PETRIFYING SPRING SURVEY AND ASSESSMENT
COOLNABACKY, CO. LAOIS

December 2022

Report produced by Denyer Ecology for:
ESB

CONTENTS

1 INTRODUCTION

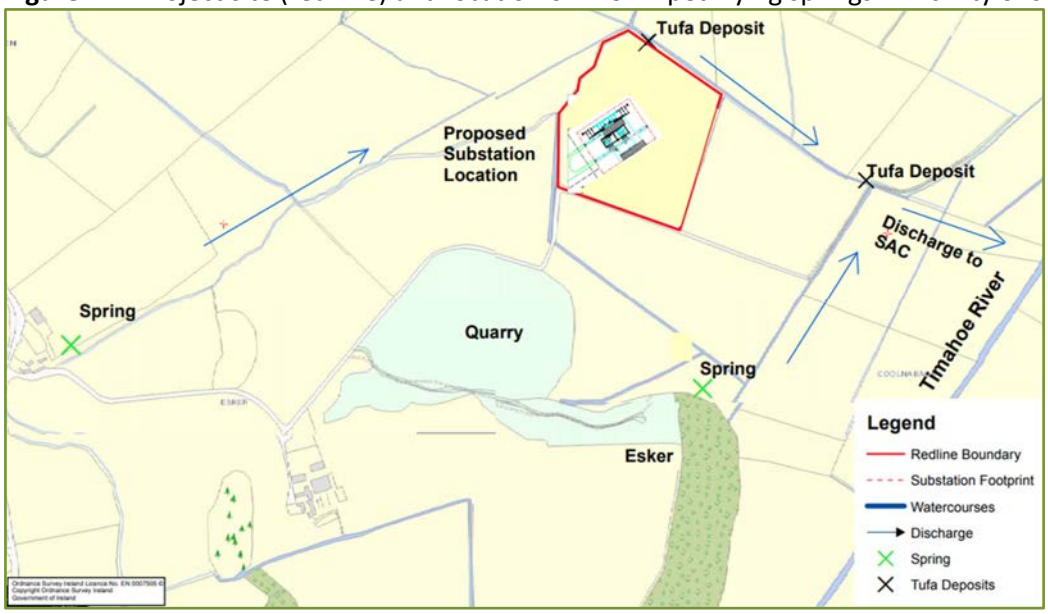
1.1 Background

Denyer Ecology was commissioned by ESB to map petrifying springs of lands at Coolnabacky, Timahoe, Co. Laois. Annex I Priority Habitat Petrifying springs with tufa formation (*Cratoneurion*) [7220] is an Annex I priority habitat listed under the Habitats Directive and was recorded from the project site in 2021.

1.2 Project aims and survey area

The aim of the petrifying spring assessment was to map and assess all locations of examples of Petrifying spring habitat *7220 within the project area (Figure 1.1).

Figure 1.1. Project site (red line) and location of known petrifying springs in vicinity of site



Map provided by IE Consulting

1.3 Relevant expertise

Dr Joanne Denyer

Dr Joanne Denyer 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 specialises in wetland habitats and is Ireland's leading Annex I habitat priority petrifying spring specialist. She 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.

2 METHODOLOGY

2.1 Desktop data

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

- British Bryological Society Atlas dataset.

- Aerial photography and OSI mapping.

2.2 Walk-over survey

The site was walked over in June 2021 and all streams with tufa formation within the project site were mapped.

2.3 Detailed spring survey

- Two detailed plots were undertaken in two streams where tufa formation is present. The relevé locations were positioned to contain representative spring vegetation at each stream location and to encompass the variation of tufa types in the survey area. The two plots were surveyed in June 2021 and July 2022.
- Data collected from each plot 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
- 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.

2.4 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). Criteria include positive and negative indicator species (frequency and cover), woody species cover, vegetation height and disturbance.

2.5 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. 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).

2.6 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).

2.7 Limitations

Some of the streams have dense hedgerows adjacent to them which limits access. However, it was possible to walk most sections of the streams, and this did not limit the site assessment for petrifying springs.

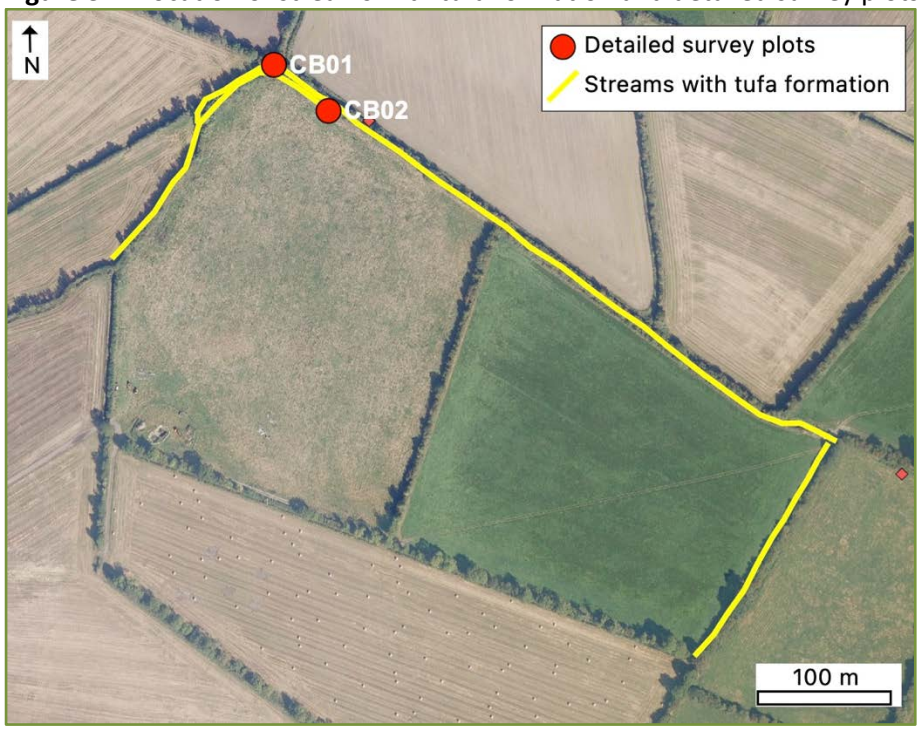
3 SPRING SURVEY RESULTS AND EVALUATION

3.1 Walk-over survey

Several small streams surrounding the site (Figure 3.1) were found to have a high pH and to support tufa formation as stream crust, paludal tufa, oncoids and ooids and cascade tufa. pH values of 8.30, 8.16 and 8.22 were recorded, which is high for lowland streams and typical of petrifying springs. Cover of tufa within the streams ranged from absent to 90% of the stream bed (e.g. Photograph 3.1). The streams had a good flow, despite the season and are highly likely to be largely groundwater fed. Positive indicator species (e.g. Photograph 3.2) for the Annex I priority habitat were rare. This is likely

to be because the streams also act as drainage ditches and receive some surface water (and nutrients) from adjacent lands, increasing water depth at certain times of the year.
The surveyed streams with tufa deposition along some or all of their length are shown in Figure 3.1.

Figure 3.1. Location of streams with tufa formation and detailed survey plots



RGB Aerial Photography - © Bluesky Geospatial Limited

Photograph 3.1. High cover of tufa (mainly oncoids and ooids) in section of stream

Photograph 3.2. The Annex I petrifying spring indicator species *Pellia endiviifolia* in a stream section

3.2 Detailed plot survey and condition assessment

Two detailed petrifying spring plots were surveyed (Figure 3.1). A summary of the results is shown in Tables 3.1 and 3.2. and the full results of the plot survey and condition assessment (from 2021 and 2022) are shown in Appendix A. Stream 1 had slightly lower than average species richness and this is likely to be related to shading. Nitrate levels are high in both streams (baseline water quality sampling data from March 2022; Appendix B), related to agricultural activity in the area. Although this may partly cause the lower species richness and positive indicator species number in the plots, there was little sign of filamentous algae in either plot. The 2021 Stream 2 plot (CB02) had become overgrown and shaded in 2022 and the plot was moved to where the two streams join.

Both plots fail the condition assessment (Table 3.3). This is because of the low number of positive indicator species, high nitrate levels and shading in plot CB02 (Stream 2).

Table 3.2. Main tufa formation, vegetation type and species richness in each plot

Spring no.	Plot no.	Vegetation community[1]	Tufa formation	Plot species richness	Average sp. richness for vegetation community[2]
Stream 1	CB01	Group 3	Total 23%: Cascade 20%; paludal 3%	13 (2021); 12 (2021)	13.8
Stream 2	CB02	Group 3	Total 53%: Cascade 50%; paludal 3%	18 (2021); 16 (2022)	13.8

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

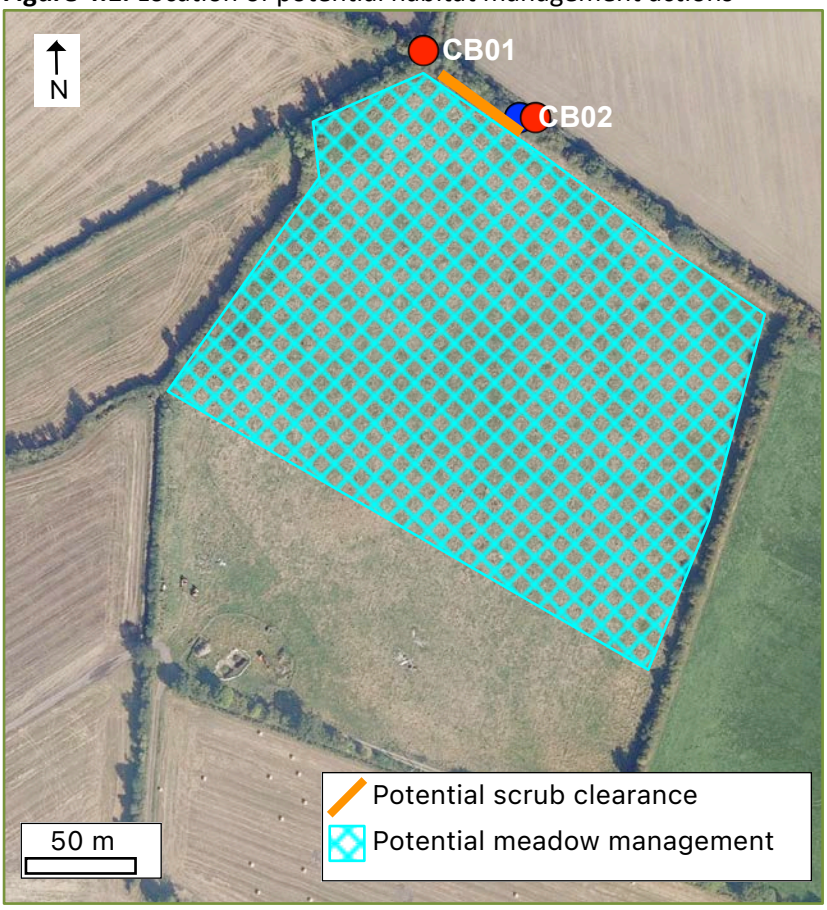
Table 3.3. Conservation score, ranking and condition assessment summary for each plot

Spring no.	Annex I spring	Conservation score	Conservation ranking	Condition assessment result
CB01	Yes	4	Moderate	UNFAVOURABLE
CB02	Yes	5	High	UNFAVOURABLE

4 RECOMMENDATIONS

- Petrifying springs are highly sensitive to changes in water chemistry and water flow. Any works in the vicinity of the streams must protect the streams from run-off to prevent sediment entering the streams. Surface water should not be discharged in locations where it could dilute the water in the tufa forming sections of the streams, as this would change the water chemistry and could affect tufa formation.
- Stream 2, which runs along the inside of the northern boundary of the site, is becoming overgrown with tall vegetation. This is shading the stream and reducing species richness in the tufa forming sections. Clearance of scrub from the ditch edge on the south-west side (Figure 4,1) would reduce the shading. This should only be undertaken with input and supervision from the project ecologist, to ensure that there are no negative impacts on fauna using this area of the site. Once agreed, an ongoing maintenance plan can be created.
- In addition to localised scrub clearance, annual mowing of the grassland in this area (Figure 4.1) would prevent the re-development of long vegetation and scrub. This could be an annual cut of the grassland around mid-August, with the cuttings removed. This would also enhance species diversity in the grassland. Not all of the grassland needs to be cut each year and retaining some areas of long grass would provide refuge for overwintering insects and other fauna. Again, this should only be undertaken with input and supervision from the project ecologist. Once agreed, an ongoing maintenance plan can be created.
- The petrifying springs should be re-surveyed in 2023 to ensure there are no negative impacts from any works on the survey site and to provide further habitat management recommendations as required.

Figure 4.1. Location of potential habitat management actions



5 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

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

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APPENDIX A - SURVEY AND CONDITION ASSESSMENT RESULTS

SITE AND SPRING DETAILS

Site name: Coolnabacky	**Spring name:** Stream 1	**Relevé No.:** CB01
Survey dates: 24/06/22 & 24/07/22	**Relevé dimensions:** 1m x 4m	**Relevé area:** 4m^2
Grid reference: S 53818 93075	**Spring type:** Spring-fed stream	
Slope: <5°	**Altitude (m):** *c.* 100m	**Aspect:** SW
pH: 8.16 (2021); 7.85 (2022)	**EC:** 1890 µS (2021); 1060 µS (2022)	**Temp.:** 12.8 (2021); 12.6 (2022)

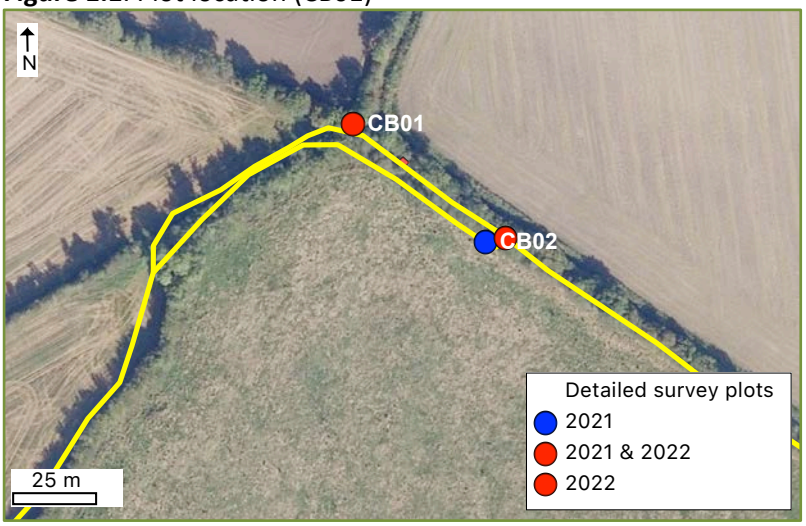
Spring description:

This stream flows SW to NE across the NW corner of the site. The stream originates further to the SW, but tufa is only present in the stream *c.* 200m SW of the plot location (Figure 1). This suggests that groundwater is entering the stream around this location. The stream had good flow in both surveys despite dry summer conditions. The tufa is mainly present as oncoids and ooids in the SW, but cascade tufa and stream crust tufa are more frequent in the vicinity of the plot. The stream is shaded by hedgerows for most of its length. Positive indicator species for the Annex I habitat 'petrifying springs with tufa formation' are rare. This is likely to be because the streams also act as drainage ditches and receive some surface water (and nutrients) from adjacent lands, increasing water depth at certain times of the year. Although measured nitrate levels are high, there was little/ none filamentous algae.
The stream is an example of **Group 3 *Brachythecium rivulare-Platyhypnidium riparioides* tufaceous streams and flushes** vegetation community (Lyons & Kelly, 2017).

Plot location:

The plot (CB01) is located in the NW of the site, just upstream of where several streams join and flow to the SE along the northern boundary of the site.

Figure 1.1. Plot location (CB01)



RGB Aerial Photography - © Bluesky Geospatial Limited

Photograph 1.1. Plot CB01 (view to SW), 2021

Photograph 1.2. Plot CB01 (view to SW), 2022

APPENDIX A - SURVEY AND CONDITION ASSESSMENT RESULTS

DETAILED RELEVÉ

Physical characteristics (2021)

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	30	Flowing/ trickling	100	Living field/ ground flora	60
Paludal (1)	5	Pool/ standing water	-	Bare tufa (active/ recent)	10
Stream crust	10	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	-	Damp	-	Leaf litter/ standing dead	-
Dam	-	Dry, not impacted by spring	-	Bare soil	-
Cemented rudites	-	Other:	-	Bare stone	30
Non-tufa	55			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous
Cover values: record to nearest 5%. If <5% then use 3%, 1% 0.5%, 0.1%

Physical characteristics (2022)

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	30	Flowing/ trickling	100	Living field/ ground flora	60
Paludal (1)	5	Pool/ standing water	-	Bare tufa (active/ recent)	25
Stream crust	30	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	10	Damp	-	Leaf litter/ standing dead	-
Dam	-	Dry, not impacted by spring	-	Bare soil	-
Cemented rudites	-	Other:	-	Bare stone	15
Non-tufa	25			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous
Cover values: record to nearest 5%. If <5% then use 3%, 1% 0.5%, 0.1%

Shrub/ canopy layer (2021)

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Alnus glutinosa	10	-	-
Corylus avellana	5		
Fraxinus excelsior	15		
Prunus spinosa	10		
Rosa canina	5	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 45	**TOTAL %**	**TOTAL %**
MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE): 10m			

Shrub/ canopy layer (2022)

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Alnus glutinosa	10	-	-
Corylus avellana	5		
Fraxinus excelsior	5		
Prunus spinosa	10		
Rosa canina	5	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 35	**TOTAL %**	**TOTAL %**
MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE): 10m			

APPENDIX A - SURVEY AND CONDITION ASSESSMENT RESULTS

Field/ ground flora (2021)

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Helioscadium nodiflorum	3	*Agrostis stolonifera* [A]	3	*Cratoneuron filicinum*	3	*Hedera hibernica*	3
Ranunculus repens [A]	3	*Poa trivialis* [A]	1	*Pellia endiviifolia**	30	*Rubus fruticosus*	3
Heracleum sphondylium	5	*Brachypodium sylvaticum*	1				
Filipendula ulmaria [A]	3					**TOTAL WOODY <50cm**	**6**
Viola riviniana	<1					**PTERIDOPHYTES**	
Cardamine pratense [A]	1						
						TOTAL PTERIDOPHYTES	**0**
						ALGAE	
						TOTAL ALGAE	**0**
TOTAL FORBS	**16**	**TOTAL GRAMINOIDS**	**5**	**TOTAL BRYOPHYTES**	**33**	**TOTAL CANOPY**	**60**

*=Annex I positive indicator species; [A]=Accompanying species

Field/ ground flora (2022)

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Helioscadium nodiflorum	3	*Agrostis stolonifera* [A]	3	*Cratoneuron filicinum*	8	*Hedera hibernica*	3
Ranunculus repens [A]	1	*Brachypodium sylvaticum*	1	*Pellia endiviifolia**	40	*Rubus fruticosus*	1
Filipendula ulmaria [A]	1			*Kindbergia praelonga*	<1		
Epilobium hirsutum	<1					**TOTAL WOODY <50cm**	**4**
Veronica montana	<1					**PTERIDOPHYTES**	
						TOTAL PTERIDOPHYTES	**0**
						ALGAE	
						TOTAL ALGAE	**0**
TOTAL FORBS	**6**	**TOTAL GRAMINOIDS**	**4**	**TOTAL BRYOPHYTES**	**45**	**TOTAL CANOPY**	**60**

*=Annex I positive indicator species; [A]=Accompanying species

APPENDIX A - SURVEY AND CONDITION ASSESSMENT RESULTS

Photos

Photo 1.3. Plot, view to SW (upstream), 2021

Photo 1.4. Plot, view to SW (upstream), 2022

Photo 1.5. Close up of plot vegetation, 2021

Photo 1.6. Close up of plot vegetation, 2022

Condition assessment (2021 & 2022)

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	None recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	1 species recorded (* in species table)	3 species AND no loss from baseline number of species	**FAIL**
Typical accompanying species (neutral indicators)	5 species (2021), 3 species (2022) ([A] in species table)	n/a	For information only

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Criteria	Result	Target value	Result and pass/ Fail
Invasive species	None recorded	Absent	Result = absent **PASS**
Negative herbaceous indicator species	1 species recorded: *Helioscadium nodiflorum*	Total cover should not be dominant or abundant	**PASS**
Negative bryophyte indicator species	1 species recorded: *Cratoneuron filicinum* (occasional to frequent)	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	**PASS**
Negative woody indicator species	n/a as wooded spring	Absent (except in wooded springs)	n/a
Spring water composition and flow			
Nitrate level	Upstream value of 39.4 mg/l and downstream of 37.7 mg/l	No increase from baseline and not above 10 mg/l	**FAIL**
Phosphate level	Upstream value 2021 of <15 mg/l and downstream of <15 mg/l	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	No obvious alteration	No alteration of natural flow	**PASS**
Impacts of grazing			
Field layer height	<2cm	Height between 10 and 50cm	**PASS***
Trampling/dung	None recorded	Impact should not be abundant/dominant	**Result =** none recorded **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	
1 - 2 Fail		Amber - Unfavourable Inadequate	**UNFAVOURABLE**
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
None recorded			**UNFAVOURABLE**

***Vegetation height lower as dominated by thalloid liverwort = passes this criterion

Conservation Score

Criteria	Result	Score
Species diversity score	1 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	None	0
Conservation Score		4
Rank		**Moderate**

APPENDIX A - SURVEY AND CONDITION ASSESSMENT RESULTS

SITE AND SPRING DETAILS

Site name: Coolnabacky	**Spring name:** Stream 2	**Relevé No.:** CB02
Survey dates: 24/06/22 & 24/07/22	**Relevé dimensions:** 1m x 4m (2021), 2x2m (2022)	**Relevé area:** 4m^2
Grid reference: S 53859 93043 (2021); S 53868 93044 (2022)	**Spring type:** Spring-fed stream	
Slope: <1-30^o	**Altitude (m):** *c.* 100m	**Aspect:** SE (2021); SW (2022)
pH: 8.30 (2021); 7.78 (2022)	**EC:** 840 µS (2021); 910 µS (2022)	**Temp.:** 15.1 (2021); 12.8. (2022)

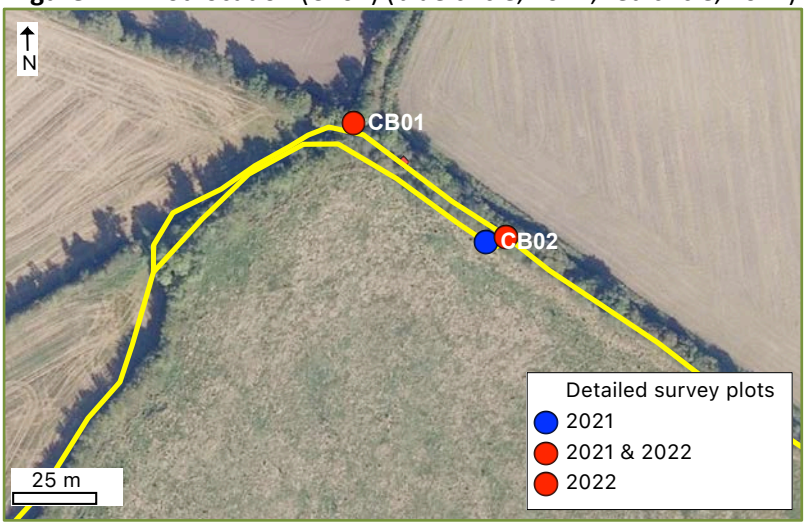
Spring description:

This stream arises near Stream 1 and flows parallel along the other side of the hedgerow but at a slightly higher elevation. It then enters Stream 1 through a gap in the hedgerow. It flows down over a tufa cascade to join Stream 1. Tufa cover is up to 85% cover in places, mostly oncoids and ooids except where cascade tufa forms where the two streams join. In 2021 a plot was positioned just upstream of where the two streams join, where they are parallel to each other either side of the hedgerow (CB02 blue circle, Figure 2.1). This had become overgrown and shaded in 2022 and the plot was moved to where the two streams join (CB02 red circle, Figure 2.1). The stream is shaded by hedgerows for most of its length except where it joins Stream 2 (where the 2022 plot is located). As for Stream 1, positive indicator species for the Annex I habitat 'petrifying springs with tufa formation' are rare. This is likely to be because the streams also act as drainage ditches and receive some surface water (and nutrients) from adjacent lands, increasing water depth at certain times of the year. Also there is shading from tall vegetation within the ditch in some areas (e.g. 2021 plot location). Although measured nitrate levels are high, there was little/ none filamentous algae. The stream is an example of **Group 3 *Brachythecium rivulare-Platyhypnidium riparioides* tufaceous streams and flushes** vegetation community (Lyons & Kelly, 2017).

Plot location:

The plot (CB02) is located in the NW of the site. In 2021 it was located just upstream of where two streams join. In 2022, the plot was moved to the location where the streams join.

Figure 2.1. Plot location (CB02) (blue circle, 2021; red circle, 2022)



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APPENDIX A - SURVEY AND CONDITION ASSESSMENT RESULTS

Photograph 2.1. Plot CB01 (view to SW), 2021

Photograph 2.2. Plot CB01 (view to SW), 2022

DETAILED RELEVÉ

Physical characteristics (2021)

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	-	Flowing/ trickling	100	Living field/ ground flora	60
Paludal (1)	-	Pool/ standing water	-	Bare tufa (active/ recent)	30
Stream crust	-	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	85	Damp	-	Leaf litter/ standing dead	5
Dam	-	Dry, not impacted by spring	-	Bare soil	5
Cemented rudites	-	Other:	-	Bare stone	-
Non-tufa	15			Other:	-
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous
Cover values: record to nearest 5%. If <5% then use 3%, 1% 0.5%, 0.1%

Physical characteristics (2022)

Tufa	% Cover	Water	% Cover	Surface	% Cover
Cascade	50	Flowing/ trickling	100	Living field/ ground flora	45
Paludal (1)	3	Pool/ standing water	-	Bare tufa (active/ recent)	30
Stream crust	-	Dripping	-	Ancient/ inactive tufa	-
Oncoids/ ooids	20	Damp	-	Leaf litter/ standing dead	-
Dam	-	Dry, not impacted by spring	-	Bare soil	20
Cemented rudites	-	Other:	-	Bare stone	-
Non-tufa	27			Other:	5
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

Paludal tufa: 1 = weak/ thin/ discontinuous, 3 = strongly forming/ continuous/ conspicuous
Cover values: record to nearest 5%. If <5% then use 3%, 1% 0.5%, 0.1%

Shrub/ canopy layer (2021)

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Corylus avellana	30		
Crataegus monogyna	5		
Prunus spinosa	5		
Rosa canina	1	-	-
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 41	**TOTAL %**	**TOTAL %**
MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE): 8m			

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Shrub/ canopy layer (2022)

Species	Routed outside Canopy (%)	Routed inside Canopy (%)	Routed inside Height (m)
Ilex aquifolium	20		
Corylus avellana	20		
Crataegus monogyna	20		
Prunus spinosa		<1	2m
Rosa canina	5		
Sambucus nigra	<1		
TOTAL CANOPY (ROOTED INSIDE + ROOTED OUTSIDE) %	**TOTAL %:** 65	**TOTAL %**	**TOTAL %**
MAX HEIGHT (m) ABOVE QUADRAT (ROOTED INSIDE + ROOTED OUTSIDE): 10m			

Field/ ground flora (2021)

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Epilobium hirsutum	10	*Brachypodium sylvaticum* [A]	1	*Cratoneuron filicinum*	1	*Rubus fruticosus*	5
Mentha aquatica [A]	10	*Poa trivialis* [A]	1	*Pellia endiviifolia**	3		
Galium aparine	3	*Carex flacca* [A]	3	*Kindbergia praelonga*	3		
Filipendula ulmaria [A]	5	*Festuca rubra**	1	*Eurhynchium striatum*	3	**TOTAL WOODY <50cm**	**5**
Lythrum salicaria	3			*Plagiomnium undulatum*	1	**PTERIDOPHYTES**	
				Brachythecium rivulare	3	*Equisetum palustre*	3
				*Palustriella commutata**	1	**TOTAL PTERIDOPHYTES**	**0**
						ALGAE	
						TOTAL ALGAE	**0**
TOTAL FORBS	**31**	**TOTAL GRAMINOIDS**	**6**	**TOTAL BRYOPHYTES**	**15**	**TOTAL CANOPY**	**60**

*=Annex I positive indicator species; [A]=Accompanying species

Field/ ground flora (2022)

FORBS	%	GRAMINOIDS	%	BRYOPHYTES	%	WOODY	%
Helioscadium nodiflorum	3	*Agrostis stolonifera* [A]	3	*Cratoneuron filicinum*	1	*Rubus fruticosus*	15
Geranium robertianum	<1	*Brachypodium sylvaticum*	3	*Pellia endiviifolia**	10		
Mentha aquatica [A]	<1	*Carex remota*	<1	*Fissidens taxifolius*	<1		
Epilobium hirsutum	<1	*Poa trivialis* [A]	<1	*Palustriella commutata**	3	**TOTAL WOODY <50cm**	**15**
				Eurhynchium striatum	<1	**PTERIDOPHYTES**	
						Equisetum arvense	3
						Asplenium scolopendrium	<1
						TOTAL PTERIDOPHYTES	**4**
						ALGAE	
						TOTAL ALGAE	**0**
TOTAL FORBS	**4**	**TOTAL GRAMINOIDS**	**7**	**TOTAL BRYOPHYTES**	**15**	**TOTAL CANOPY**	**45**

*=Annex I positive indicator species; [A]=Accompanying species

APPENDIX A - SURVEY AND CONDITION ASSESSMENT RESULTS

Photos

Photo 2.3. Plot, view to NE (across stream), 2021

Photo 2.4. Plot, view to SW (upstream), 2022

Photo 2.5. Close up of plot vegetation, 2021

Photo 2.6. Close up of plot vegetation, 2022

APPENDIX A - SURVEY AND CONDITION ASSESSMENT RESULTS

Condition assessment (2021 & 2022)

Criteria	Result	Target value	Result and pass/ Fail
Species assessment criteria			
High quality indicator species	None recorded	n/a (included below)	n/a (included with positive indicator species)
Positive indicator species	3 species (2021), 2 species (2022) (* in species table)	3 species AND no loss from baseline number of species	**FAIL**
Typical accompanying species (neutral indicators)	5 species (2021), 3 species (2022) ([A] in species table)	n/a	For information only
Invasive species	None recorded	Absent	Result = absent **PASS**
Negative herbaceous indicator species	1 species recorded 2022: *Helioscadium nodiflorum*	Total cover should not be dominant or abundant	**PASS**
Negative bryophyte indicator species	1 species recorded: *Cratoneuron filicinum* (rare)	No one species dominant or abundant; if ≥2 species present) then fails if ≥2 are frequent or 1 is abundant	**PASS**
Negative woody indicator species	n/a as wooded spring	Absent (except in wooded springs)	n/a
Spring water composition and flow			
Nitrate level	Upstream value of 39.4 mg/l and downstream of 37.7 mg/l	No increase from baseline and not above 10 mg/l	**PASS**
Phosphate level	Upstream value 2021 of <15 mg/l and downstream of <15 mg/l	No increase from baseline and not above 15 µg/l	**PASS**
Water flow	No obvious alteration	No alteration of natural flow	**PASS**
Impacts of grazing			
Field layer height	>1m (2021); 5-20 (2022)	Height between 10 and 50cm	**FAIL***
Trampling/dung	None recorded	Impact should not be abundant/dominant	**Result =** none recorded **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	
1 - 2 Fail		Amber - Unfavourable Inadequate	**UNFAVOURABLE**
>2 Fail		Red – Unfavourable Bad	
Future prospects: Negative activities			
None recorded			**UNFAVOURABLE**

***Vegetation height passed in plot in 2022, but would fail along the length of the stream in both years

Conservation Score

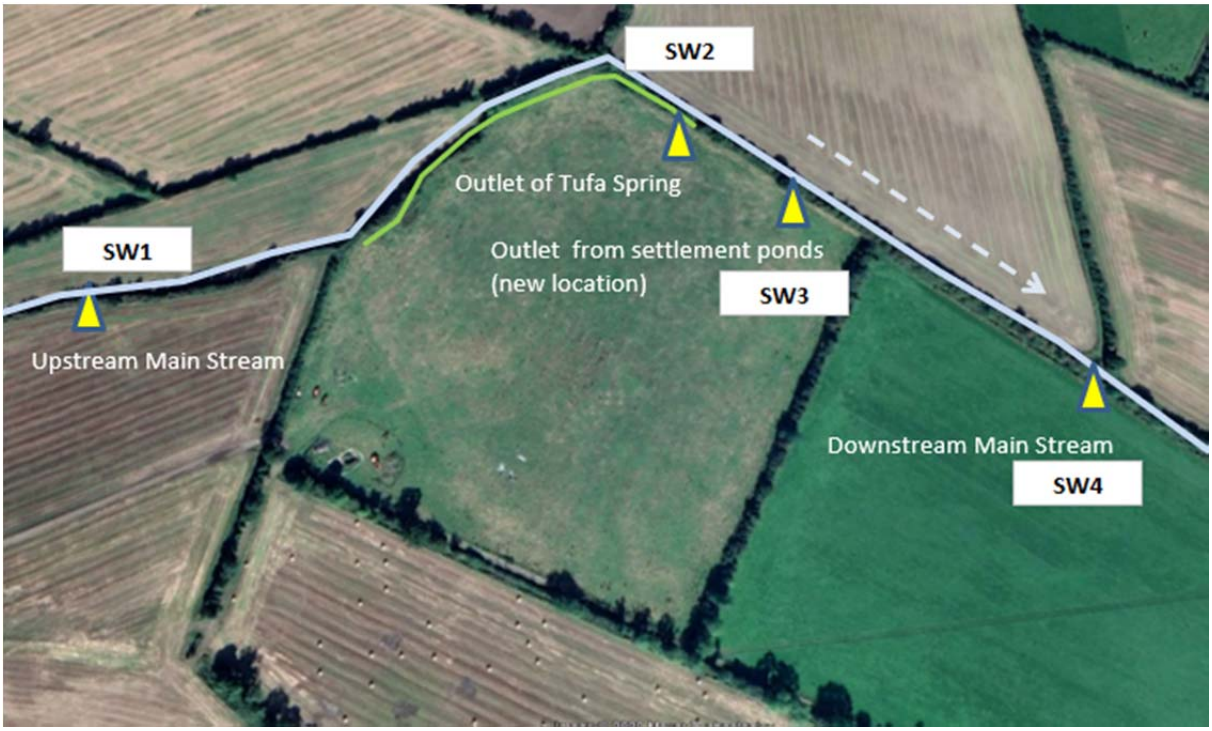
Criteria	Result	Score
Species diversity score	3 positive indicator species (=low)	1
HQ Indicator Species	0	0
Tufa-forming capacity	Massive, strongly consolidated deposits	4
Other positive characteristics	None	0
Conservation Score		5
Rank		**High**

BASELINE SURFACE WATER SAMPLING 30TH MARCH 2022

COOLNABACKY, TIMAHOE, CO. LAOIS

INTRODUCTION

IE Consulting took surface water samples at three locations SW1, SW2 and SW4 as shown below, because SW3 has not yet been constructed. The samples were taken to establish baseline conditions prior to commencement of the main civils works at the site



The samples were analysed at Element Laboratories, and the results were interpreted by IE Consulting

INTERPRETATION

The results of analysis are provided in the table below and are compared to the relevant EQS standards.

The results are all very similar suggesting, that all streams are calcium rich groundwater fed in the area.

There is no evidence of any deterioration in water quality as the stream passes the site.

The only negative is the elevated Nitrate concentrations since nutrient enrichment can cause damage to Tufa spring habitats. The results suggest some nutrient loss to groundwater from the agricultural activity in the vicinity of the site.

Parameter Surface Water Monitoring	SI272/2009 as amended by SI372/2012; SI386/2015; SI77/2019; SI659/2021	Units	SW1 Upstream 30/03/2022	SW2 Tufa Spring Outlet 30/03/2022	SW4 Downstream 30/03/2022
Calcium	-	mg/l	117.5	118.8	117.3
Magnesium	-	mg/l	5.2	5.3	6.5
Potassium	-	mg/l	3.2	3	3
Sodium	-	mg/l	6.8	7	9.6
Sulphate as SO_4	-	mg/l	22.8	22.4	22.9
Chloride	-	mg/l	23.8	23.8	32.6
Nitrate as NO_3	-	mg/l	39.4	37.7	38.2
Molybdate Reactive Phosphorous as P	≤ 0.035 Good Status	mg/l	<0.015	<0.015	<0.015
Ammoniacal Nitrogen as NH_4	≤ 0.004 High Status	mg/l	<0.03	0.03	0.03
Electrical Conductivity	-	uS/cm	678	677	699
pH	6.0 < pH < 9.0 *	pH units	8.14	8.31	8.19
Total Alkalinity as $CaCO_3$	-	mg/l	302	292	290
TPH CWG					
>C5-C6	-	ug/l	<10	<10	<10
>C6-C8	-	ug/l	<10	<10	<10
>C8-C10	-	ug/l	<10	<10	<10
>C10-C12	-	ug/l	<5	<5	<5
>C12-C16	-	ug/l	<10	<10	<10
>C16-C21	-	ug/l	<10	<10	<10
>C21-C35	-	ug/l	<10	<10	<10
>C35-C44	-	ug/l	<10	<10	<10
Total aliphatics C5-44	-	ug/l	<10	<10	<10
>C5-C6	-	ug/l	<10	<10	<10
>C5-EC7	-	ug/l	<10	<10	<10
>EC7-EC8	-	ug/l	<10	<10	<10
>EC8-EC10	-	ug/l	<10	<10	<10
>EC10-EC12	-	ug/l	<5	<5	<5
>EC12-EC16	-	ug/l	<10	<10	<10
>EC16-EC21	-	ug/l	<10	<10	<10
>EC21-EC35	-	ug/l	<10	<10	<10
>EC35-EC44	-	ug/l	<10	<10	<10
Total aromatics C5-44	-	ug/l	<10	<10	<10
Total aliphatics and aromatics (C5-44)	-	ug/l	<10	<10	<10
MTBE	-	ug/l	<5	<5	<5
Benzene	10 #	ug/l	<5	<5	<5
Toluene	10 #	ug/l	<5	<5	<5
Ethylbenzene	-	ug/l	<5	<5	<5
m/p-Xylene	10 #	ug/l	<5	<5	<5
o-Xylene	10 #	ug/l	<5	<5	<5

*Water hardness > 100 mg/l

River Water body