mg/l	18%	17/08/2021	DB	EPA_W05 *
Selenium	<1	µg/l	14%	17/08/2021	DB	EPA_W05 *
Sodium	13	mg/l	14%	17/08/2021	DB	EPA_W05 *
Strontium	710	µg/l	9%	17/08/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	17/08/2021	DB	EPA_W05 *
Uranium	1.4	µg/l	9%	17/08/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Zinc	1.4	µg/l	11%	17/08/2021	DB	EPA_W05 *
Sulphate	11	mg/l	11%	10/08/2021	KK	EPA_W12 *

Comment:

Sample Number:	21-13138	**Sampled Date:**	05/08/2021 14:00:00
Sampling Point:	MISC	**Sampled By:**	J Denyer
Description:	M04 Old Qauy Schoolhouse	**Replicate / Split:**	None
		Grab/Composite:	Grab
Sample Condition:	Normal	**Received in Lab:**	06/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	359	mg/l CaCO3		19%	06/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	06/08/2021	CB	EPA_W07 *
Chloride	22.0	mg/l		16%	06/08/2021	CB	EPA_W07 *
Conductivity @25'C	750	µS/cm		15%	06/08/2021	CB	EPA_W08 *
Hardness	378	mg/l CaCO3		16%	06/08/2021	CB	EPA_W16 *
Nitrate	1.7	mg/l N		22%	09/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	06/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	06/08/2021	CB	EPA_W07 *
pH	7.7	pH units		0.2 pH units	06/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	1.7	mg/l N		25%	06/08/2021	CB	EPA_W07 *
Aluminium	33	µg/l		17%	17/08/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	17/08/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	17/08/2021	DB	EPA_W05 *
Barium	24	µg/l		10%	17/08/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	17/08/2021	DB	EPA_W05 *
Boron	17	µg/l		14%	17/08/2021	DB	EPA_W05 *
Cadmium	0.22	µg/l		10%	17/08/2021	DB	EPA_W05 *
Calcium	140	mg/l		14%	17/08/2021	DB	EPA_W05 *
Chromium	1.8	µg/l		13%	17/08/2021	DB	EPA_W05 *
Cobalt	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Copper	1.4	µg/l		8%	17/08/2021	DB	EPA_W05 *
Iron	56	µg/l		15%	17/08/2021	DB	EPA_W05 *
Lead	0.27	µg/l		10%	17/08/2021	DB	EPA_W05 *
Magnesium	9.1	mg/l		15%	17/08/2021	DB	EPA_W05 *
Manganese	<5	µg/l		20%	17/08/2021	DB	EPA_W05 *
Molybdenum	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *

Nickel	2.0	µg/l	9%	17/08/2021	DB	EPA_W05 *
Potassium	3.0	mg/l	18%	17/08/2021	DB	EPA_W05 *
Selenium	1.3	µg/l	14%	17/08/2021	DB	EPA_W05 *
Sodium	13	mg/l	14%	17/08/2021	DB	EPA_W05 *
Strontium	890	µg/l	9%	17/08/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	17/08/2021	DB	EPA_W05 *
Uranium	1.1	µg/l	9%	17/08/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Zinc	2.0	µg/l	11%	17/08/2021	DB	EPA_W05 *
Sulphate	10	mg/l	11%	10/08/2021	KK	EPA_W12 *

Comment:

Sample Number:	21-13139	**Sampled Date:**	05/08/2021 17:00:00
Sampling Point:	MISC	**Sampled By:**	J Denyer
Description:	M06 Belleek Woods	**Replicate / Split:**	None
		Grab/Composite:	Grab
Sample Condition:	Normal	**Received in Lab:**	06/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	158	mg/l CaCO3		19%	06/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	06/08/2021	CB	EPA_W07 *
Chloride	13.3	mg/l		16%	06/08/2021	CB	EPA_W07 *
Conductivity @25'C	381	µS/cm		15%	06/08/2021	CB	EPA_W08 *
Hardness	177	mg/l CaCO3		16%	06/08/2021	CB	EPA_W16 *
Nitrate	0.89	mg/l N		22%	09/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	06/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	06/08/2021	CB	EPA_W07 *
pH	7.9	pH units		0.2 pH units	06/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	0.89	mg/l N		25%	06/08/2021	CB	EPA_W07 *
Aluminium	71	µg/l		17%	17/08/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	17/08/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	17/08/2021	DB	EPA_W05 *
Barium	17	µg/l		10%	17/08/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	17/08/2021	DB	EPA_W05 *
Boron	21	µg/l		14%	17/08/2021	DB	EPA_W05 *
Cadmium	0.32	µg/l		10%	17/08/2021	DB	EPA_W05 *
Calcium	65	mg/l		14%	17/08/2021	DB	EPA_W05 *
Chromium	1.6	µg/l		13%	17/08/2021	DB	EPA_W05 *
Cobalt	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Copper	2.3	µg/l		8%	17/08/2021	DB	EPA_W05 *
Iron	630	µg/l		15%	17/08/2021	DB	EPA_W05 *
Lead	<0.2	µg/l		10%	17/08/2021	DB	EPA_W05 *
Magnesium	3.8	mg/l		15%	17/08/2021	DB	EPA_W05 *
Manganese	110	µg/l		20%	17/08/2021	DB	EPA_W05 *
Molybdenum	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *

Nickel	3.9	µg/l	9%	17/08/2021	DB	EPA_W05 *
Potassium	3.4	mg/l	18%	17/08/2021	DB	EPA_W05 *
Selenium	1.4	µg/l	14%	17/08/2021	DB	EPA_W05 *
Sodium	8.0	mg/l	14%	17/08/2021	DB	EPA_W05 *
Strontium	300	µg/l	9%	17/08/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	17/08/2021	DB	EPA_W05 *
Uranium	0.57	µg/l	9%	17/08/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Zinc	3.5	µg/l	11%	17/08/2021	DB	EPA_W05 *
Sulphate	12	mg/l	11%	10/08/2021	KK	EPA_W12 *

Comment:

Report Approved By:

Alan Stephens - Regional Chemist

Results in bold are outside specified limits, not taking account of measurement uncertainty. * Indicates accredited method. nm = not measured, nr = not reported, vob = visible on bottom. The temperature reading of a **composite** sample is provided to allow the interpretation of the field pH result only.

Field Measurements are performed on the date of sampling. Results relate only to the item tested as received.

EPA Laboratory Test Report

EPA Regional Inspectorate Castlebar
John Moore Road
Castlebar
Co. Mayo

Final

Report To: Internal Customer

Project: EPA-21-01374
Report Number : 6051
Entity: MISC
Location/Site: MISC
Site Visit Number:

Sample Number: 21-13142
Sampling Point: MISC
Description: M07

Sample Condition: Normal

Sampled Date: 06/08/2021 09:00:00
Sampled By: J Denyer
Replicate / Split: None
Grab/Composite: Grab
Received in Lab: 09/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	166	mg/l CaCO3		19%	10/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Chloride	22.4	mg/l		16%	10/08/2021	CB	EPA_W07 *
Conductivity @25'C	426	µS/cm		15%	10/08/2021	CB	EPA_W08 *
Hardness	194	mg/l CaCO3		16%	10/08/2021	CB	EPA_W16 *
Nitrate	1.1	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	10/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	10/08/2021	CB	EPA_W07 *
pH	7.0	pH units		0.2 pH units	10/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	1.1	mg/l N		25%	10/08/2021	CB	EPA_W07 *
Sulphate	12	mg/l		11%	12/08/2021	KK	EPA_W12 *
Aluminium	15	µg/l		17%	17/08/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	17/08/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	17/08/2021	DB	EPA_W05 *
Barium	26	µg/l		10%	17/08/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	17/08/2021	DB	EPA_W05 *
Boron	20	µg/l		14%	17/08/2021	DB	EPA_W05 *
Cadmium	0.030	µg/l		10%	17/08/2021	DB	EPA_W05 *
Calcium	120	mg/l		14%	17/08/2021	DB	EPA_W05 *

Chromium	1.6	µg/l	13%	17/08/2021	DB	EPA_W05 *
Cobalt	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Copper	1.4	µg/l	8%	17/08/2021	DB	EPA_W05 *
Iron	100	µg/l	15%	17/08/2021	DB	EPA_W05 *
Lead	<0.2	µg/l	10%	17/08/2021	DB	EPA_W05 *
Magnesium	8.1	mg/l	15%	17/08/2021	DB	EPA_W05 *
Manganese	8.4	µg/l	20%	17/08/2021	DB	EPA_W05 *
Molybdenum	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Nickel	2.3	µg/l	9%	17/08/2021	DB	EPA_W05 *
Potassium	2.6	mg/l	18%	17/08/2021	DB	EPA_W05 *
Selenium	1.3	µg/l	14%	17/08/2021	DB	EPA_W05 *
Sodium	14	mg/l	14%	17/08/2021	DB	EPA_W05 *
Strontium	800	µg/l	9%	17/08/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	17/08/2021	DB	EPA_W05 *
Uranium	1.6	µg/l	9%	17/08/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Zinc	1.0	µg/l	11%	17/08/2021	DB	EPA_W05 *

Comment:

Sample Number:	21-13143	**Sampled Date:**	06/08/2021 10:00:00
Sampling Point:	MISC	**Sampled By:**	J Denyer
Description:	M08	**Replicate / Split:**	None
		Grab/Composite:	Grab
Sample Condition:	Normal	**Received in Lab:**	09/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	143	mg/l CaCO3		19%	10/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Chloride	17.6	mg/l		16%	10/08/2021	CB	EPA_W07 *
Conductivity @25'C	396	µS/cm		15%	10/08/2021	CB	EPA_W08 *
Hardness	185	mg/l CaCO3		16%	10/08/2021	CB	EPA_W16 *
Nitrite	<4	µg/l N		18%	10/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	10/08/2021	CB	EPA_W07 *
pH	7.2	pH units		0.2 pH units	10/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	0.43	mg/l N		25%	10/08/2021	CB	EPA_W07 *
Sulphate	9.3	mg/l		11%	12/08/2021	KK	EPA_W12 *
Aluminium	27	µg/l		17%	17/08/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	17/08/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	17/08/2021	DB	EPA_W05 *
Barium	27	µg/l		10%	17/08/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	17/08/2021	DB	EPA_W05 *
Boron	20	µg/l		14%	17/08/2021	DB	EPA_W05 *
Cadmium	0.060	µg/l		10%	17/08/2021	DB	EPA_W05 *
Calcium	120	mg/l		14%	17/08/2021	DB	EPA_W05 *
Chromium	1.5	µg/l		13%	17/08/2021	DB	EPA_W05 *
Cobalt	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Copper	2.1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Iron	130	µg/l		15%	17/08/2021	DB	EPA_W05 *
Lead	0.74	µg/l		10%	17/08/2021	DB	EPA_W05 *
Magnesium	7.7	mg/l		15%	17/08/2021	DB	EPA_W05 *
Manganese	40	µg/l		20%	17/08/2021	DB	EPA_W05 *
Molybdenum	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *

Nickel	1.2	µg/l	9%	17/08/2021	DB	EPA_W05 *
Potassium	1.8	mg/l	18%	17/08/2021	DB	EPA_W05 *
Selenium	<1	µg/l	14%	17/08/2021	DB	EPA_W05 *
Sodium	12	mg/l	14%	17/08/2021	DB	EPA_W05 *
Strontium	700	µg/l	9%	17/08/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	17/08/2021	DB	EPA_W05 *
Uranium	0.95	µg/l	9%	17/08/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Zinc	3.8	µg/l	11%	17/08/2021	DB	EPA_W05 *

Comment:

Sample Number:	21-13144	**Sampled Date:**	06/08/2021 11:30:00
Sampling Point:	MISC	**Sampled By:**	J Denyer
Description:	M09	**Replicate / Split:**	None
		Grab/Composite:	Grab
Sample Condition:	Normal	**Received in Lab:**	09/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	153	mg/l CaCO3		19%	10/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Chloride	24.7	mg/l		16%	10/08/2021	CB	EPA_W07 *
Conductivity @25'C	414	µS/cm		15%	10/08/2021	CB	EPA_W08 *
Hardness	183	mg/l CaCO3		16%	10/08/2021	CB	EPA_W16 *
Nitrate	0.91	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	10/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	10/08/2021	CB	EPA_W07 *
pH	6.8	pH units		0.2 pH units	10/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	0.91	mg/l N		25%	10/08/2021	CB	EPA_W07 *
Sulphate	7.7	mg/l		11%	12/08/2021	KK	EPA_W12 *
Aluminium	28	µg/l		17%	17/08/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	17/08/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	17/08/2021	DB	EPA_W05 *
Barium	25	µg/l		10%	17/08/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	17/08/2021	DB	EPA_W05 *
Boron	19	µg/l		14%	17/08/2021	DB	EPA_W05 *
Cadmium	0.080	µg/l		10%	17/08/2021	DB	EPA_W05 *
Calcium	130	mg/l		14%	17/08/2021	DB	EPA_W05 *
Chromium	1.6	µg/l		13%	17/08/2021	DB	EPA_W05 *
Cobalt	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Copper	4.2	µg/l		8%	17/08/2021	DB	EPA_W05 *
Iron	64	µg/l		15%	17/08/2021	DB	EPA_W05 *
Lead	0.66	µg/l		10%	17/08/2021	DB	EPA_W05 *
Magnesium	9.4	mg/l		15%	17/08/2021	DB	EPA_W05 *
Manganese	11	µg/l		20%	17/08/2021	DB	EPA_W05 *

Molybdenum	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Nickel	1.7	µg/l	9%	17/08/2021	DB	EPA_W05 *
Potassium	2.6	mg/l	18%	17/08/2021	DB	EPA_W05 *
Selenium	1.0	µg/l	14%	17/08/2021	DB	EPA_W05 *
Sodium	14	mg/l	14%	17/08/2021	DB	EPA_W05 *
Strontium	820	µg/l	9%	17/08/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	17/08/2021	DB	EPA_W05 *
Uranium	1.2	µg/l	9%	17/08/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Zinc	1.8	µg/l	11%	17/08/2021	DB	EPA_W05 *

Comment:

Sample Number:	21-13145	**Sampled Date:**	06/08/2021 13:00:00
Sampling Point:	MISC	**Sampled By:**	J Denyer
Description:	M11	**Replicate / Split:**	None
		Grab/Composite:	Grab
Sample Condition:	Normal	**Received in Lab:**	09/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	181	mg/l CaCO3		19%	10/08/2021	CB	EPA_W17 *
Ammonia	0.027	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Chloride	34.7	mg/l		16%	10/08/2021	CB	EPA_W07 *
Conductivity @25'C	506	µS/cm		15%	10/08/2021	CB	EPA_W08 *
Hardness	217	mg/l CaCO3		16%	10/08/2021	CB	EPA_W16 *
Nitrate	2.2	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Nitrite	9.83	µg/l N		18%	10/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	10/08/2021	CB	EPA_W07 *
pH	6.8	pH units		0.2 pH units	10/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	2.2	mg/l N		25%	10/08/2021	CB	EPA_W07 *
Sulphate	9.7	mg/l		11%	12/08/2021	KK	EPA_W12 *
Aluminium	16	µg/l		17%	17/08/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	17/08/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	17/08/2021	DB	EPA_W05 *
Barium	23	µg/l		10%	17/08/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	17/08/2021	DB	EPA_W05 *
Boron	31	µg/l		14%	17/08/2021	DB	EPA_W05 *
Cadmium	0.040	µg/l		10%	17/08/2021	DB	EPA_W05 *
Calcium	150	mg/l		14%	17/08/2021	DB	EPA_W05 *
Chromium	1.6	µg/l		13%	17/08/2021	DB	EPA_W05 *
Cobalt	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Copper	1.1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Iron	71	µg/l		15%	17/08/2021	DB	EPA_W05 *
Lead	<0.2	µg/l		10%	17/08/2021	DB	EPA_W05 *
Magnesium	7.6	mg/l		15%	17/08/2021	DB	EPA_W05 *
Manganese	23	µg/l		20%	17/08/2021	DB	EPA_W05 *

Molybdenum	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Nickel	2.6	µg/l	9%	17/08/2021	DB	EPA_W05 *
Potassium	5.8	mg/l	18%	17/08/2021	DB	EPA_W05 *
Selenium	1.2	µg/l	14%	17/08/2021	DB	EPA_W05 *
Sodium	17	mg/l	14%	17/08/2021	DB	EPA_W05 *
Strontium	740	µg/l	9%	17/08/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	17/08/2021	DB	EPA_W05 *
Uranium	1.5	µg/l	9%	17/08/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Zinc	<1	µg/l	11%	17/08/2021	DB	EPA_W05 *

Comment:

Sample Number:	21-13146	**Sampled Date:**	06/08/2021 14:00:00
Sampling Point:	MISC	**Sampled By:**	J Denyer
Description:	M12	**Replicate / Split:**	None
		Grab/Composite:	Grab
Sample Condition:	Normal	**Received in Lab:**	09/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	186	mg/l CaCO3		19%	10/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Chloride	23.2	mg/l		16%	10/08/2021	CB	EPA_W07 *
Conductivity @25'C	453	µS/cm		15%	10/08/2021	CB	EPA_W08 *
Hardness	208	mg/l CaCO3		16%	10/08/2021	CB	EPA_W16 *
Nitrate	1.1	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	10/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	10/08/2021	CB	EPA_W07 *
pH	6.8	pH units		0.2 pH units	10/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	1.1	mg/l N		25%	10/08/2021	CB	EPA_W07 *
Sulphate	4.9	mg/l		11%	12/08/2021	KK	EPA_W12 *
Aluminium	21	µg/l		17%	17/08/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	17/08/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	17/08/2021	DB	EPA_W05 *
Barium	23	µg/l		10%	17/08/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	17/08/2021	DB	EPA_W05 *
Boron	21	µg/l		14%	17/08/2021	DB	EPA_W05 *
Cadmium	0.070	µg/l		10%	17/08/2021	DB	EPA_W05 *
Calcium	140	mg/l		14%	17/08/2021	DB	EPA_W05 *
Chromium	1.8	µg/l		13%	17/08/2021	DB	EPA_W05 *
Cobalt	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Copper	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Iron	57	µg/l		15%	17/08/2021	DB	EPA_W05 *
Lead	0.42	µg/l		10%	17/08/2021	DB	EPA_W05 *
Magnesium	10	mg/l		15%	17/08/2021	DB	EPA_W05 *
Manganese	7.2	µg/l		20%	17/08/2021	DB	EPA_W05 *

Molybdenum	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Nickel	2.2	µg/l	9%	17/08/2021	DB	EPA_W05 *
Potassium	2.9	mg/l	18%	17/08/2021	DB	EPA_W05 *
Selenium	1.1	µg/l	14%	17/08/2021	DB	EPA_W05 *
Sodium	14	mg/l	14%	17/08/2021	DB	EPA_W05 *
Strontium	750	µg/l	9%	17/08/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	17/08/2021	DB	EPA_W05 *
Uranium	1.4	µg/l	9%	17/08/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Zinc	1.3	µg/l	11%	17/08/2021	DB	EPA_W05 *

Comment:

Sample Number:	21-13147	**Sampled Date:**	06/08/2021 15:30:00
Sampling Point:	MISC	**Sampled By:**	J Denyer
Description:	M14	**Replicate / Split:**	None
		Grab/Composite:	Grab
Sample Condition:	Normal	**Received in Lab:**	09/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	181	mg/l CaCO3		19%	10/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Chloride	19.8	mg/l		16%	10/08/2021	CB	EPA_W07 *
Conductivity @25'C	431	µS/cm		15%	10/08/2021	CB	EPA_W08 *
Hardness	198	mg/l CaCO3		16%	10/08/2021	CB	EPA_W16 *
Nitrate	0.51	mg/l N		22%	10/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	10/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	10/08/2021	CB	EPA_W07 *
pH	6.5	pH units		0.2 pH units	10/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	0.51	mg/l N		25%	10/08/2021	CB	EPA_W07 *
Sulphate	4.4	mg/l		11%	12/08/2021	KK	EPA_W12 *
Aluminium	3.1	µg/l		17%	17/08/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	17/08/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	17/08/2021	DB	EPA_W05 *
Barium	26	µg/l		10%	17/08/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	17/08/2021	DB	EPA_W05 *
Boron	26	µg/l		14%	17/08/2021	DB	EPA_W05 *
Cadmium	0.020	µg/l		10%	17/08/2021	DB	EPA_W05 *
Calcium	140	mg/l		14%	17/08/2021	DB	EPA_W05 *
Chromium	1.7	µg/l		13%	17/08/2021	DB	EPA_W05 *
Cobalt	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Copper	<1	µg/l		8%	17/08/2021	DB	EPA_W05 *
Iron	29	µg/l		15%	17/08/2021	DB	EPA_W05 *
Lead	<0.2	µg/l		10%	17/08/2021	DB	EPA_W05 *
Magnesium	8.6	mg/l		15%	17/08/2021	DB	EPA_W05 *
Manganese	<5	µg/l		20%	17/08/2021	DB	EPA_W05 *

Molybdenum	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Nickel	1.5	µg/l	9%	17/08/2021	DB	EPA_W05 *
Potassium	1.3	mg/l	18%	17/08/2021	DB	EPA_W05 *
Selenium	<1	µg/l	14%	17/08/2021	DB	EPA_W05 *
Sodium	12	mg/l	14%	17/08/2021	DB	EPA_W05 *
Strontium	780	µg/l	9%	17/08/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	17/08/2021	DB	EPA_W05 *
Uranium	0.95	µg/l	9%	17/08/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	17/08/2021	DB	EPA_W05 *
Zinc	1.1	µg/l	11%	17/08/2021	DB	EPA_W05 *

Comment:

Report Approved By:

Alan Stephens - Regional Chemist

Results in bold are outside specified limits, not taking account of measurement uncertainty. * Indicates accredited method. nm = not measured, nr = not reported, vob = visible on bottom. The temperature reading of a **composite** sample is provided to allow the interpretation of the field pH result only.

Field Measurements are performed on the date of sampling. Results relate only to the item tested as received.

EPA Laboratory Test Report

EPA Regional Inspectorate Castlebar
John Moore Road
Castlebar
Co. Mayo

Final

Report To: External Customer
bvfdbvd
bfdb

Project: EPA-21-01548
Report Number : 6126
Entity: MISC
Location/Site: MISC
Site Visit Number:

Sample Number: 21-14853
Sampling Point: MISC
Description: M17

Sample Condition: Normal

Sampled Date: 27/08/2021 10:15:00
Sampled By: J Denyer
Replicate / Split: None
Grab/Composite: Grab
Received in Lab: 31/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	175	mg/l CaCO3		19%	31/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	31/08/2021	CB	EPA_W07 *
Chloride	19.0	mg/l		16%	31/08/2021	CB	EPA_W07 *
Conductivity @25'C	409	µS/cm		15%	31/08/2021	CB	EPA_W08 *
Hardness	187	mg/l CaCO3		16%	31/08/2021	CB	EPA_W16 *
Nitrate	0.62	mg/l N		22%	31/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	31/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	31/08/2021	CB	EPA_W07 *
pH	7.0	pH units		0.2 pH units	31/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	0.62	mg/l N		25%	31/08/2021	CB	EPA_W07 *
Aluminium	8.6	µg/l		17%	07/09/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	07/09/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	07/09/2021	DB	EPA_W05 *
Barium	42	µg/l		10%	07/09/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	07/09/2021	DB	EPA_W05 *
Boron	18	µg/l		14%	07/09/2021	DB	EPA_W05 *
Cadmium	0.020	µg/l		10%	07/09/2021	DB	EPA_W05 *
Calcium	160	mg/l		14%	07/09/2021	DB	EPA_W05 *
Chromium	<1	µg/l		13%	07/09/2021	DB	EPA_W05 *

Cobalt	<1	µg/l	8%	07/09/2021	DB	EPA_W05 *
Copper	<1	µg/l	8%	07/09/2021	DB	EPA_W05 *
Iron	140	µg/l	15%	07/09/2021	DB	EPA_W05 *
Lead	<0.2	µg/l	10%	07/09/2021	DB	EPA_W05 *
Magnesium	10	mg/l	15%	07/09/2021	DB	EPA_W05 *
Manganese	22	µg/l	20%	07/09/2021	DB	EPA_W05 *
Molybdenum	<1	µg/l	8%	07/09/2021	DB	EPA_W05 *
Nickel	1.8	µg/l	9%	07/09/2021	DB	EPA_W05 *
Potassium	3.2	mg/l	18%	07/09/2021	DB	EPA_W05 *
Selenium	1.3	µg/l	14%	07/09/2021	DB	EPA_W05 *
Sodium	14	mg/l	14%	07/09/2021	DB	EPA_W05 *
Strontium	880	µg/l	9%	07/09/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	07/09/2021	DB	EPA_W05 *
Uranium	1.6	µg/l	9%	07/09/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	07/09/2021	DB	EPA_W05 *
Zinc	<1	µg/l	11%	07/09/2021	DB	EPA_W05 *
Sulphate	6.0	mg/l	11%	10/09/2021	KK	EPA_W12 *

Comment:

Sample Number:	21-14854	**Sampled Date:**	27/08/2021 11:00:12
Sampling Point:	MISC	**Sampled By:**	J Denyer
Description:	M182	**Replicate / Split:**	None
		Grab/Composite:	Grab
Sample Condition:	Normal	**Received in Lab:**	31/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	161	mg/l CaCO3		19%	31/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	31/08/2021	CB	EPA_W07 *
Chloride	16.5	mg/l		16%	31/08/2021	CB	EPA_W07 *
Conductivity @25'C	395	µS/cm		15%	31/08/2021	CB	EPA_W08 *
Hardness	180	mg/l CaCO3		16%	31/08/2021	CB	EPA_W16 *
Nitrate	0.52	mg/l N		22%	31/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	31/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	31/08/2021	CB	EPA_W07 *
pH	7.1	pH units		0.2 pH units	31/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	0.52	mg/l N		25%	31/08/2021	CB	EPA_W07 *
Aluminium	3.2	µg/l		17%	07/09/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	07/09/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	07/09/2021	DB	EPA_W05 *
Barium	25	µg/l		10%	07/09/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	07/09/2021	DB	EPA_W05 *
Boron	23	µg/l		14%	07/09/2021	DB	EPA_W05 *
Cadmium	0.020	µg/l		10%	07/09/2021	DB	EPA_W05 *
Calcium	120	mg/l		14%	07/09/2021	DB	EPA_W05 *
Chromium	<1	µg/l		13%	07/09/2021	DB	EPA_W05 *
Cobalt	<1	µg/l		8%	07/09/2021	DB	EPA_W05 *
Copper	1.5	µg/l		8%	07/09/2021	DB	EPA_W05 *
Iron	17	µg/l		15%	07/09/2021	DB	EPA_W05 *
Lead	<0.2	µg/l		10%	07/09/2021	DB	EPA_W05 *
Magnesium	7.4	mg/l		15%	07/09/2021	DB	EPA_W05 *
Manganese	<5	µg/l		20%	07/09/2021	DB	EPA_W05 *
Molybdenum	<1	µg/l		8%	07/09/2021	DB	EPA_W05 *

Nickel	<1	µg/l	9%	07/09/2021	DB	EPA_W05 *
Potassium	2.2	mg/l	18%	07/09/2021	DB	EPA_W05 *
Selenium	<1	µg/l	14%	07/09/2021	DB	EPA_W05 *
Sodium	14	mg/l	14%	07/09/2021	DB	EPA_W05 *
Strontium	700	µg/l	9%	07/09/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	07/09/2021	DB	EPA_W05 *
Uranium	1.4	µg/l	9%	07/09/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	07/09/2021	DB	EPA_W05 *
Zinc	4.0	µg/l	11%	07/09/2021	DB	EPA_W05 *
Sulphate	9.4	mg/l	11%	10/09/2021	KK	EPA_W12 *

Comment:

Sample Number:	21-14855	**Sampled Date:**	27/08/2021 11:30:00
Sampling Point:	MISC	**Sampled By:**	J Denyer
Description:	M186	**Replicate / Split:**	None
		Grab/Composite:	Grab
Sample Condition:	Normal	**Received in Lab:**	31/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	134	mg/l CaCO3		19%	31/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	31/08/2021	CB	EPA_W07 *
Chloride	23.4	mg/l		16%	31/08/2021	CB	EPA_W07 *
Conductivity @25'C	476	µS/cm		15%	31/08/2021	CB	EPA_W08 *
Hardness	215	mg/l CaCO3		16%	31/08/2021	CB	EPA_W16 *
Nitrate	0.30	mg/l N		22%	31/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	31/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	31/08/2021	CB	EPA_W07 *
pH	7.0	pH units		0.2 pH units	31/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	0.30	mg/l N		25%	31/08/2021	CB	EPA_W07 *
Aluminium	3.9	µg/l		17%	07/09/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	07/09/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	07/09/2021	DB	EPA_W05 *
Barium	29	µg/l		10%	07/09/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	07/09/2021	DB	EPA_W05 *
Boron	21	µg/l		14%	07/09/2021	DB	EPA_W05 *
Cadmium	0.020	µg/l		10%	07/09/2021	DB	EPA_W05 *
Calcium	130	mg/l		14%	07/09/2021	DB	EPA_W05 *
Chromium	<1	µg/l		13%	07/09/2021	DB	EPA_W05 *
Cobalt	<1	µg/l		8%	07/09/2021	DB	EPA_W05 *
Copper	<1	µg/l		8%	07/09/2021	DB	EPA_W05 *
Iron	<10	µg/l		15%	07/09/2021	DB	EPA_W05 *
Lead	<0.2	µg/l		10%	07/09/2021	DB	EPA_W05 *
Magnesium	7.8	mg/l		15%	07/09/2021	DB	EPA_W05 *
Manganese	<5	µg/l		20%	07/09/2021	DB	EPA_W05 *
Molybdenum	<1	µg/l		8%	07/09/2021	DB	EPA_W05 *

Nickel	1.2	µg/l	9%	07/09/2021	DB	EPA_W05 *
Potassium	2.2	mg/l	18%	07/09/2021	DB	EPA_W05 *
Selenium	<1	µg/l	14%	07/09/2021	DB	EPA_W05 *
Sodium	12	mg/l	14%	07/09/2021	DB	EPA_W05 *
Strontium	730	µg/l	9%	07/09/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	07/09/2021	DB	EPA_W05 *
Uranium	1.4	µg/l	9%	07/09/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	07/09/2021	DB	EPA_W05 *
Zinc	<1	µg/l	11%	07/09/2021	DB	EPA_W05 *
Sulphate	12	mg/l	11%	10/09/2021	KK	EPA_W12 *

Comment:

Sample Number:	21-14856	**Sampled Date:**	27/08/2021 18:15:00
Sampling Point:	MISC	**Sampled By:**	J Denyer
Description:	M24	**Replicate / Split:**	None
		Grab/Composite:	Grab
Sample Condition:	Normal	**Received in Lab:**	31/08/2021

Parameter	Result	Units	Limits	Measurement Uncertainty	Analysis Date	Lab	Method
Alkalinity	185	mg/l CaCO3		19%	31/08/2021	CB	EPA_W17 *
Ammonia	<0.02	mg/l N		22%	31/08/2021	CB	EPA_W07 *
Chloride	27.5	mg/l		16%	31/08/2021	CB	EPA_W07 *
Conductivity @25'C	586	µS/cm		15%	31/08/2021	CB	EPA_W08 *
Hardness	262	mg/l CaCO3		16%	31/08/2021	CB	EPA_W16 *
Nitrate	0.65	mg/l N		22%	31/08/2021	CB	EPA_W07 *
Nitrite	<4	µg/l N		18%	31/08/2021	CB	EPA_W07 *
o-Phosphate	<0.01	mg/l P		21%	31/08/2021	CB	EPA_W07 *
pH	7.0	pH units		0.2 pH units	31/08/2021	CB	EPA_W09 *
Total Oxidised Nitrogen	0.65	mg/l N		25%	31/08/2021	CB	EPA_W07 *
Aluminium	5.4	µg/l		17%	07/09/2021	DB	EPA_W05 *
Antimony	<1	µg/l		23%	07/09/2021	DB	EPA_W05 *
Arsenic	<1	µg/l		13%	07/09/2021	DB	EPA_W05 *
Barium	45	µg/l		10%	07/09/2021	DB	EPA_W05 *
Beryllium	<1	µg/l		14%	07/09/2021	DB	EPA_W05 *
Boron	30	µg/l		14%	07/09/2021	DB	EPA_W05 *
Cadmium	0.030	µg/l		10%	07/09/2021	DB	EPA_W05 *
Calcium	150	mg/l		14%	07/09/2021	DB	EPA_W05 *
Chromium	<1	µg/l		13%	07/09/2021	DB	EPA_W05 *
Cobalt	<1	µg/l		8%	07/09/2021	DB	EPA_W05 *
Copper	<1	µg/l		8%	07/09/2021	DB	EPA_W05 *
Iron	95	µg/l		15%	07/09/2021	DB	EPA_W05 *
Lead	<0.2	µg/l		10%	07/09/2021	DB	EPA_W05 *
Magnesium	10	mg/l		15%	07/09/2021	DB	EPA_W05 *
Manganese	13	µg/l		20%	07/09/2021	DB	EPA_W05 *
Molybdenum	<1	µg/l		8%	07/09/2021	DB	EPA_W05 *

Nickel	1.3	µg/l	9%	07/09/2021	DB	EPA_W05 *
Potassium	2.2	mg/l	18%	07/09/2021	DB	EPA_W05 *
Selenium	1.2	µg/l	14%	07/09/2021	DB	EPA_W05 *
Sodium	19	mg/l	14%	07/09/2021	DB	EPA_W05 *
Strontium	1600	µg/l	9%	07/09/2021	DB	EPA_W05 *
Thallium	<0.2	µg/l	8%	07/09/2021	DB	EPA_W05 *
Uranium	1.3	µg/l	9%	07/09/2021	DB	EPA_W05 *
Vanadium	<1	µg/l	8%	07/09/2021	DB	EPA_W05 *
Zinc	2.2	µg/l	11%	07/09/2021	DB	EPA_W05 *
Sulphate	51	mg/l	11%	10/09/2021	KK	EPA_W12 *

Comment:

Report Approved By:

Alan Stephens - Regional Chemist

Results in bold are outside specified limits, not taking account of measurement uncertainty. * Indicates accredited method. nm = not measured, nr = not reported, vob = visible on bottom. The temperature reading of a **composite** sample is provided to allow the interpretation of the field pH result only.

Field Measurements are performed on the date of sampling. Results relate only to the item tested as received.

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

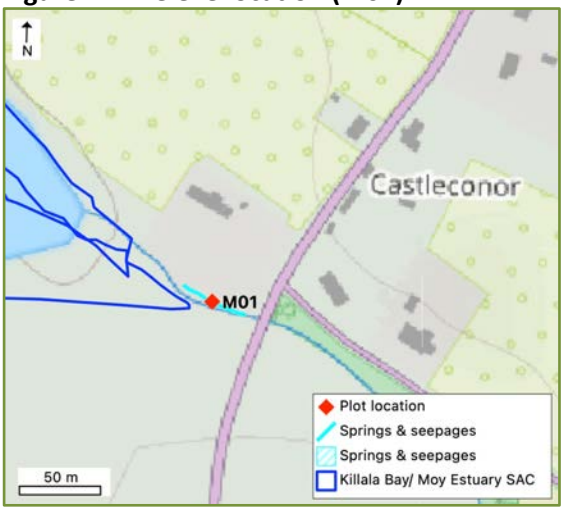
SPRING DETAILS

Site name: Castleconnor		
Spring name: M01	**Relevé No.:** MR01	**Water sample**: M01
Survey date: 05/08/2021	**Relevé dimensions:** 2m x 2m	**Relevé area:** 4m^2
Grid reference: G2612924265	**Spring type:** Stream flowing into estuary	
Slope: 5 ^{o}	**Altitude (m):** ca. 7m	**Aspect:** E
pH: 7.82 (field); 7.7 (lab)	**EC:** 626 µS/cm (lab)	**Temp.:** 14.7 (field)

Spring description: This is a stream which flows under the coast road and discharges into the estuary to the west. Where it enters the estuary (and downstream of the relevé location), the stream is brackish. The stream is 4-5m wide. Tufa is mainly in the form of cascade tufa but there is some paludal tufa around bryophytes on stones and a small amount of oncoids/ ooids. The vegetation is mainly bryophyte dominated with just scattered vascular plants. The main species are *Helioscadium nodiflorum, Agrostis stolonifera* and the bryophytes *Cratoneuron filicinum, Pellia endiviifolia, Rhynchostegium riparioides* and *Fissidens rufulus.*
The vegetation has most affinity to **Group 3 *Brachythecium rivulare-Platyhypnidium riparioides* tufaceous streams and flushes** vegetation community (Lyons & Kelly, 2017).

Relevé location:
The relevé (Figure 1.1; Photograph 1.1) is located *ca.* 30m west (downstream) of the coast road

Figure 1.1. Relevé location (M01)



Photograph 1.1. Relevé location (view to W)

DETAILED RELEVÉ

Physical characteristics

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	45	Flowing/ trickling	100	Living field/ ground flora	50
Paludal (2)	2	Pool/ standing water	-	Bare tufa (active/ recent)	10
Stream crust	-	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	2	Damp	-	Leaf litter/ standing dead	-
Dam	-	Dry, not impacted by spring	-	Bare soil	-
Cemented rudites	-	Other:	-	Bare stone	-
Non-tufa	50			Other:	40
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous

Shrub/ canopy layer

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Acer pseudoplatanus	60	-	-
Rubus fruticosus agg.	2	-	-
	-	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 62		

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE):	c. 1.5 m

Field/ ground flora

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Helioscadium nodiflorum	3	*Agrostis stolonifera*	3	*Rhynchostegium riparioides*	8		
				Cratoneuron filicinum	3		
				Pellia endiviifolia	3		
				Fissidens rufulus	3		
						TOTAL WOODY <50cm	**0**
						PTERIDOPHYTES	
						TOTAL PTERIDOPHYTES	**0**
						ALGAE	
						Filamentous algae	27
						TOTAL ALGAE*	**0**
TOTAL FORBS	**3**	**TOTAL GRAMINOIDS**	**3**	**TOTAL BRYOPHYTES**	**17**	**TOTAL COVER**	**23**

*Algae not included in total vegetation cover (Lyons & Kelly, 2016)

Photos

Photograph 1.2. View upstream (west) from relevé

Photograph 1.3. Vegetation within relevé

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Condition assessment

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	0 recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	2 species recorded: *Pellia endiviifolia, Fissidens rufulus*	3 species AND no loss from baseline number of species	Result = 2 positive indicator species **FAIL**
Typical accompanying species (neutral indicators)	1 species recorded: *Agrostis stolonifera*	n/a	For information only
Invasive species	0 species recorded	Absent	Result = Absent **PASS**
Negative herbaceous indicator species	1 species recorded: *Helioscadium nodiflorum*	Total cover should not be dominant or abundant	Result = Occasional **PASS**
Negative bryophyte indicator species	2 species recorded: *Cratoneuron filicinum, Rhynchostegium riparioides*	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	Result = 1 occasional, 1 frequent **PASS**
Negative woody indicator species	n/a as wooded stream	Absent (except in wooded springs)	n/a
Spring water composition and flow			
Nitrate level	Baseline unknown 2021 value = 0.32 mg/l	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	Baseline unknown 2021 value (Ortho-P) = 20 µg/l	No increase from baseline and not above 15 µg/l	**FAIL**
Water flow	Not determined	No alteration of natural flow	No obvious alteration **PASS**
Impacts of grazing			
Field layer height	25cm	Height between 10 and 50cm	Result = 5cm **PASS***
Trampling/dung	Absent	Impact should not be abundant/dominant	Result = Absent **PASS**
Overall Structure & Functions Assessment			
All pass or one minor/borderline fail AND, if some indicators are Not Determined, the number of passes is at least five AND there is a pass for Positive Indicator Species		Green - Favourable	**Result = 2 fail UNFAVOURABLE - INADEQUATE**
1 - 2 Fail		Amber - Unfavourable Inadequate	
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
J01 Mixed source pollution to surface and ground waters (limnic and terrestrial)		Moderate negative impact, originating outside of site	**UNFAVOURABLE - INADEQUATE**

*Bryophyte dominated so vegetation naturally lower in height

Conservation Score

Criteria	Result	Score
Species diversity score	2 positive indicator species (=low)	1
HQ Indicator Species	0	0
Tufa-forming capacity	Smaller consolidated deposits or strongly formed paludal tufa (high)	3
Other positive characteristics	Spring discharges into Killala Bay/Moy Estuary SAC	1
Conservation Score		5
Rank		**High**

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

SPRING DETAILS

Site name: Quay House		
Spring name: M04	**Relevé No.:** MR02	**Water sample**: M04
Survey date: 05/08/2021	**Relevé dimensions:** 2m x 2m	**Relevé area:** 4m^2
Grid reference: G2573321569	**Spring type:** Stream flowing into estuary	
Slope: 20°	**Altitude (m):** ca. 11m	**Aspect:** W
pH: 8.11 (field); 7.7 (lab)	**EC:** 750 µS/cm (lab)	**Temp.:** 12.4 (field)

Spring description: This is a spring which arises in a property to the east of the coast road. It flows down the hill and under the road. Below the road it forms a large tufa mound (Figure 2.1) and discharges into the estuary. The main tufa formation is cascade tufa but there is also significant stream crust tufa in the main spring channel and some paludal tufa. The tufa mound extends approximately 20m along the shoreline. Where the spring joins the estuary, the tufa cascades are algal covered. Much of the main tufa mound is dominated by trees and scrub. The relevé was undertaken in the area with the highest cover of petrifying spring vegetation. The vegetation is bryophyte dominated, with abundant *Palustriella commutata* and occasional to frequent *Bryum pseudotriquetrum, Palustriella falcata* and *Brachythecium rivulare.* The main vascular plants are *Agrostis stolonifera, Festuca rubra* and *Potentilla reptans* with patches of *Equisetum variegatum*.
The vegetation has most affinity to **Group 4 *Palustriella commutata-Agrostis stolonifera Springheads*** vegetation community (Lyons & Kelly, 2017).

Relevé location:
The relevé (Figure 2.1; red arrow Photograph 2.1) is located on the top of the tufa mound.

Figure 2.1. Relevé location (M04)

© OpenStreetMap contributors

Photograph 2.1. Relevé location (view to W)

DETAILED RELEVÉ

Physical characteristics

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	60	Flowing/ trickling	40	Living field/ ground flora	80
Paludal (3)	10	Pool/ standing water	5	Bare tufa (active/ recent)	20
Stream crust	30	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	-	Damp	55	Leaf litter/ standing dead	-
Dam	-	Dry, not impacted by spring	-	Bare soil	-
Cemented rudites	-	Other:	-	Bare stone	-
Non-tufa	-			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Shrub/ canopy layer

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Acer pseudoplatanus	5	-	-
Rubus fruticosus agg.	-	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 5		
MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE):			1 m

Field/ ground flora

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Potentilla reptans	10	*Agrostis stolonifera*	15	*Plagiomnium elatum*	1	*Hedera hibernica*	1
Angelica sylvestris	3	*Festuca rubra*	3	*Cratoneuron filicinum*	3		
Arctium minus	3			*Calliergonella cuspidata*	1		
				Palustriella commutata	30		
				Bryum pseudotriquetrum	8	**TOTAL WOODY <50cm**	**1**
				Brachythecium rivulare	3		
				Palustriella falcata	3	**PTERIDOPHYTES**	
				Plagiomnium undulatum	1	*Equisetum variegatum*	1
						TOTAL PTERIDOPHYTES	**1**
						ALGAE	
						Filamentous algae	0
						TOTAL ALGAE*	**0**
TOTAL FORBS	**16**	**TOTAL GRAMINOIDS**	**13**	**TOTAL BRYOPHYTES**	**50**	**TOTAL COVER**	**80**

*Algae not included in total vegetation cover (Lyons & Kelly, 2016)

Photos

Photograph 2.2. Tufa cascades where spring joins estuary (view to south)

Photograph 2.3. Vegetation within relevé (*Palustriella commutata, Equisetum variegatum, Potentilla reptans*)

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Condition assessment

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	0 recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	5 species recorded: *Festuca rubra, Palustriella commutata, Palustriella falcata, Bryum pseudotriquetrum, Equisetum variegatum*	3 species AND no loss from baseline number of species	Result = 5 positive indicator species **PASS**
Typical accompanying species (neutral indicators)	1 species recorded: *Agrostis stolonifera*	n/a	For information only
Invasive species	0 species recorded	Absent	Result = Absent **PASS**
Negative herbaceous indicator species	0 species recorded	Total cover should not be dominant or abundant	Result = Absent **PASS**
Negative bryophyte indicator species	2 species recorded: *Cratoneuron filicinum*	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	Result = 1 occasional **PASS**
Negative woody indicator species	Absent from relevé (but present on spring mound)	Absent (except in wooded springs)	**PASS**
Spring water composition and flow			
Nitrate level	Baseline unknown 2021 value = 1.7 mg/l	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	Baseline unknown 2021 value (Ortho-P) = <10 µg/l	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	Not determined	No alteration of natural flow	No obvious alteration **PASS**
Impacts of grazing			
Field layer height	25cm	Height between 10 and 50cm	Result = 10cm **PASS**
Trampling/dung	Absent	Impact should not be abundant/dominant	Result = Absent **PASS**
Overall Structure & Functions Assessment			
All pass or one minor/borderline fail AND, if some indicators are Not Determined, the number of passes is at least five AND there is a pass for Positive Indicator Species		Green - Favourable	**Result = All pass FAVOURABLE**
1 - 2 Fail		Amber - Unfavourable Inadequate	
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
L02 Natural succession resulting in species composition change (other than by direct changes of agricultural or forestry practices)		Moderate negative impact, originating inside of site	**UNFAVOURABLE - INADEQUATE**

Conservation Score

Criteria	Result	Score
Species diversity score	5 positive indicator species (=moderate)	2
HQ Indicator Species	0	0
Tufa-forming capacity	Massive, strongly consolidated deposits (very high)	4
Other positive characteristics	Spring discharges into Killala Bay/Moy Estuary SAC	1
Conservation Score		7
Rank		**Very high**

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

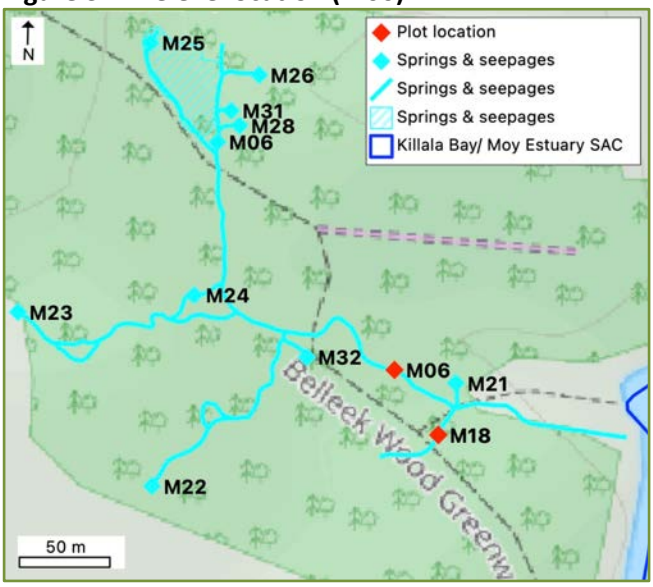
SPRING DETAILS

Site name: Belleek Woods (north)		
Spring name: M06	**Relevé No.:** MR03	**Water sample**: M06 & M182
Survey date: 06 & 27/08/2021	**Relevé dimensions:** 1.5m x 3.5 m	**Relevé area:** 4m^2
Grid reference: G2525821965	**Spring type:** Stream flowing into estuary	
Slope: 0°	**Altitude (m):** ca. 7m	**Aspect:** E
pH: 7.1 (lab – lower stream); 7.9 (lab – upper stream)	**EC:** 476 µS/cm (lab)	**Temp.:** 13.3 (field)

Spring description: This stream is part of a system of highly tufa forming streams in Belleek Woods (north). The streams are approximately 1m wide with good flow in summer. Tufa is in the form of extensive areas of stream crust, cascade tufa and occasional oncoids/ ooids. In-stream vegetation can be sparse, presumably due to fluctuating water levels. However, typical petrifying spring species are frequent throughout the system. Vascular plants such as *Carex flacca, Carex pendula, Filipendula ulmaria, Scrophularia auriculata* and *Chrysosplenium oppositifolium* are largely confined to the stream banks. In-stream bryophytes include abundant *Pellia endiviifolia* and occasional to frequent *Cratoneuron filicinum* and *Palustriella commutata.*
The vegetation has most affinity with **Group 2 *Palustriella commutata-Geranium robertianum* Springheads** vegetation community (Lyons & Kelly, 2017).

Relevé location:
The relevé (Figure 3.1; Photograph 3.1) is located is located in the lower section of spring M06. This spring originates in the north of the site (between M25 and M26 in Figure 3.1)

Figure 3.1. Relevé location (M06)



Photograph 3.1. Relevé location (view to NW)

DETAILED RELEVÉ

Physical characteristics

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	10	Flowing/ trickling	90	Living field/ ground flora	75
Paludal	-	Pool/ standing water	-	Bare tufa (active/ recent)	20
Stream crust	75	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	10	Damp	10	Leaf litter/ standing dead	5
Dam	-	Dry, not impacted by spring	-	Bare soil	-
Cemented rudites	-	Other:	-	Bare stone	-
Non-tufa	5			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Shrub/ canopy layer

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Fraxinus excelsior	70	-	-
	-	-	-
	-	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 70		
MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE):			c. 7 m

Field/ ground flora

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Filipendula ulmaria	1	*Carex flacca*	1	*Eurhynchium striatum*	8	*Rubus fruticosus* agg.	3
Scrophularia auriculata	1	*Carex pendula*	8	*Cratoneuron filicinum*	8	*Hypericum androsaemum*	8
Geranium robertianum	1			*Pellia endiviifolia*	25	*Hedera hibernica*	<1
Circaea lutetiana	1			*Palustriella commutata*	5		
Chrysosplenium oppositifolium	1			*Plagiochila asplenioides*	5	**TOTAL WOODY <50cm**	**11**
Potentilla reptans	<1			*Plagiochila asplenioides*	5		
						PTERIDOPHYTES	
						TOTAL PTERIDOPHYTES	**0**
						ALGAE	
						TOTAL ALGAE*	**0**
TOTAL FORBS	**5**	**TOTAL GRAMINOIDS**	**3**	**TOTAL BRYOPHYTES**	**51**	**TOTAL COVER**	**75**

*Algae not included in total vegetation cover (Lyons & Kelly, 2016)

Photos

Photograph 3.2. View upstream (west) from relevé

Photograph 3.3. Vegetation within relevé

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Condition assessment

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	0 recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	3 species recorded: *Pellia endiviifolia, Palustriella commutata, Chrysosplenium oppositifolium*	3 species AND no loss from baseline number of species	Result = 3positive indicator species **PASS**
Typical accompanying species (neutral indicators)	3 species recorded: *Carex flacca, Filipendula ulmaria, Geranium robertianum,*	n/a	For information only
Invasive species	0 species recorded	Absent	Result = Absent **PASS**
Negative herbaceous indicator species	0 species recorded	Total cover should not be dominant or abundant	Result = Absent **PASS**
Negative bryophyte indicator species	1 species recorded: *Cratoneuron filicinum*	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	Result = 1 frequent **PASS**
Negative woody indicator species	n/a as wooded stream	Absent (except in wooded springs)	n/a
Spring water composition and flow			
Nitrate level	Baseline unknown; 2021 values: a) Upper stream = 0.89 mg/l b) Lower stream = 0.52 mg/l	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	Baseline unknown 2021 values (Ortho-P): a) Upper stream = <10 µg/l b) Lower stream = <10 µg/l	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	Not determined	No alteration of natural flow	No obvious alteration **PASS**
Impacts of grazing			
Field layer height	25cm	Height between 10 and 50cm	Result = 5cm **PASS***
Trampling/dung	Absent	Impact should not be abundant/dominant	Result = Absent **PASS**
Overall Structure & Functions Assessment			
All pass or one minor/borderline fail AND, if some indicators are Not Determined, the number of passes is at least five AND there is a pass for Positive Indicator Species		Green - Favourable	**Result = All pass FAVOURABLE**
1 - 2 Fail		Amber - Unfavourable Inadequate	
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
n/a		n/a	**FAVOURABLE**

*Bryophyte dominated so vegetation naturally lower in height

Conservation Score

Criteria	Result	Score
Species diversity score	3 positive indicator species (=low)	1
HQ Indicator Species	0	0
Tufa-forming capacity	Massive, strongly consolidated deposits (very high)	4
Other positive characteristics	Spring is part of a large spring/ stream complex in this woodland; spring discharges into Killala Bay/Moy Estuary SAC	2
Conservation Score		7
Rank		**Very high**

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

SPRING DETAILS

Site name: Cregg's Road/ Quay Road Jct		
Spring name: M07	**Relevé No.:** MR04	**Water sample**: M07
Survey date: 06/08/2021	**Relevé dimensions:** 1m x 4m	**Relevé area:** 4m^2
Grid reference: G2577521169	**Spring type:** Stream flowing into estuary	
Slope: 0°	**Altitude (m):** ca. 5m	**Aspect:** SW
pH: 8.42 (field); 7.0 (lab)	**EC:** 426 µS/cm (lab)	**Temp.:** n/a

Spring description: This is a roadside stream which flows along Cregg's Road. It is approximately 1m wide. There are tufa cascades at frequent intervals in the section of stream which was accessible for survey, at the junction with the Quay Road. The vegetation is bryophyte dominated in the stream with *Pellia endiviifolia, Didymodon tophaceus, Eucladium verticillatum, Cratoneuron filicinum* and *Marchantia polymorpha* subsp. *polymorpha.* Wetland vascular plants have low cover and grow at the stream edges *Epilobium hirsutum, Helioscadium nodiflorum, Scrophularia auriculata, Carex lepidocarpa* and *Cardamine flexuosus.*

The vegetation has most affinity to **Group 1 *Eucladium verticillatum-Pellia endiviifolia Tufa Cascades*** vegetation community (Lyons & Kelly, 2017).

Relevé location:

The relevé (Figure 4.1; Photograph 4.1) is located at the junction of Cregg's Road and the Quay Road

Figure 4.1. Relevé location (M07)

© OpenStreetMap contributors

Photograph 4.1. Relevé location (view to SE)

DETAILED RELEVÉ

Physical characteristics

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	40	Flowing/ trickling	100	Living field/ ground flora	35
Paludal	-	Pool/ standing water	-	Bare tufa (active/ recent)	20
Stream crust	-	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	5	Damp	-	Leaf litter/ standing dead	-
Dam	-	Dry, not impacted by spring	-	Bare soil	10
Cemented rudites	-	Other:	-	Bare stone	35
Non-tufa	55			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous

Shrub/ canopy layer

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Salix cinerea	5	-	-
Rubus fruticosus agg.	10	3	0.2
Alnus glutinosa	5	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 20		

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE):	c. **2**.5 m

Field/ ground flora

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Helioscadium nodiflorum	1	*Agrostis stolonifera*	1	*Rhynchostegium riparioides*	3	*Rubus fruticosus* agg.	1
Epilobium hirsutum	3	*Carex lepidocarpa*	<1	*Cratoneuron filicinum*	1		
Calystegia sepium	1			*Pellia endiviifolia*	10		
Scrophularia auriculata	3			*Marchantia polymorpha* subsp. *polymorpha*	1		
Taraxacum officinale agg.	1			*Didymodon insulanus*	1	**TOTAL WOODY <50cm**	**1**
Plantago lanceolata	1			*Eucladium verticillatum*	1		
Cardamine flexuosa	1			*Didymodon tophaceus*	3	**PTERIDOPHYTES**	
						TOTAL PTERIDOPHYTES	**0**
						ALGAE	
						TOTAL ALGAE*	**0**
TOTAL FORBS	**11**	**TOTAL GRAMINOIDS**	**2**	**TOTAL BRYOPHYTES**	**20**	**TOTAL COVER**	**35**

*Algae not included in total vegetation cover (Lyons & Kelly, 2016)

Photos

Photograph 4.2. View downstream (south) from relevé

Photograph 4.3. Vegetation and tufa at edge of relevé

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Condition assessment

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	0 recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	4 species recorded: *Pellia endiviifolia, Didymodon tophaceus, Eucladium verticillatum, Carex lepidocarpa*	3 species AND no loss from baseline number of species	Result = 4 positive indicator species **PASS**
Typical accompanying species (neutral indicators)	1 species recorded: *Agrostis stolonifera*	n/a	For information only
Invasive species	0 species recorded	Absent	Result = Absent **PASS**
Negative herbaceous indicator species	1 species recorded: *Helioscadium nodiflorum*	Total cover should not be dominant or abundant	Result = Rare **PASS**
Negative bryophyte indicator species	2 species recorded: *Cratoneuron filicinum, Rhynchostegium riparioides*	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	Result = 1 occasional, 1 rare **PASS**
Negative woody indicator species	*Rubus fruticosus* agg.	Absent (except in wooded springs)	**Result =** present **FAIL**
Spring water composition and flow			
Nitrate level	Baseline unknown 2021 value = 1.1 mg/l	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	Baseline unknown 2021 value (Ortho-P) = <10 µg/l	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	Not determined	No alteration of natural flow	No obvious alteration **PASS**
Impacts of grazing			
Field layer height	25cm	Height between 10 and 50cm	Result = 20cm **PASS**
Trampling/dung	Absent	Impact should not be abundant/dominant	Result = Absent **PASS**
Overall Structure & Functions Assessment			
All pass or one minor/borderline fail AND, if some indicators are Not Determined, the number of passes is at least five AND there is a pass for Positive Indicator Species		Green - Favourable	**Result = 1 minor fail as (woody indicator of low cover) FAVOURABLE**
1 - 2 Fail		Amber - Unfavourable Inadequate	
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
L02 Natural succession resulting in species composition change (other than by direct changes of agricultural or forestry practices)		Moderate negative impact, originating inside of site	**UNFAVOURABLE - INADEQUATE**

Conservation Score

Criteria	Result	Score
Species diversity score	4 positive indicator species (=low)	1
HQ Indicator Species	0	0
Tufa-forming capacity	Smaller consolidated deposits or strongly formed paludal tufa (high)	3
Other positive characteristics	Spring discharges into Killala Bay/Moy Estuary SAC	1
Conservation Score		5
Rank		**High**

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

SPRING DETAILS

Site name: Quay House to Pump House		
Spring name: M09	**Relevé No.:** MR05	**Water sample**: M09
Survey date: 06/08/2021	**Relevé dimensions:** 2m x 2m	**Relevé area:** 4m^2
Grid reference: G2575321522	**Spring type:** Spring seeping from wooded bank into estuary	
Slope: 5 ^{o}	**Altitude (m):** ca. 3m	**Aspect:** W
pH: 7.85 (field); 6.8 (lab)	**EC:** 414 µS/cm (lab)	**Temp.:** 12.8

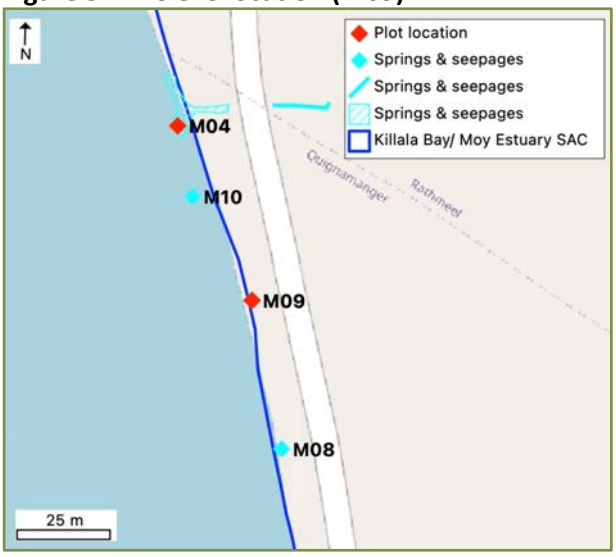
Spring description: This is a seepage area arising from the eastern estuary bank. There was a small water flow at the time of survey but the whole spring area was damp. The estuary bank is wooded in this location. There is cascade tufa formed at the base of the bank with species-rich bryophyte vegetation and some vascular plants. This plot had the highest number (9) of positive indicator species within the Moy Estuary survey area, of which 8 were bryophytes. The spring flows into the estuary and there is filamentous algae in the brackish zone below the relevé plot location.

The vegetation has most affinity with **Group 2 *Palustriella commutata-Geranium robertianum* Springheads** vegetation community (Lyons & Kelly, 2017).

Relevé location:

The relevé (Figure 5.1; Photograph 5.1) is located *ca.* 30m west (downstream) of the coast road

Figure 5.1. Relevé location (M09)



© OpenStreetMap contributors

Photograph 5.1. Relevé location (view to NE)

DETAILED RELEVÉ

Physical characteristics

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	80	Flowing/ trickling	5	Living field/ ground flora	70
Paludal	-	Pool/ standing water	5	Bare tufa (active/ recent)	10
Stream crust	-	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	-	Damp	90	Leaf litter/ standing dead	5
Dam	-	Dry, not impacted by spring	-	Bare soil	-
Cemented rudites	-	Other:	-	Bare stone	10
Non-tufa	20			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous

Shrub/ canopy layer

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Acer pseudoplatanus	10	-	-
Salix fragilis	60	-	-
Fraxinus excelsior	5	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 75		

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE):	c. 15 m

Field/ ground flora

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Jacobaea aquatica	3	*Agrostis stolonifera*	3	*Fissidens adianthoides*	8	*Rubus fruticosus* agg.	3
Taraxacum officinale agg.	1	*Brachypodium sylvaticum*	1	*Cratoneuron filicinum*	1	*Hedera hibernica*	5
Cardamine pratensis	3	*Carex lepidocarpa*	1	*Pellia endiviifolia*	<1		
				Didymodon tophaceus	3		
				Palustriella commutata	15	**TOTAL WOODY <50cm**	**8**
				Oxyrrhynchium hians	1		
				Bryum pseudotriquetrum	1	**PTERIDOPHYTES**	
				Mesoptychia turbinata	5		
				Fontinalis antipyretica	5		
				Palustriella falcata	3		
				Chiloscyphus pallescens	1	**TOTAL PTERIDOPHYTES**	**0**
				Jungermannia atrovirens	3	**ALGAE**	
				Didymodon insulanus	3	Filamentous algae	3
						TOTAL ALGAE*	**0**
TOTAL FORBS	**7**	**TOTAL GRAMINOIDS**	**5**	**TOTAL BRYOPHYTES**	**50**	**TOTAL COVER**	**23**

*Algae not included in total vegetation cover (Lyons & Kelly, 2016)

Photos

Photograph 5.2. Estuary shoreline at relevé location (view to north east)

Photograph 5.3. Vegetation within relevé (*Palustriella commutata* on a tufa mound)

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Condition assessment

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	0 recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	9 species recorded: *Carex lepidocarpa, Pellia endiviifolia, Fissidens adianthoides, Didymodon tophaceus, Palustriella commutata, Bryum pseudotriquetrum, Mesoptychia turbinata, Palustriella falcata, Jungermannia atrovirens*	3 species AND no loss from baseline number of species	Result = 9 positive indicator species **PASS**
Typical accompanying species (neutral indicators)	2 species recorded: *Agrostis stolonifera, Cardamine pratensis*	n/a	For information only
Invasive species	0 species recorded	Absent	Result = Absent **PASS**
Negative herbaceous indicator species	0 species recorded	Total cover should not be dominant or abundant	Result = Absent **PASS**
Negative bryophyte indicator species	1 species recorded: *Cratoneuron filicinum*	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	Result = 1 rare **PASS**
Negative woody indicator species	n/a as wooded edge to estuary	Absent (except in wooded springs)	n/a
Spring water composition and flow			
Nitrate level	Baseline unknown 2021 value = 0.91 mg/l	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	Baseline unknown 2021 value (Ortho-P) = <10 µg/l	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	Not determined	No alteration of natural flow	No obvious alteration **PASS**
Impacts of grazing			
Field layer height	25cm	Height between 10 and 50cm	Result = 20cm **PASS**
Trampling/dung	Absent	Impact should not be abundant/dominant	Result = Absent **PASS**
Overall Structure & Functions Assessment			
All pass or one minor/borderline fail AND, if some indicators are Not Determined, the number of passes is at least five AND there is a pass for Positive Indicator Species		Green - Favourable	**Result = All pass FAVOURABLE**
1 - 2 Fail		Amber - Unfavourable Inadequate	
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
n/a		n/a	**FAVOURABLE**

Conservation Score

Criteria	Result	Score
Species diversity score	9 positive indicator species (=moderate)	2
HQ Indicator Species	0	0
Tufa-forming capacity	Smaller consolidated deposits or strongly formed paludal tufa (high)	3
Other positive characteristics	Spring discharges into Killala Bay/Moy Estuary SAC	1
Conservation Score		5
Rank		**High**

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

SPRING DETAILS

Site name: Knockroe, N Castleconner		
Spring name: M12	**Relevé No.:** MR06	**Water sample**: M12
Survey date: 06/08/2021	**Relevé dimensions:** n/a	**Relevé area:** Whole mound
Grid reference: G2613825348	**Spring type:** Spring flowing into estuary	
Slope: 5 °	**Altitude (m):** ca. 1m	**Aspect:** SW
pH: 8.23 (field); 6.8 (lab)	**EC:** 453 µS/cm (lab)	**Temp.:** 14.6

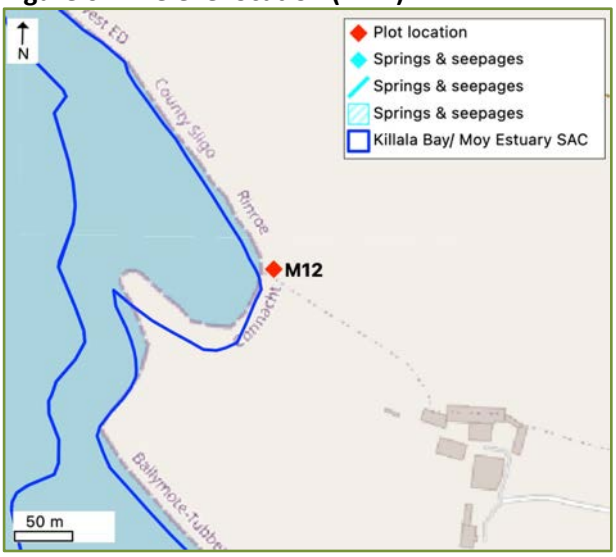
Spring description: This is a spring which discharges from the northern bank of a small inlet along the eastern shoreline of the Moy Estuary. Where the spring arises from the bank, it has formed a tufa mound over 1m in height and several metres in diameter. This is covered in grass (mainly *Agrostis stolonifera*) with scattered wetland vascular plants (*Oenanthe crocata, Veronica beccabunga* and *Filipendula ulmaria*). Where grass cover is lower (on the eastern side of the mound), the bryophyte *Didymodon tophaceus* was locally frequent. There was a strong flow of water from the spring at the time of survey, which discharges SW into the estuary.

The vegetation has most affinity to **Group 4 Palustriella commutata-Agrostis stolonifera Springheads** vegetation community (Lyons & Kelly, 2017).

Relevé location:

The relevé (Figure 6.1; Photograph 6.1) is located in a small inlet near Knockroe, N Castleconner.

Figure 6.1. Relevé location (M12)



© OpenStreetMap contributors

Photograph 6.1. Relevé (whole mound) (view to E)

DETAILED RELEVÉ

Physical characteristics

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	90	Flowing/ trickling	20	Living field/ ground flora	90
Paludal	-	Pool/ standing water	-	Bare tufa (active/ recent)	5
Stream crust	-	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	-	Damp	80	Leaf litter/ standing dead	-
Dam	-	Dry, not impacted by spring	-	Bare soil	-
Cemented rudites	-	Other:	-	Bare stone	5
Non-tufa	10			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous

Shrub/ canopy layer

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Prunus spinosa	5	-	-
Rubus fruticosus agg.	5	-	-
	-	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 10		

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE):	c. 2 m

Field/ ground flora

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Oenanthe crocata	3	*Agrostis stolonifera*	40	*Didymodon tophaceus*	20	*Hedera hibernica*	3
Veronica beccabunga	3	*Festuca rubra*	15	*Cratoneuron filicinum*	1		
Filipendula ulmaria	3	*Carex lepidocarpa*	2				
						TOTAL WOODY <50cm	**3**
						PTERIDOPHYTES	
						TOTAL PTERIDOPHYTES	**0**
						ALGAE	
						TOTAL ALGAE*	**0**
TOTAL FORBS	**9**	**TOTAL GRAMINOIDS**	**57**	**TOTAL BRYOPHYTES**	**21**	**TOTAL COVER**	**90**

*Algae not included in total vegetation cover (Lyons & Kelly, 2016)

Photos

Photograph 6.2. View of tufa mound (red arrow) within estuary (view to southeast). Water discharges to the right of the photo into the estuary.

Photograph 6.3. Vegetation within relevé. Area with *Didymodon tophaceus* shown by red arrow (view to north east).

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Condition assessment

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	0 recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	3 species recorded: *Didymodon tophaceus, Festuca rubra, Carex lepidocarpa*	3 species AND no loss from baseline number of species	Result = 3 positive indicator species **PASS**
Typical accompanying species (neutral indicators)	3 species recorded: *Agrostis stolonifera, Filipendula ulmaria, Veronica beccabunga*	n/a	For information only
Invasive species	0 species recorded	Absent	Result = Absent **PASS**
Negative herbaceous indicator species	0 species recorded	Total cover should not be dominant or abundant	Result = Absent **PASS**
Negative bryophyte indicator species	1 species recorded: *Cratoneuron filicinum*	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	Result = 1 rare **PASS**
Negative woody indicator species	n/a as wooded stream	Absent (except in wooded springs)	n/a
Spring water composition and flow			
Nitrate level	Baseline unknown 2021 value = 1.1 mg/l	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	Baseline unknown 2021 value (Ortho-P) = <10 µg/l	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	Not determined	No alteration of natural flow	No obvious alteration **PASS**
Impacts of grazing			
Field layer height	25cm	Height between 10 and 50cm	Result = 15cm **PASS**
Trampling/dung	Absent	Impact should not be abundant/dominant	Result = Absent **PASS**
Overall Structure & Functions Assessment			
All pass or one minor/borderline fail AND, if some indicators are Not Determined, the number of passes is at least five AND there is a pass for Positive Indicator Species		Green - Favourable	**Result = All pass FAVOURABLE**
1 - 2 Fail		Amber - Unfavourable Inadequate	
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
L02 Natural succession resulting in species composition change (other than by direct changes of agricultural or forestry practices)		Moderate negative impact, originating inside of site	**UNFAVOURABLE - INADEQUATE**

Conservation Score

Criteria	Result	Score
Species diversity score	3 positive indicator species (=low)	1
HQ Indicator Species	0	0
Tufa-forming capacity	Massive, strongly consolidated deposits	4
Other positive characteristics	Spring discharges into Killala Bay/Moy Estuary SAC	1
Conservation Score		6
Rank		**High**

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

SPRING DETAILS

Site name: Warren Walk Woods		
Spring name: M14	**Relevé No.:** MR07	**Water sample**: M14
Survey date: 06/08/2021	**Relevé dimensions:** 2m x 2m	**Relevé area:** 4m^2
Grid reference: G2671726387	**Spring type:** Spring flowing under path	
Slope: 5 ^{o}	**Altitude (m):** ca. 6m	**Aspect:** W
pH: 7.97 (field); 6.5 (lab)	**EC:** 431 µS/cm (lab)	**Temp.:** 11.6

Spring description: This is a spring which arises in Warren Way woods on the eastern side of the estuary. It flows under the path through the woods and into an area of wet woodland downstream. The tufa formation is mainly cascade tufa, with some paludal tufa and oncoids and ooids. The vegetation has equal proportions of woodland and wetland vascular plants (*Agrostis stolonifera, Circaea lutetiana, Ranunculus repens* and *Filipendula ulmaria*) and bryophytes (*Eurhynchium striatum, Palustriella commutata, Cratoneuron filicinum, Pellia endiviifolia, Plagiomnium elatum, Thamnobryum alopecurum* and *Oxyrrhynchium hians*).
The vegetation has most affinity to **Group 4 *Palustriella commutata-Agrostis stolonifera Springheads*** vegetation community (Lyons & Kelly, 2017).

Relevé location:
The relevé (Figure 7.1; Photograph 7.1) is located below the path through Warren Walk Woods.

Figure 7.1. Relevé location (M01)

© OpenStreetMap contributors

Photograph 7.1. Relevé location (view to E)

DETAILED RELEVÉ

Physical characteristics

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	45	Flowing/ trickling	70	Living field/ ground flora	80
Paludal (2)	5	Pool/ standing water	-	Bare tufa (active/ recent)	3
Stream crust	-	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	10	Damp	30	Leaf litter/ standing dead	3
Dam	-	Dry, not impacted by spring	-	Bare soil	14
Cemented rudites	-	Other:	-	Bare stone	-
Non-tufa	40			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous

Shrub/ canopy layer

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Acer pseudoplatanus	90	-	-
	-	-	-
	-	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 90		

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE):	c. 20 m

Field/ ground flora

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Circaea lutetiana	5	*Agrostis stolonifera*	20	*Eurhynchium striatum*	10	*Hedera hibernica*	5
Ranunculus repens	5			*Cratoneuron filicinum*	5		
Filipendula ulmaria	3			*Pellia endiviifolia*	5		
				Palustriella commutata	10		
				Oxyrrhynchium hians	3	**TOTAL WOODY <50cm**	**5**
				Thamnobryum alopecurum	3		
				Plagiomnium elatum	3	**PTERIDOPHYTES**	
						Asplenium scolopendrium	3
						TOTAL PTERIDOPHYTES	**3**
						ALGAE	
						TOTAL ALGAE*	**0**
TOTAL FORBS	**13**	**TOTAL GRAMINOIDS**	**20**	**TOTAL BRYOPHYTES**	**39**	**TOTAL COVER**	**80**

*Algae not included in total vegetation cover (Lyons & Kelly, 2016)

Photos

Photograph 7.2. View upstream (west) from relevé

Photograph 1.3. Vegetation within relevé

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Condition assessment

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	0 recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	3 species recorded: *Pellia endiviifolia, Palustriella commutata, Plagiomnium elatum*	3 species AND no loss from baseline number of species	Result = 3 positive indicator species **PASS**
Typical accompanying species (neutral indicators)	2 species recorded: *Agrostis stolonifera, Filipendula ulmaria*	n/a	For information only
Invasive species	0 species recorded	Absent	Result = Absent **PASS**
Negative herbaceous indicator species	0 species recorded	Total cover should not be dominant or abundant	Result = Absent **PASS**
Negative bryophyte indicator species	1 species recorded: *Cratoneuron filicinum*	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	Result = 1 occasional **PASS**
Negative woody indicator species	n/a as wooded stream	Absent (except in wooded springs)	n/a
Spring water composition and flow			
Nitrate level	Baseline unknown 2021 value = 0.51 mg/l	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	Baseline unknown 2021 value (Ortho-P) = <10 µg/l	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	Not determined	No alteration of natural flow	No obvious alteration **PASS**
Impacts of grazing			
Field layer height	25cm	Height between 10 and 50cm	Result = 15cm **PASS**
Trampling/dung	Absent	Impact should not be abundant/dominant	Result = Absent **PASS**
Overall Structure & Functions Assessment			
All pass or one minor/borderline fail AND, if some indicators are Not Determined, the number of passes is at least five AND there is a pass for Positive Indicator Species		Green - Favourable	**Result = All pass FAVOURABLE**
1 - 2 Fail		Amber - Unfavourable Inadequate	
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
n/a		n/a	**FAVOURABLE**

Conservation Score

Criteria	Result	Score
Species diversity score	3 positive indicator species (=low)	1
HQ Indicator Species	0	0
Tufa-forming capacity	Smaller consolidated deposits or strongly formed paludal tufa (high)	3
Other positive characteristics	Spring discharges into Killala Bay/Moy Estuary SAC	1
Conservation Score		5
Rank		**High**

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

SPRING DETAILS

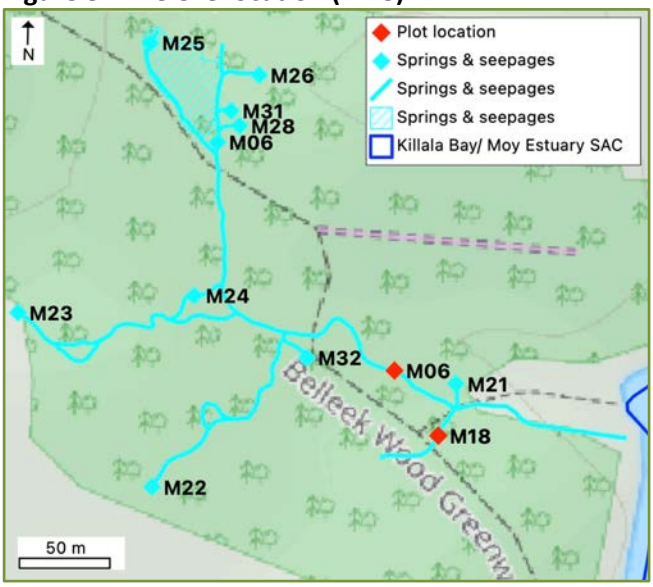
Site name: Belleek Woods (north)		
Spring name: M18	**Relevé No.:** MR08	**Water sample**: M186
Survey date: 27/08/2021	**Relevé dimensions:** 1m x 4m	**Relevé area:** 4m^2
Grid reference: G2527121941	**Spring type:** Stream within woodland	
Slope: 0°	**Altitude (m):** ca. 7m	**Aspect:** E
pH: 7.94 (field); 7.0 (lab)	**EC:** 476 µS/cm (lab)	**Temp.:** 12.4

Spring description: This stream is part of a system of highly tufa forming streams in Belleek Woods (north). The streams are approximately 1m wide with good flow in summer. Tufa is in the form of extensive areas of stream crust, cascade tufa and occasional oncoids/ ooids. In-stream vegetation can be sparse, presumably due to fluctuating water levels. However, typical petrifying spring species are frequent throughout the system. The relevé stream section in spring M18 had lower tufa than the downstream section, but higher cover of petrifying spring species. Vascular plants such as *Carex flacca, Carex remota* and *Scrophularia auriculata* are largely confined to the stream banks. In-stream bryophytes include abundant *Palustriella commutata* and *Pellia endiviifolia* and frequent *Fissidens adianthoides.* The vegetation has most affinity with **Group 2 *Palustriella commutata-Geranium robertianum* Springheads** vegetation community (Lyons & Kelly, 2017).

Relevé location:

The relevé (Figure 8.1; Photograph 8.1) is located in the middle section of spring M18. This spring originates in the southeast of the site and flows northeast to join M06 (Figure 3.1)

Figure 8.1. Relevé location (M18)



© OpenStreetMap contributors

Photograph 8.1. Relevé location (view to SW)

DETAILED RELEVÉ

Physical characteristics

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	5	Flowing/ trickling	70	Living field/ ground flora	50
Paludal	-	Pool/ standing water	-	Bare tufa (active/ recent)	15
Stream crust	-	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	25	Damp	30	Leaf litter/ standing dead	10
Dam	-	Dry, not impacted by spring	-	Bare soil	20
Cemented rudites	-	Other:	-	Bare stone	5
Non-tufa	75			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Shrub/ canopy layer

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Fraxinus excelsior	15	5	1.2
Picea sp.	30	-	-
Quercus petraea	10	-	-
Betula pubescens	10		
Fagus sylvatica	10		
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 80		
MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE):			c. 15 m

Field/ ground flora

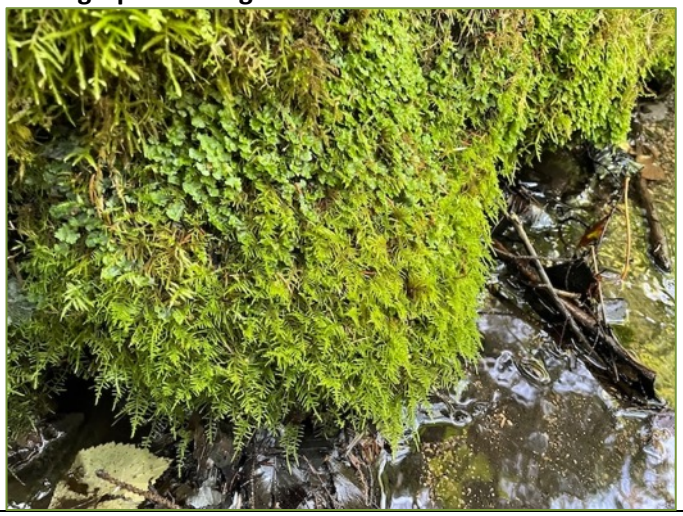
FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Scrophularia auriculata	1	*Brachypodium sylvaticum*	1	*Palustriella commutata*	8	*Fraxinus excelsior*	3
Viola riviniana	1	*Carex flacca*	1	*Fissidens adianthoides*	3	*Lonicera periclymenum*	1
		Carex remota	8	*Pellia endiviifolia*	8	*Rubus fruticosus* agg.	1
				Plagiomnium undulatum	1	*Acer pseudoplatanus*	<1
				Eurhynchium striatum	3	**TOTAL WOODY <50cm**	**5**
				Thamnobryum alopecurum	1		
				Plagiomnium elatum	<1	**PTERIDOPHYTES**	
				Oxyrrhynchium hians	1	*Asplenium scolopendrium*	3
				Calliergonella cuspidata	3		
				Cratoneuron filicinum	<1	**TOTAL PTERIDOPHYTES**	**3**
				Kindbergia praelonga	1	**ALGAE**	
						TOTAL ALGAE*	**0**
TOTAL FORBS	**2**	**TOTAL GRAMINOIDS**	**10**	**TOTAL BRYOPHYTES**	**30**	**TOTAL COVER**	**50**

*Algae not included in total vegetation cover (Lyons & Kelly, 2016)

Photos

Photograph 8.2. Tufa in stream upstream of relevé

Photograph 8.3. Vegetation within relevé



APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Condition assessment

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	0 recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	4 species recorded: *Pellia endiviifolia, Fissidens adianthoides, Palustriella commutata, Plagiomnium elatum*	3 species AND no loss from baseline number of species	Result = 4 positive indicator species **PASS**
Typical accompanying species (neutral indicators)	3 species recorded: *Agrostis stolonifera, Care remota, Carex flacca*	n/a	For information only
Invasive species	0 species recorded	Absent	Result = Absent **PASS**
Negative herbaceous indicator species	0 species recorded	Total cover should not be dominant or abundant	Result = Absent **PASS**
Negative bryophyte indicator species	0 species recorded	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	Result = Absent **PASS**
Negative woody indicator species	n/a as wooded stream	Absent (except in wooded springs)	n/a
Spring water composition and flow			
Nitrate level	Baseline unknown 2021 value = 0.3 mg/l	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	Baseline unknown 2021 value (Ortho-P) = <10 µg/l	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	Not determined	No alteration of natural flow	No obvious alteration **PASS**
Impacts of grazing			
Field layer height	25cm	Height between 10 and 50cm	Result = 10cm **PASS**
Trampling/dung	Absent	Impact should not be abundant/dominant	Result = Absent **PASS**
Overall Structure & Functions Assessment			
All pass or one minor/borderline fail AND, if some indicators are Not Determined, the number of passes is at least five AND there is a pass for Positive Indicator Species		Green - Favourable	**Result = All pass FAVOURABLE**
1 - 2 Fail		Amber - Unfavourable Inadequate	
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
n/a		n/a	**FAVOURABLE**

Conservation Score

Criteria	Result	Score
Species diversity score	4 positive indicator species (=low)	1
HQ Indicator Species	0	0
Tufa-forming capacity	Smaller consolidated deposits or strongly formed paludal tufa (high)	3
Other positive characteristics	Spring is part of a large spring/ stream complex in this woodland; spring discharges into Killala Bay/Moy Estuary SAC	2
Conservation Score		6
Rank		**High**

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

SPRING DETAILS

Site name: Belleek Woods (south)		
Spring name: M27	**Relevé No.:** MR09	**Water sample**: M24
Survey date: 27/08/2021	**Relevé dimensions:** 2m x 2m	**Relevé area:** 4m^2
Grid reference: G2518220721	**Spring type:** Stream within woodland	
Slope: 0°	**Altitude (m):** ca. 8m	**Aspect:** E
pH: 8.02 (field); 7.0 (lab)	**EC:** 586 µS/cm (lab)	**Temp.:** 13.7

Spring description: Unlike the stream/ spring system in Belleek Woods (north), this appears to be the only petrifying stream in Belleek Woods south. The tufa in the stream is largely confined to a series of dams, which potentially are artificial in origin but now have cascade tufa on them. The stream flows into a pond (man-made) and then discharges to the estuary from two discharge points with cascade tufa formation. The stream is larger than the streams in Belleek Woods (north) and has less bryophyte cover in the main channel. In the upstream, western section (and relevé) location there is tufa on the stream banks as well as in the main channel. The main petrifying spring bryophyte present is *Pellia endiviifolia*, with the typical watercourse bryophyte *Rhynchostegium riparioides.* Where there is cascade tufa or bank seepages, additional spring bryophytes such as *Bryum pseudotriquetrum, Didymodon tophaceus* and *Fissidens adianthoides* are occasional. The main petrifying spring vascular plant present is *Chrysosplenium oppositifolium.* The vegetation has most affinity to **Group 3 *Brachythecium rivulare-Platyhypnidium riparioides* tufaceous streams and flushes** vegetation community (Lyons & Kelly, 2017).

Relevé location:

The relevé (Figure 9.1; Photograph 9.1) is located *ca.* 30m west (downstream) of the coast road

Figure 9.1. Relevé location (M27)

Photograph 9.1. Relevé location (view to N)

DETAILED RELEVÉ

Physical characteristics

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	60	Flowing/ trickling	50	Living field/ ground flora	45
Paludal	5	Pool/ standing water	-	Bare tufa (active/ recent)	5
Stream crust	-	Dripping	20	Ancient/ inactive tufa	-
Oncoids/ ooids	2	Damp	30	Leaf litter/ standing dead	8
Dam	-	Dry, not impacted by spring	-	Bare soil	-5
Cemented rudites	-	Other:	-	Bare stone	27
Non-tufa	35			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Shrub/ canopy layer

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Acer pseudoplatanus	20	-	-
Fraxinus excelsior	30	-	-
	-	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 50		
MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE):			c. 10 m

Field/ ground flora

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Chrysosplenium oppositifolium	1	*Agrostis stolonifera*	3	*Rhynchostegium riparioides*	25	*Hedera hibernica*	3
				Cratoneuron filicinum	3		
				Pellia endiviifolia	8		
				Thamnobryum alopecurum	1		
				Fissidens adianthoides	1	**TOTAL WOODY <50cm**	**3**
				Brachythecium rivulare	3		
				Didymodon tophaceus	1	**PTERIDOPHYTES**	
				Bryum pseudotriquetrum	<1		
						TOTAL PTERIDOPHYTES	**0**
						ALGAE	
						TOTAL ALGAE*	**0**
TOTAL FORBS	**1**	**TOTAL GRAMINOIDS**	**0**	**TOTAL BRYOPHYTES**	**42**	**TOTAL COVER**	**45**

*Algae not included in total vegetation cover (Lyons & Kelly, 2016)

Photos

Photograph 9.2. View downstream (east). Relevé shown by red arrow.

Photograph 9.3. Vegetation within relevé (*Fissidens adianthoides, Pellia endiviifolia*)

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Condition assessment

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	0 recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	5 species recorded: *Pellia endiviifolia, Fissidens adianthoides, Bryum pseudotriquetrum, Didymodon tophaceus, Chrysosplenium oppositifolium*	3 species AND no loss from baseline number of species	Result = 5 positive indicator species **PASS**
Typical accompanying species (neutral indicators)	0 species recorded	n/a	For information only
Invasive species	0 species recorded	Absent	Result = Absent **PASS**
Negative herbaceous indicator species	0 species recorded	Total cover should not be dominant or abundant	Result = Absent **PASS**
Negative bryophyte indicator species	2 species recorded: *Rhynchostegium riparioides*	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	Result = 1 abundant **FAIL**
Negative woody indicator species	n/a as wooded stream	Absent (except in wooded springs)	n/a
Spring water composition and flow			
Nitrate level	Baseline unknown 2021 value = 0.65 mg/l	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	Baseline unknown 2021 value (Ortho-P) = <10 µg/l	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	Not determined	No alteration of natural flow	No obvious alteration **PASS**
Impacts of grazing			
Field layer height	25cm	Height between 10 and 50cm	Result = 10cm **PASS**
Trampling/dung	Absent	Impact should not be abundant/dominant	Result = Absent **PASS**
Overall Structure & Functions Assessment			
All pass or one minor/borderline fail AND, if some indicators are Not Determined, the number of passes is at least five AND there is a pass for Positive Indicator Species		Green - Favourable	**Result = 1 fail UNFAVOURABLE - INADEQUATE**
1 - 2 Fail		Amber - Unfavourable Inadequate	
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
J01 Mixed source pollution to surface and ground waters (limnic and terrestrial)		Moderate negative impact, originating outside of site	**UNFAVOURABLE - INADEQUATE**

Conservation Score

Criteria	Result	Score
Species diversity score	4 positive indicator species (=low)	1
HQ Indicator Species	0	0
Tufa-forming capacity	Smaller consolidated deposits or strongly formed paludal tufa (high)	3
Other positive characteristics	Spring discharges into Killala Bay/Moy Estuary SAC	1
Conservation Score		5
Rank		**High**

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

SPRING DETAILS

Site name: Lecarrow		
Spring name: M30	**Relevé No.:** MR10	**Water sample**: n/a
Survey date: 27/08/2021	**Relevé dimensions:** 2m x 2m	**Relevé area:** 4m^2
Grid reference: G2528726159	**Spring type:** Seepage from estuary bank with tufa	
Slope: 5 ^{o}	**Altitude (m):** ca. 0m	**Aspect:** E
pH: n/a (no flow)	**EC:** n/a	**Temp.:** n/a

Spring description: This is a section of the western estuary shoreline with spring seepage and tufa formation. At the time of survey there was no flow, but the tufa areas were damp. There are two main areas of tufa formation: M29 (*ca.* 20m of shoreline and 2m in height) and M30 (*ca.* 20m of shoreline and 2m in height). The tufa is both active and inactive and it is likely that the seepage areas have changed slightly over time. The relevé was undertaken in area M30. The tufa is cascade formation on mainly vertical slopes on the rocky shoreline. Bryophytes dominate the tufa with *Didymodon tophaceus, Eucladium verticillatum. Pellia endiviifolia, Trichostomum crispulum* and *Mesoptychia turbinata*. Vascular plants are mainly those tolerant of coastal habitats such as *Festuca rubra, Carex flacca, Triglochin maritima, Aster tripolium, Daucus carota* and *Cochlearia officinalis*
The vegetation has most affinity to **Group 1 *Eucladium verticillatum-Pellia endiviifolia Tufa Cascades*** vegetation community (Lyons & Kelly, 2017).

Relevé location:
The relevé (Figure 10.1; Photograph 10.1) is located in the northern seepage section.

Figure 10.1. Relevé location (M30)

© OpenStreetMap contributors

Photograph 10.1. Relevé location (view to W)

DETAILED RELEVÉ

Physical characteristics

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	80	Flowing/ trickling	-	Living field/ ground flora	45
Paludal	-	Pool/ standing water	-	Bare tufa (active/ recent)	40
Stream crust	-	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	-	Damp	80	Leaf litter/ standing dead	-
Dam	-	Dry, not impacted by spring	20	Bare soil	-
Cemented rudites	-	Other:	-	Bare stone	20
Non-tufa	20			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Shrub/ canopy layer

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Acer pseudoplatanus	80	-	-
	-	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 62		
MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE):			c. 10 m

Field/ ground flora

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Daucus carota	1	*Festuca rubra*	8	*Eucladium verticillatum*	10	*Hedera hibernica*	8
Triglochin maritimum	<1	*Carex flacca*	1	*Trichostomum crispulum*	3		
				Pellia endiviifolia	5		
				Didymodon tophaceus	3		
				Didymodon insulanus	1	**TOTAL WOODY <50cm**	**8**
				Fissidens adianthoides	3		
				Mesoptychia turbinata	1	**PTERIDOPHYTES**	
						TOTAL PTERIDOPHYTES	**0**
						ALGAE	
						TOTAL ALGAE*	**0**
TOTAL FORBS	**2**	**TOTAL GRAMINOIDS**	**9**	**TOTAL BRYOPHYTES**	**26**	**TOTAL COVER**	**45**

*Algae not included in total vegetation cover (Lyons & Kelly, 2016)

Photos

Photograph 1.2. View north along estuary shoreline. Relevé shown by red arrow.

Photograph 1.3. Vegetation within relevé (*Pellia endiviifolia, Didymodon tophaceus* and *Eucladium verticillatum*)

APPENDIX B - MOY ESTUARY SPRING SURVEY AND CONDITION ASSESSMENT RESULTS 2021

Condition assessment

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	0 recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	6 species recorded: *Pellia endiviifolia, Fissidens adianthoides, Festuca rubra, Didymodon tophaceus, Mesoptychia turbinata, Eucladium verticillatum*	3 species AND no loss from baseline number of species	Result = 6 positive indicator species **PASS**
Typical accompanying species (neutral indicators)	1 species recorded: *Trichostomum crispulum*	n/a	For information only
Invasive species	0 species recorded	Absent	Result = Absent **PASS**
Negative herbaceous indicator species	0 species recorded	Total cover should not be dominant or abundant	Result = Absent **PASS**
Negative bryophyte indicator species	0 species recorded	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	Result = Absent **PASS**
Negative woody indicator species	Absent	Absent (except in wooded springs)	Result = Absent **PASS**
Spring water composition and flow			
Nitrate level	n/a (no flow)	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	n/a (no flow)	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	Not determined	No alteration of natural flow	No obvious alteration **PASS**
Impacts of grazing			
Field layer height	25cm	Height between 10 and 50cm	Result = 5-10cm **PASS***
Trampling/dung	Absent	Impact should not be abundant/dominant	Result = Absent **PASS**
Overall Structure & Functions Assessment			
All pass or one minor/borderline fail AND, if some indicators are Not Determined, the number of passes is at least five AND there is a pass for Positive Indicator Species		Green - Favourable	**Result = All pass FAVOURABLE**
1 - 2 Fail		Amber - Unfavourable Inadequate	
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
n/a		n/a	**FAVOURABLE**

*Bryophyte dominated so vegetation naturally lower in height

Conservation Score

Criteria	Result	Score
Species diversity score	6 positive indicator species (=moderate)	2
HQ Indicator Species	0	0
Tufa-forming capacity	Smaller consolidated deposits or strongly formed paludal tufa (high)	3
Other positive characteristics	Spring discharges into Killala Bay/Moy Estuary SAC	1
Conservation Score		6
Rank		**High**

APPENDIX C - SUMMARY OF PETRIFYING SPRING VEGETATION COMMUNITIES

Summary of petrifying spring vegetation communities from Lyons & Kelly (2016)[1]. Refer also to Lyons & Kelly (2017)[2].

The eight plant communities of Irish petrifying springs (described based on relevé data) are:

No.	Name	n
Group 1	*Eucladium verticillatum-Pellia endiviifolia* Tufa Cascades	18
Group 2	*Palustriella commutata-Geranium robertianum* Springheads	26
Group 3	*Brachythecium rivulare-Platyhypnidium riparioides* Tufaceous Streams and Flushes	29
Group 4	*Palustriella commutata-Agrostis stolonifera* Springheads	28
Group 5	*Schoenus nigricans* Springs	22
Group 6	*Carex lepidocarpa* Small Sedge Springs	30
Group 7	*Palustriella falcata-Carex panicea* Springs	20
Group 8	*Saxifraga aizoides-Seligeria oelandica* Springs	13

These groups encompass a broad range of variation within petrifying springs as they occur in Ireland. The number of samples (n) in each group ranged from 13 (in Group 8) to 30 (in Group 6).

- **Group 1** *Eucladium verticillatum-Pellia endiviifolia* Tufa Cascades consist of substantial tufa formations, dominated by bryophytes, formed on steep slopes; they have affinities with A*diantion* communities of damp cliffs (e.g. Deil 1994).
- **Group 2** *Palustriella commutata-Geranium robertianum* Springheads usually form on wooded hillsides, often giving rise downslope to flush vegetation constituting the **Group 3** community, *Brachythecium rivulare-Platyhypnidium riparioides* Tufaceous Streams and Flushes. Both are related to the *Equiseto telmatejae-Fraxinetum* Oberd. ex Seib. 1987.
- **Group 4** *Palustriella commutata-Agrostis stolonifera* Springheads are intermediate in many respects between Groups 1 to 3 and Groups 5 to 8; they occur on unshaded, gentle slopes and are dominated by a combination of bryophytes and graminoids.
- **Group 5** *Schoenus nigricans* Springs, **Group 6** *Carex lepidocarpa* Small Sedge Springs and **Group 7** *Palustriella falcata-Carex panicea* Springs are transitional between *Cratoneurion* petrifying spring communities and *Caricion davallianae* small-sedge fen communities. They occur on level or gently sloping ground and range from being weakly tufaceous to forming conspicuous deposits of consolidated paludal tufa; Group 7 is best exemplified on karst limestone in the Burren, Co. Clare.
- **Group 8** *Saxifraga aizoides-Seligeria oelandica* Springs constitute a highly specialised sub-community of *the Saxifragetum aizoidis* McVean & Ratcliffe 1962. This community is of limited biogeographical extent and is best exemplified on steep (mostly north-facing) cliffs of the Benbulbin Range. It contains a suite of rare bryophytes and is of the highest conservation value. It is weakly tufa-forming, typically producing a thin film of stream crust tufa over more or less vertical rock exposures.

[1] Lyons, M.D. & Kelly, D.L. (2016). Monitoring guidelines for the assessment of petrifying springs in Ireland. *Irish Wildlife Manual*s, No. 94. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland.

[2] Lyons, M.D. & Kelly, D.L. (2017). Plant community ecology of petrifying springs (*Cratoneurion*) – a priority habitat. *Phytocoenologia* 47 (1): 13-32.

APPENDIX D - SUMMARY OF PETRIFYING SPRING TUFA FORMATION

Summary of petrifying spring tufa formation types occurring in Ireland (from Lyons & Kelly (2016)[1].

Geomorphological classification of tufa formation types occurring in Ireland

Category	Description
Cascade	Developing on steep slopes at varying distances from the water source; characterised by massive, frequently complex build-ups.
Dam	Similar to cascades but forming along streams and rivers and causing the impoundment of water behind a tufa crest.
Stream crust	Sheet-like deposits forming in streams of intermediate to low gradient; these may merge with cascades.
Paludal	Formed in low gradient mires where tufa accumulates around the bases of plants, often surrounded by carbonate muds.
Cemented rudites	Gravels etc. cemented by tufa; often found on coasts where spring water seeps onto shingle banks.
Oncoids/ooids	Unattached, coated grains (<1mm up to 30 cm); the cortex may consist of biotic or abiotic particles, such as stones or plant fragments.

[1] Lyons, M.D. & Kelly, D.L. (2016). Monitoring guidelines for the assessment of petrifying springs in Ireland. *Irish Wildlife Manuals*, No. 94. National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs, Ireland.