

KILDALKEY ROAD PETRIFYING SPRING SURVEY AND ASSESSMENT 2025

June 2026



Annex I priority Petrifying spring habitat at Kildalkey Road

**Report produced by Denyer Ecology
for Loughlynn Developments Limited**



Dr Joanne Denyer

Ecological Consultant, BSc (Hons) DPhil MCIEEM

Denyer Ecology, 11 Dargle View, Rathfarnham, Dublin, D16 XY51, Ireland

joanne@denyerecology.com | www.denyerecology.com | +353 86 2379153

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1 INTRODUCTION

1.1 Background

Dr Joanne Denyer was commissioned by Loughglynn Developments Limited to undertake detailed plot survey and condition assessment of petrifying spring habitat Kildalkey Road, Trim, Co. Meath. Petrifying springs with tufa formation (*Cratoneurion*) [7220] are an EC Habitats Directive Annex I priority habitat. Part of the survey site is located within the River Boyne and River Blackwater SAC [site code 002299]. Whilst there are several examples of Annex I priority petrifying springs recorded from this SAC, they are not currently listed as a Qualifying Interest for the site.

1.2 Survey area

The survey area is shown in Figure 1.1 The site is located on the western edge of Trim, Co. Meath, between Kildalkey Road to the north and the River Boyne to the south.



Figure 1.1 Survey area

Maps © Thunderforest, Data © OpenStreetMap contributors

1.3 Aims

A walk-over survey of the site in February 2025 mapped an area of Annex I petrifying springs/ seepages in the south of the site (Figure 1.2). The summary report for this survey (Appendix A) recommended that a detailed botanical survey and condition assessment be undertaken of the petrifying springs/ seepages, in the survey season (May to September), with water chemistry sampling. This was undertaken and the results are included in this report.

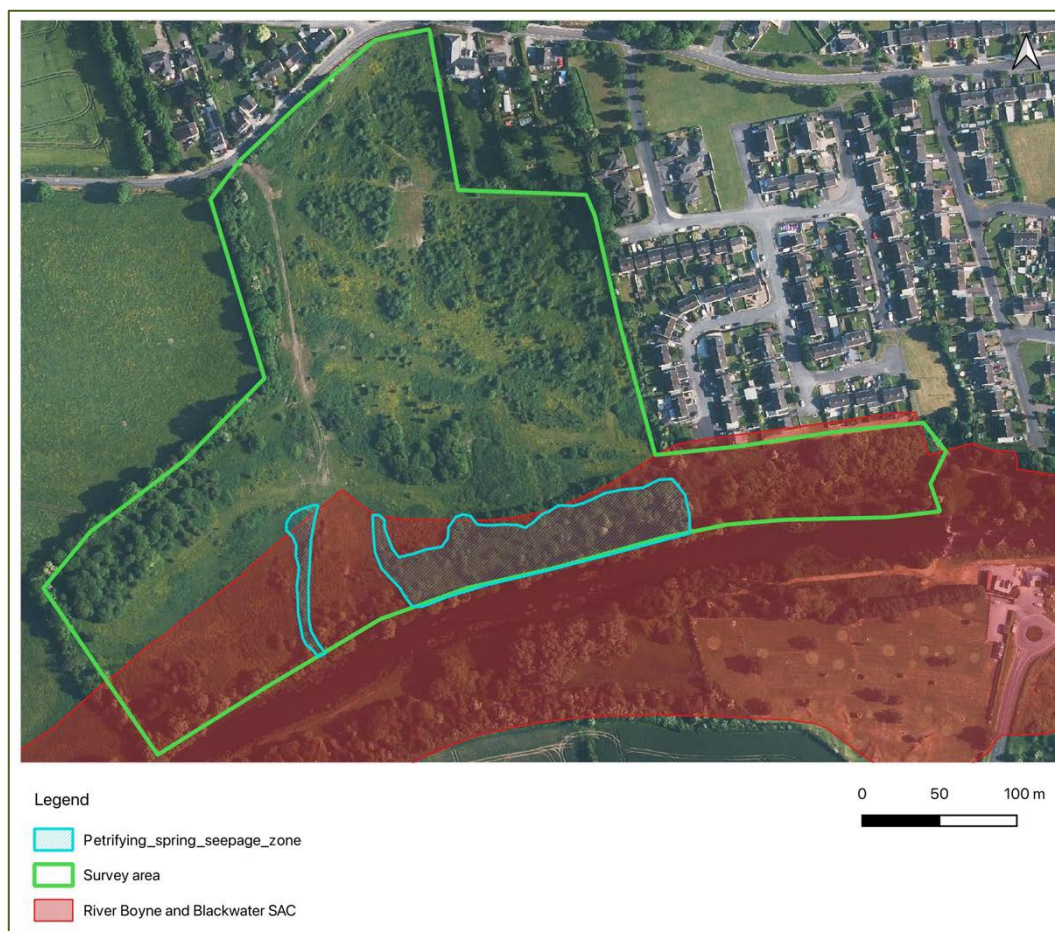


Figure 1.2 Location of petrifying spring/ seepage areas within the survey area
 RGB Aerial Photography - © Bluesky Geospatial Limited

1.4 Relevant expertise

Dr Joanne Denyer is a highly experienced botanist and bryologist with over 25 years' experience of ecological survey and research. She specialises in botanical, wetland and bryological survey in the Republic of Ireland. She is a national expert on Annex I priority habitat petrifying springs and has worked on a wide range of projects and sites in relation to this habitat. This includes detailed site survey, assessment and monitoring, habitat management, Ecological Impact Assessment, pre and post construction monitoring, acting as an expert witness on calcareous springs at Oral Hearing and providing advice to county councils and NPWS. In 2018 (Denyer et al, 2018) and 2024 she assisted National Parks and Wildlife Service (NPWS) in Article 17 reporting on Petrifying springs to the European Commission. The 2024 assessment included a national survey of petrifying spring sites across Ireland. She is the lead author of new guidance on petrifying spring assessment and monitoring (Denyer et al, 2023 and Denyer, in press).

2 METHODOLOGY

2.1 Desktop information

The following resources were consulted:

- GIS boundaries of designated site data (data accessed via NPWS website).
- Site synopsis for River Boyne and River Blackwater SAC [site code 002299] (NPWS, 2014)
- Site specific conservation objectives for River Boyne and River Blackwater SAC (SSCOs) (NPWS 2021).
- Aerial photography and historic mapping for the site (geohive.ie).

- Article 17 of the Habitats Directive reports and accompanying data for the periods 2013-2018 (NPWS, 2019b) and 2008-2023 (NPWS, 2013b).
- Article 17 of the Habitats Directive data for the period 2019-2024 (NPWS, In Preparation).

2.2 Survey and assessment

- Three detailed plots were undertaken in Annex I petrifying springs within the survey area in June 2025. The plot locations were positioned to contain representative spring vegetation at each spring location and to encompass the variation of tufa types in the survey area.
- Spring water pH and conductivity was measured in the field from each surveyed spring using a handheld pH meter.
- Detailed water chemistry sampling was also undertaken in the three surveyed petrifying springs in June 2025 and October 2025. These were laboratory tested for the following parameters (see Denyer et al., 2023 for more details): pH, Electrical conductivity, Alkalinity (HCO_3^- mg/l), Calcium (Ca^{2+} mg/l), Magnesium (Mg^{2+} mg/l), Potassium (K^+ mg/l), Sodium (Na^+ mg/l), Chloride (Cl^- mg/l), Nitrate (NO_3^- mg/l), Soluble Reactive Phosphorous (ortho-phosphate) (PO_4^{3-} $\mu\text{g/l}$), Ammonia (NH_3 mg/l) and ammonium (NH_4^+ mg/l) and Sulphate (SO_4^{2-} mg/l).
- The plot sampling methodology follows Denyer (2025); Denyer et al. (2023) and Lyons & Kelly (2016). The plots were either 2m x 2m or 1m x 4m in size, depending on the spring type. Within each plot the data collected included habitat and plot photographs; plot location(s) (GPS); recording of percentage cover of 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 quantity, trampling and dumping).
- Petrifying spring vegetation communities were classified using Lyons & Kelly (2017).
- The ecological condition of the springs was assessed using Denyer (2025); Denyer et al. (2023) and Lyons & Kelly (2016). Criteria include positive and negative indicator species (frequency and cover), woody species cover, vegetation height and disturbance.
- The 'Conservation Score' of the petrifying springs was assessed using Denyer et al. (2023) and 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. The maximum score possible is 10. This score is then used to rank the quality of the spring at a national level as follows: 1-2 = Low; 3-4 = Moderate; 5-6 = High, 7-8 = Very high and 9-10 = Outstanding. See Denyer et al. (2023) and Lyons & Kelly (2016) for more details.

2.3 Plant species nomenclature

Vascular plant nomenclature follows that of the *New Flora of the British Isles*. 4th Edition (Stace, 2019). The bryophyte nomenclature adopted by Blockeel et al. (2021) is used.

3 RESULTS

3.1 Detailed plot survey and condition assessment

Three detailed petrifying spring plots were undertaken: KD01- KD03. These are shown on Figure 3.1 and listed in Table 3.1. A summary of the results is shown in Tables 3.2 and 3.3. and the full results of the plot survey and condition assessment are shown in Appendix B.

The petrifying springs within plots KD01 and KD03 are examples of the vegetation community Group 3 *Brachythecium rivulare-Platyhypnidium riparioides* tufaceous streams and flushes (Lyons & Kelly, 2017), which is typical of water with moderate to high levels of nutrient enrichment. The petrifying spring vegetation in KD02 however is an example of *Carex lepidocarpa* small sedge springs, with open low growing vegetation and the presence of frequent *Chara vulgaris* (charophyte). This may change as the vegetation recovers from the disturbance in this area.

The main tufa type in most of the petrifying springs is sparse but frequent paludal tufa, with some cascade tufa in the wooded spring (KD03). KD02 and KD03 have three positive indicator species, which is the minimum for good condition in petrifying springs (Denyer, 2025; Denyer et al., 2023). However, only one positive indicator species was recorded from KD01.

All three of the plots with water chemistry data had elevated nitrate levels at least one water sample. KD01 had very high nitrate levels in both the June and October samples and this has the lowest number of positive indicator species. KD02, which had vegetation typical of lower nutrient conditions, only had high nitrate in the June sample. KD03 exceeded the phosphate threshold in June with very high phosphate levels, but phosphate was non-detectable in the October sample. All three plots are considered to fail the condition assessment on water quality based on the current sample data. Additional impacts to the surveyed springs include the vegetation and soil disturbance prior to February 2025, where some springs were completely cleared of vegetation and there was landscaping/ soil movement within the spring area. As the springs are recovering from this past disturbance, they may change over the next year as vegetation regenerates and there are less nutrients and sediment entering the water from the disturbed soil.

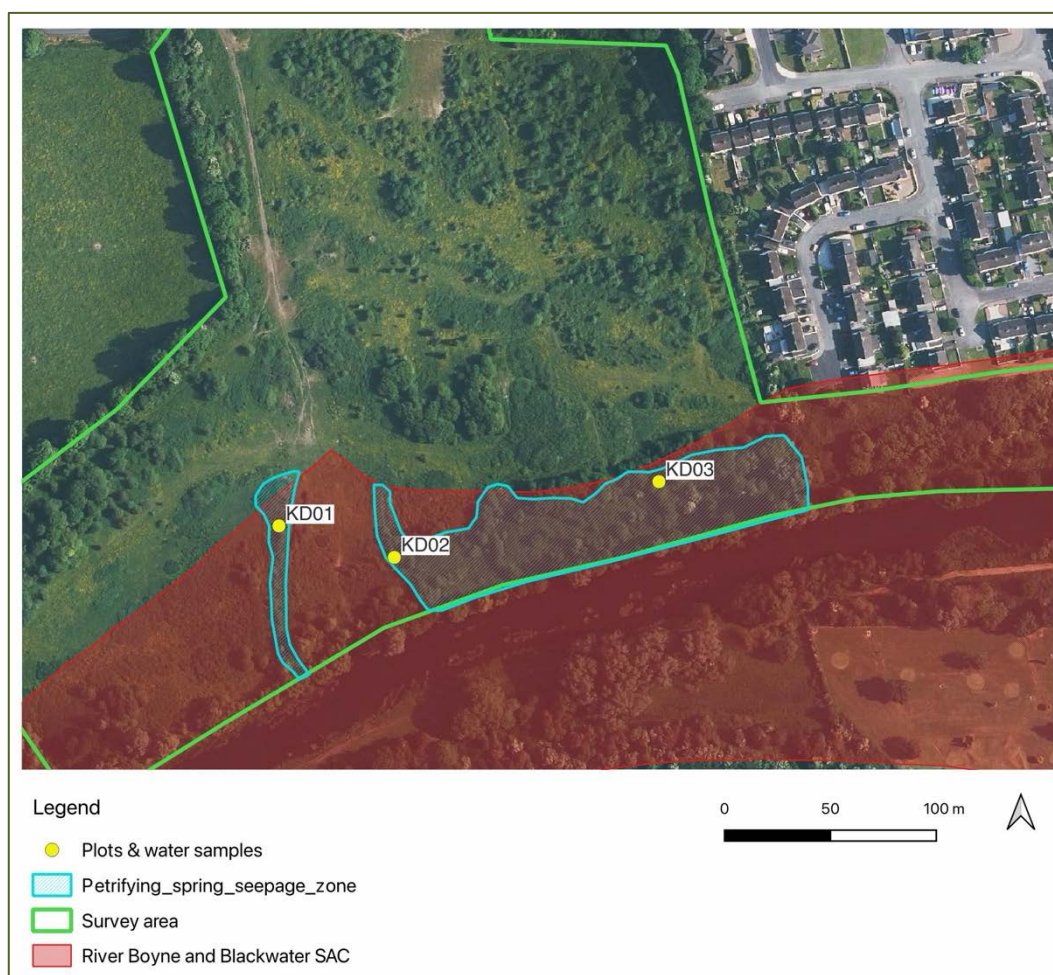


Figure 3.1. Location of botanical plots and water samples within petrifying spring seepage areas
 RGB Aerial Photography - © Bluesky Geospatial Limited

Table 3.1. Summary of petrifying springs and seepages within the survey area




Map reference	Description	Detailed plot & water sample	Photo
KD01	Spring in west of site, linked to site of 'St Patrick's Well' and marked as spring on old mapping. Appears to arise from broken concrete structure and flows south. Sparse paludal tufa present on bryophytes. Linked to wetland area with hydrophilous tall herb fen to west and some tall vegetation within spring. Signs of nutrient enrichment such and low number of positive indicator species.	Plot KD01 and Water sample KD01	
KD02	Western edge of large seepage zone where springs arise in multiple locations. This spring has an obvious channel and flow. Sparse but frequent paludal tufa present on bryophytes. Positive indicator species frequent in channel. This spring area was damaged with disturbance of soil, vegetation and tufa prior to the February 2025 walk-over survey.	Plot KD02 and Water sample KD02	
KD03	Eastern edge of large seepage zone where springs arise in multiple locations. This area is wooded with wet Willow <i>Salix cinerea</i> woodland. KD03 located where there is a clear spring flow. Frequent paludal tufa in channel and on banks and some cascade tufa in channel. Cover of negative indicator species suggests some nutrient enrichment.	Plot KD03 and Water sample KD03	

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

Plot ID	Vegetation community ¹	Main tufa type ²	Total tufa formation (%)	No. of positive indicator species
KD01	Group 3	Paludal	20	1
KD02	Group 6	Paludal	25	3
KD03	Group 3	Paludal and cascade	19	3

¹Lyons & Kelly (2017) & Denyer (2025); ²Lyons (2015) and Denyer (2025).

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

Plot no.	Conservation score	Conservation ranking	Condition assessment	Failed criteria
KD01	6	Moderate	Fail	Positive indicator species; nitrate level, negative indicator species, woody species and recent disturbance
KD02	5	Moderate	Fail	Nitrate level, negative indicator species, woody species and recent disturbance
KD03	4	Moderate	Fail	Nitrate level, phosphate level, negative indicator species.

3.2 Water chemistry

The 2025 water chemistry data is shown in Table 3.4 and is shown in full in Appendix C. The water chemistry data is largely consistent with that recorded in Irish springs by Lyons (2015) and more recent fieldwork (Denyer, unpublished data). However, the phosphate levels in the June water sample in KD03 (0.384 mg/l) were very high and outside of the recorded range by Lyon (2015) (0.002-0.14), although within sampling from additional springs by Denyer in Ireland (0-0.78 mg/l). Phosphate in this spring was non-detectable in the October sample but should be monitored in case this exceedance is repeated.

The threshold for nitrate in Annex I petrifying springs (Denyer, 2025) is 5 mg/l. Above this level there is likely to be anthropogenic influence. All of the water samples had nitrate levels of >5 mg/l in at least one sample. The levels in KD01 (17.8 and 19.8) were very high, although within the recorded range from Irish springs (<0.07-44.05 mg/l; Lyons, 2015) (<4.4-85.5 mg/l, Denyer, unpublished data).

There is currently no threshold for ammonia (NH₃) or ammonium (NH₄⁺) levels in petrifying springs in Ireland (Denyer, in press). An upper limit of 1.0 mg/l ammonia is recommended until further information is available (Denyer, 2025), but it is not currently included as a criterion in the Structure and Functions assessment. The total ammonia and ammonium concentrations recorded from the Kildalkey sampled springs (Table 3.4) are below 1.0 mg/l but are detectable and should be monitored.

Table 3.4. 2025 water chemistry data from the Kildalkey sampled springs

Water chemistry parameter	KD01 - Jun	KD01 - Oct	KD02 - Jun	KD02 - Oct	KD03 - Jun	KD03 - Oct
Alkalinity (mg CaCO ₃ /l)	353	353	347	345	351	343
Alkalinity (mg HCO ₃ /l)	431	431	423	421	428	418
Ammonia (mg /l)	0.0130	0.031	0.0500	<0.01	0.727	0.01
Ammonium (mg /l)	0.0140	0.033	0.0520	<0.01	0.770	0.011
Calcium (mg/l)	151	118	149.0	151.0	146.0	148
Chloride (mg/l)	25.2	24.7	27.4	25.9	29.6	28.4
Conductivity @25°C (µS/cm)	740	754	758	753	754	751
Magnesium (mg/l)	15.3	16.3	15.8	15.9	16.8	16.8
Nitrate (mg N/l)	19.8	17.8	6.42	<4.4	7.240	5.91
pH	7.2	7.1	7.4	7.6	7.2	7.2
Phosphate Ortho-P (mg P/l)	<0.03	<0.03	<0.03	<0.03	0.384	<0.03
Potassium (mg/l)	1.47	1.79	1.54	1.84	1.7	1.76
Sodium (mg/l)	9.76	9.72	10.3	10.1	12.1	11.9
Sulphate (mg/l)	47.8	55.0	66.8	71.6	60.0	65.3
Temperature	n/a	n/a	n/a	n/a	n/a	n/a

Lyons (2015) sampled the water from 91 separate Irish springs (115 water samples in total) from 2012-2013. The summary data from this work is shown in Table 3.5 to compare with the samples from the

Kildalkey sampled springs (Table 3.4). Note that Lyons (2015) did not analyse electrical conductivity or ammonia so there are no reference values for these parameters.

4 POTENTIAL IMPACTS FROM PROPOSED DEVELOPMENT

A Large Scale Residential Development is proposed on the lands to the north of the petrifying spring/seepage area, outside of the SAC area where the petrifying springs are located (Figure 4.1).

- The proposed development comprises a Large-Scale Residential Development (LRD) on lands at Crowpark (1st Division), Kildalkey Road, Trim, Co. Meath.
- The scheme provides a total of 183 residential units, comprising 127 houses and 56 apartments. The housing mix includes 19 no. detached 4-bedroom houses, 9 no. semi-detached/end-terrace 4-bedroom houses, 4 no. detached 3-bedroom houses, 43 no. semi-detached/end-terrace 3-bedroom houses, and 52 no. mid-terrace 3-bedroom houses, with building heights from 2 to 2 ½ storeys. The apartment element comprises 56 no. units in two blocks of up to four storeys, including 16 no. one-bedroom and 40 no. two-bedroom units.
- The development also includes a crèche facility, new vehicular and pedestrian accesses from Kildalkey Road.
- The proposal provides for associated infrastructure and site works, including landscaping, public and communal open space, internal streets and footpaths, car and bicycle parking, bin stores, private open space, boundary treatments, plant and waste management areas, utility infrastructure and a foul sewer connection to the existing network adjoining the OPW offices on Jonathan Swift Street, to be delivered beneath the River Boyne and Trim Pitch & Putt.

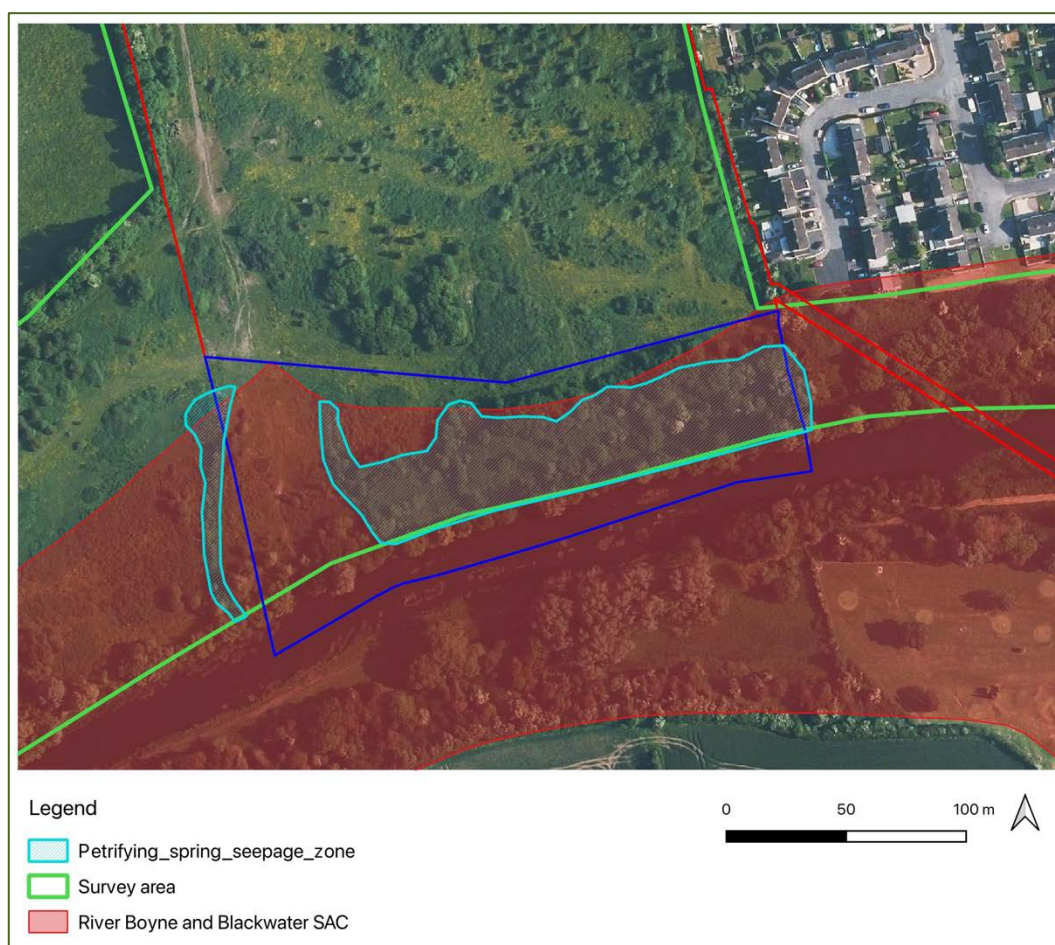


Figure 4.1. Location of proposed LRD (red line) (outside of the petrifying spring seepage zone), and adjacent site ownership (blue line)

RGB Aerial Photography - © Bluesky Geospatial Limited

Petrifying springs can be damaged by direct habitat loss (removal or disturbance of springs) and changes to water quality (e.g. pH, mineral composition and nutrient levels) and quantity (e.g. flow rate). Changes to land-use in the recharge area of the petrifying springs (for instance from creation of hardstanding areas and changes in groundwater flow and direction resulting from landscaping and excavation) can reduce water flow. In addition, surface water run-off into the recharge area can potentially negatively impact petrifying spring water quality. Potential impacts and recommended mitigation measures and monitoring are summarised below.

4.1 Direct disturbance

- The spring/ seepages should be **protected** from any **direct disturbance**. There should be no construction works in the petrifying spring/ seepage zones within the SAC as shown on Figure 3.1.
- The spring/ seepages should be **protected from recreational disturbance/** pressure resulting from the proposed development. Public access is required to the western spring ('St Patrick's Well'). This should be limited to the well only and access to the riverbank from this location prevented/ discouraged as this would cause damage to the petrifying spring and adjacent hydrophilous tall-herb vegetation.

4.2 Hydrogeological impacts

An assessment of potential hydrogeological impacts on petrifying springs within the site from the proposed LRD and required design and mitigation features to avoid impacts are detailed in Meehan (2026) '*Hydrogeological assessment for proposed Large Scale Residential Development (LRD), by Loughglynn Developments Limited, at a site on the Kildalkey road, Trim, County Meath –Land, soils, geology, hydrology and hydrogeology.*'

This states that no works will be undertaken in the vicinity of the springs, that the depths of the groundwater across the site are well below the level of any of the construction activities (e.g. foundations and other excavations into the subsurface on the site) and the proposed rising main borehole will not pump or dewater the area within and around it (Section 7.8.3, Hydrogeological assessment). Required mitigation and avoidance measures are detailed in Section 9.2 of the Hydrogeological assessment.

The hydrogeological assessment concludes:

'Due to the nature of proposed LRD developments being near-surface construction activities, impacts on groundwater are generally negligible and surface water is generally the main sensitive receptor assessed during impact assessments. The design of the proposed LRD Project has maintained the existing hydrological and hydrogeological regime on the site in as much as possible.

This means that all SUDS measures will discharge as diffusely as possible and at as shallow a depth as possible, using individual shallow soakaways for each house individually and wide, expansive, shallow soakaways for the road network.

This will mean no significant effects on groundwater levels and / or flows, and / or surface water, will occur as a result of the proposed LRD Project.'

4.3 Monitoring

- All survey and monitoring of the petrifying springs (pre- during and post-construction) must be undertaken by an **experienced petrifying spring ecologist**.
- The petrifying springs must be surveyed **pre-construction** to provide an updated baseline from the 2025 surveys. As the vegetation was disturbed in 2024/ 2025 the petrifying spring vegetation is recovering and is likely to change in the next 1-2 years. The pre-construction surveys must be undertaken within 12 months of construction works starting.
- The petrifying springs must be monitored annually **during construction**. This will include a repeat of the detailed baseline plots at least once and annual walk-over surveys.
- The petrifying springs must be monitored **post construction**, once the site is operational) to assess any impact from recreational access. This should be undertaken one year after operation commences and then every two years for a minimum of five years in total. If there

is any disturbance to the petrifying springs, then access to the petrifying springs must be reviewed.

5 SUMMARY

- Dr Joanne Denyer was commissioned by Loughglynn Developments Limited to undertake survey and assessment of petrifying spring habitat Kildalkey Road, Trim, Co. Meath.
- Petrifying springs with tufa formation (*Cratoneurion*) [7220] are an EC Habitats Directive Annex I priority habitat. Part of the survey site is located within the River Boyne and River Blackwater SAC [site code 002299].
- A walk-over survey of the site was undertaken in February 2025 to map examples of Annex I petrifying springs/ seepages within the site. Detailed plot survey and condition assessment of the Annex I petrifying springs/ seepages was undertaken in June 2025 and water chemistry sampled in June and October 2025.
- Annex I priority petrifying spring/ seepages occur in the south of the site (Figure 1.2). The three sampling points (detailed botanical survey and assessment and water chemistry sampling) were located to sample three different areas within this zone (Figure 3.1) and to include both open and wooded springs.
- The Annex I priority petrifying spring/ seepages have moderate tufa formation (19-25% within a 2 x 2m plot) and low species diversity (1-3 positive indicator species for this Annex habitat). They are assessed as being over moderate national conservation ranking.
- The Annex I priority petrifying spring/ seepages all failed the condition assessment. Reasons for poor condition of the springs are low positive indicator species, elevated nitrate levels, elevated ammonia and phosphate levels (June sampling only) high cover of negative indicator species, invasion of woody species in open springs, recent disturbance by heavy machinery.
- A Large Scale Residential Development (LRD) is proposed on the lands to the north of the petrifying spring/ seepage area.
- Annex I priority petrifying springs are sensitive to direct habitat loss and disturbance and changes to water quantity (flow) and quality (water chemistry including nutrient levels).
- Measures to reduce direct disturbance are listed in Section 4.1 (protection during construction work and protection from recreational disturbance/ access during operation).
- There are no predicted significant hydrogeological impacts to the Annex I priority petrifying springs from the proposed development (Section 4.2). This is because no works will be undertaken in the vicinity of the springs, the depths of the groundwater across the site are well below the level of any of the construction activities and the proposed rising main borehole will not pump or dewater the area within and around it (Meehan, 2025). Required hydrogeological mitigation and avoidance measures are detailed in the Hydrogeological assessment (Meehan, 2025).
- Monitoring and survey of the Annex I priority petrifying springs pre, during and post construction is outlined (Section 4.3).

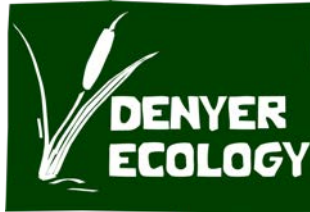
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APPENDIX A: WALK-OVER SURVEY SUMMARY



To: Aidan Hora (Loughglynn Developments Limited)
From: Dr Joanne Denyer (Denyer Ecology)
Date: 27 February 2025
Subject: Kildalkey Road, Trim, Petrifying spring walk-over survey 2025

Survey summary

This site was visited on 25 February 2025 to assess whether there were any examples of the Annex I priority habitat 'Petrifying springs with tufa formation' [*7220] present. The project site and an adjacent area of riverbank to the east were walked over and the presence of *7220 recorded where encountered. Detailed plots were not undertaken at this stage, as it is outside of the main survey season for petrifying springs. Part of the site is located within the River Boyne and River Blackwater SAC [002299].

Tufa formation was found in a number of locations in streams/ springs in the lower part of the site, within the SAC (Figure 1). There is a spring in the west of the site (Photograph 1), which is marked on historic mapping. This has a springhead area with tufa present in an adjacent area of wet grassland/ spring vegetation (Photograph 2). This vegetation has affinity to alkaline fen, which is a Qualifying Interest of the River Boyne and River Blackwater, but it was not the correct time of year for assessment of this habitat. A channel flows south to the river with tufa frequent throughout the length (Photograph 3). The tufa is present as lumps of cascade tufa, oncoids and ooids (coated particles) and some paludal tufa on growing plants. There were no positive indicator species for the Annex I priority habitat 'Petrifying springs with tufa formation' [*7220] recorded. **The spring is considered an example of Annex I priority habitat 'Petrifying springs with tufa formation',** in unfavourable condition. The lack of positive indicator species is likely to be due to nutrient enrichment in the catchment area (e.g. probable past use of nitrates/ phosphates on the agricultural land to the north, past shading by tall vegetation and scrub and recent damage by scrub clearance and machinery use in the area (Photograph 4). The pH of the water at the presumed springhead was 7.02, but this increased to 7.48 in the southern part of the spring. Electrical conductivity was 804 $\mu\text{S cm}^{-1}$.

To the east there is an area where there are several springs and stream channels which join each other, with tufa formation present intermittently throughout the area. The central area has been recently disturbed by machinery and scrub clearance (Photograph 5), but the eastern area has some springs still within scrub and immature wet woodland on the riverbank (Photograph 6). The tufa is present as oncoids and ooid particles in the streams (Photograph 7) and occasional areas with cascade tufa (Photographs 8-10). The disturbance of the springs and adjacent vegetation (Photographs 11-13) means that it is not possible to be clear where the original springhead and springlines would have been. Only one positive indicator species for *7220 was recorded (*Didymodon tophaceus*) (Photograph 10). This was in the eastern part of the site that had not been recently disturbed and still had wet willow scrub present. The low cover of positive indicators is likely due to past and recent impacts at the site, and so the **springs in this area** are examples of the **Annex I priority habitat 'Petrifying springs with tufa formation',** in unfavourable condition. The pH of the water at one location in the eastern disturbed area was 7.29 and electrical conductivity was 802 $\mu\text{S cm}^{-1}$.

Ecological sensitivities

Petrifying springs can be damaged by direct habitat loss and changes to water quality (e.g. pH, mineral composition and nutrient levels) and quantity (e.g. flow rate). Changes to water quantity can result from loss of recharge area above the petrifying spring/ seepage areas (e.g. from hardstanding and changes in groundwater flow and direction resulting from landscaping and excavation) and water quality from surface water flows into the springs and/ or other nutrient rich water. Input from an experienced petrifying spring hydrogeologist, in consultation with a petrifying spring ecologist, is required to avoid impacts from any proposed development on the petrifying springs/ seepage areas.

Actions:

- The spring/ seepages should be **protected** from any **direct disturbance**. There should be no further machinery works in the petrifying spring/ seepage zones within the SAC as shown on Figure 1.
- There should be **no development works in the spring/ seepage areas**. This includes landscaping works and planting.
- The area of spring/ seepages should be **protected from recreational disturbance/** pressure resulting from any proposed development.
- **Detailed botanical survey and condition assessment** of petrifying springs/ seepages and any potential alkaline fen, in the survey season (May to September). This will allow an assessment of their condition and conservation ranking, and act as a baseline for any future monitoring works. This should be accompanied by water chemistry sampling.
- An **experienced petrifying spring hydrogeologist** is required to investigate whether the proposed development to the north of the spring/ seepages could **impact the recharge zone** of the spring/ seepages. Any interception could reduce the water flow to the spring/ seepage area.
- The **drainage scheme** for the proposed development to the north of the north of the spring/ seepages will need to be **reviewed by an experienced petrifying spring hydrogeologist** to ensure there are no potential negative impacts on the spring/ seepage water quality and quantity. Surface water should not be discharged directly into this area as it would dilute the groundwater and may reduce tufa formation. Any SuDS on site must ensure that water goes through an appropriate soil zone before discharging to the spring/ seepage area, to ensure it has the correct water chemistry.
- As part of any proposed development, a **restoration plan** should be prepared by an experienced petrifying spring hydrogeologist and petrifying spring ecologist for the petrifying spring/ seepage area. With appropriate management the petrifying spring vegetation will recover from the disturbance and could be managed to improve the habitat condition.

Relevant expertise

Dr Joanne Denyer is a highly experienced botanist and bryologist with over 25 years' experience of ecological survey and research. She specialises in botanical, wetland and bryological survey in the Republic of Ireland. She is a national expert on Annex I priority habitat petrifying springs and has worked on a wide range of projects and sites in relation to this habitat. This includes detailed site survey, assessment and monitoring, habitat management, Ecological Impact Assessment, pre and post construction monitoring, acting as an expert witness on calcareous springs at Oral Hearing and providing advice to county councils and NPWS. In 2018 (Denyer et al, 2018) and 2024 she assisted National Parks and Wildlife Service (NPWS) in Article 17 reporting on Petrifying springs to the European Commission. The 2024 assessment included a national survey of petrifying spring sites

across Ireland. She is the lead author of new guidance on petrifying spring assessment and monitoring¹.

Figure 1. Location of petrifying spring/ seepage areas within the survey area



RGB Aerial Photography - © Bluesky Geospatial Limited

Photograph 1. Spring in west of site (view to north)

¹Denyer, J., Eakin, M., & Gill, M. (2023). Guidelines for the Assessment of Annex I Priority Petrifying Springs in Ireland. *Irish Wildlife Manuals*, No. 142. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.



Photograph 2. Tufa formation in fen/ spring area adjacent to springhead (view to north)



Photograph 3. Tufa formation in western spring (oncoids and ooids in channel and cascade tufa on bank).



Photograph 4. Soil and tufa disturbance on bank and in channel in western spring



Photograph 5. Springs and seepage areas in recently disturbed area (view to east)



Photograph 6. Petrifying spring/ stream in scrub in eastern part of site



Photograph 7. Tufa formation in disturbed eastern spring area (oncoids and ooids in channel)



Photograph 8. Tufa formation in disturbed eastern spring area (spring water flowing over cascade)



Photograph 9. Tufa formation in disturbed eastern spring area (dislodged cascade tufa)



Photograph 10. Tufa formation in eastern spring area within scrub (cascade tufa on bank)



Photograph 11. Disturbed spring in central part of site (view to north)



Photograph 12. Disturbed spring in eastern part of site (view to west)



Photograph 13. Disturbed spring in central-eastern part of site (iron staining by bacteria indicating groundwater source to spring but little tufa formation as heavily disturbed)



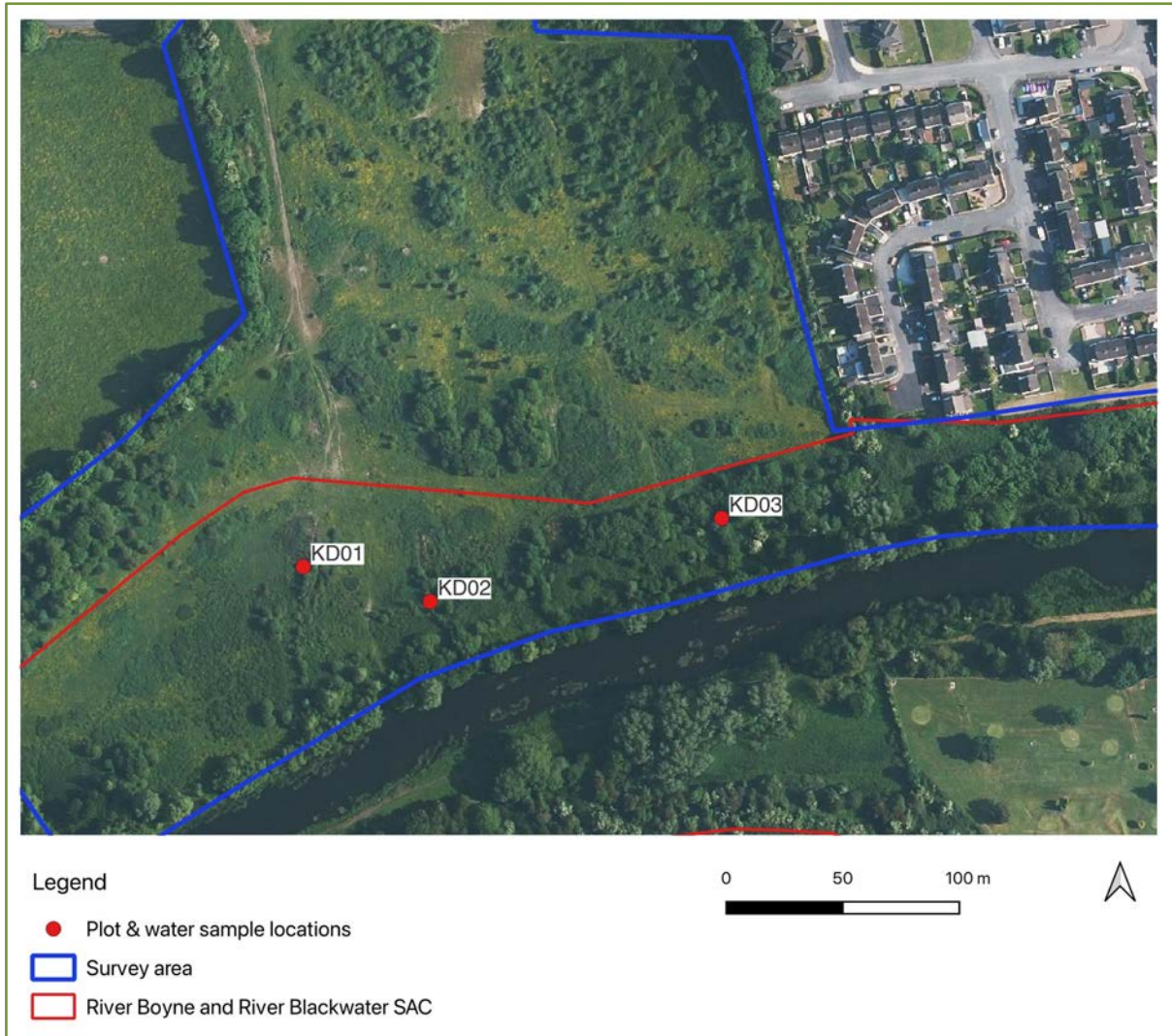


APPENDIX B: DETAILED PLOT RESULTS

APPENDIX B – PETRIIFYING SPRING DETAILED PLOT RESULTS

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PLOT LOCATION MAP



RGB Aerial Photography - © Bluesky Geospatial Limited

APPENDIX B – PETRIFYING SPRING DETAILED PLOT RESULTS

PLOT LOCATION PHOTOGRAPHS

Plot ID	Plot location
KD01	 A photograph of a field with tall grasses and yellow flowers. A red arrow points to a small stream or ditch in the foreground.
KD02	 A photograph of a narrow stream flowing through a field of tall grasses. A red arrow points to the water in the stream.
KD03	 A photograph of a stream flowing through a wooded area with many trees and green foliage. A red arrow points to the water in the stream.

APPENDIX B – PETRIFYING SPRING DETAILED PLOT RESULTS

PLOT DETAILS AND ASSESSMENT

Plot ID	KD01	KD02	KD03
Subsite	n/a	n/a	n/a
Surveyor	Joanne Denyer	Joanne Denyer	Joanne Denyer
Date survey	11/06/25 & 20/10/25	11/06/25 & 20/10/25	11/06/25 & 20/10/25
Grid code (IG)	N7933357012	N7938656997	N7951357028
Survey type	Baseline	Baseline	Baseline
Spring type	Springhead	Springhead	Springhead
Plot size	2m x 2m	1m x 4m	2m x 2m
Aspect	N	N	N
Water sample ref.	KD01	KD02	KD03
Water temp Jun	11.9	14.1	13.2
Water temp Oct	12.7	12.3	12.2
pH (field) Jun	6.84	7.11	7.07
pH (field) Oct	6.82	7.05	7.05
pH (lab) Jun	7.2	7.4	7.20
pH (lab) Oct	7.1	7.6	7.2
EC (field) Jun	792	810	914
EC (field) Oct	988	870	978
EC (lab) Jun	740	758	754
EC (lab) Oct	754	753	751
Altitude	56	55	55
Slope	3	2	5
¹ N03 Jun	19.8	6.42	7.24
¹ N03 Oct	17.8	<4.4	5.91
¹ PO43-P Jun	<0.03	<0.03	0.384
¹ PO43-P Oct	<0.03	<0.03	<0.03
Species richness	18	20	17
Vegetation ht (cm)	35	25	10
Fossitt adjacent	FS2/ ED3	GS4/ ED3	WN6
Vegetation code	Group 3	Group 6	Group 3
Vegetation cover			
Bryophyte cover	10 %	15 %	28 %
Vascular cover	55 %	31 %	39 %
Canopy cover	0 %	0 %	85 %
Tufa cover			
Cascade	0	0	8
Paludal 1	5	5	3
Paludal 2	0	0	0
Paludal 3	15	20	8
Stream crust	0	0	0
Oncoids and ooids	0	0	0
Dam	0	0	0
Rudities	0	0	0
Non tufa	80	75	81
Surface cover			
Field layer	65	45	70
Bare tufa	10	20	7
Inactive tufa	0	0	0
Leaf litter	3	5	0
Bare soil	22	30	23
Bare stone	0	0	0
Other	0	0	0
Water cover			
Flowing	50	60	50
Standing water	45	5	15
Dripping	0	0	0
Damp	5	35	35
Dry	0	0	0
Other	0	0	0

APPENDIX B – PETRIFYING SPRING DETAILED PLOT RESULTS

Plot ID	KD01	KD02	KD03
Conservation score			
Positive indicator species	1	3	3
Species diversity score	1	1	1
HQ Indicator Species	0	0	0
HQ Indicator score	0	0	0
Tufa-forming capacity	Patchy paludal tufa	Patchy paludal tufa	Patchy paludal tufa and small cascade tufa
Tufa score	2	2	2
Other positive characteristics	In complex with Annex I hydrophilous tall-herb fen vegetation and located within SAC with additional *7220 sites discharging to River Boyne.	In complex with Annex I hydrophilous tall-herb fen vegetation and located within SAC with additional *7220 sites discharging to River Boyne.	In complex with Annex I priority alluvial woodland vegetation and located within SAC with additional *7220 sites discharging to River Boyne.
Other score	1	1	1
Total score	4	4	4
National rank	Moderate	Moderate	Moderate
Condition assessment			
Positive indicator	Fail	Pass	Pass
Invasive spp.	Pass	Pass	Pass
Negative herbaceous spp.	Pass	Pass	Pass
Negative bryophytes & algae	Fail	Pass	Fail
Negative woody spp.	Fail	Fail	n/a (wooded spring)
² Nitrate	Fail	Fail (June sampling only)	Fail
Phosphate	Pass	Pass	Fail (June sampling only)
Water flow	Pass	Pass	Pass
Veg height	Pass	Pass	Pass
Trampling & dung	Fail Recent landscaping disturbance to area	Fail Recent landscaping disturbance to area	Pass
Overall plot assessment	Fail	Fail	Fail
² Overall site assessment	Unfavourable Bad		

¹Detailed water chemistry from laboratory testing

²F = Favourable; UI = Unfavourable Inadequate; UB = Unfavourable Bad

PLOT SPECIES



Plot ID	Species type	Species name	Species group	Cover %
KD01		Agrostis stolonifera	Vascular	1
KD01		Angelica sylvestris	Vascular	0.5
KD01		Calliergonella cuspidata	Bryophyte	1
KD01		Cardamine flexuosa	Vascular	0.5
KD01		Cardamine pratensis	Vascular	0.5
KD01		Cirsium palustre	Vascular	0.1
KD01		Equisetum palustre	Vascular	1
KD01		Glyceria sp.	Vascular	5
KD01		Iris pseudacorus	Vascular	20
KD01		Juncus inflexus	Vascular	3
KD01		Nasturtium officinale agg.	Vascular	15
KD01		Ranunculus repens	Vascular	1
KD01		Valeriana officinalis	Vascular	1
KD01	Negative	Brachythecium rivulare	Bryophyte	0.5
KD01	Negative	Cratoneuron filicinum	Bryophyte	8
KD01	Negative	Epilobium hirsutum	Vascular	3
KD01	Negative woody	Rubus fruticosus agg. (*unwooded springs only)	Vascular	0.5

APPENDIX B – PETRIFYING SPRING DETAILED PLOT RESULTS

Plot ID	Species type	Species name	Species group	Cover %
KD01	Positive	Carex lepidocarpa	Vascular	3
KD02		Agrostis stolonifera	Vascular	3
KD02		Calliergonella cuspidata	Bryophyte	10
KD02		Cirsium palustre	Vascular	0.3
KD02		Didymodon insulanus	Bryophyte	0.3
KD02		Equisetum palustre	Vascular	12
KD02		Filipendula ulmaria	Vascular	0.5
KD02		Potentilla erecta	Vascular	0.5
KD02		Valeriana officinalis	Vascular	3
KD02	Negative	Brachythecium rivulare	Bryophyte	1
KD02	Negative	Cratoneuron filicinum	Bryophyte	1
KD02	Negative	Epilobium hirsutum	Vascular	0.5
KD02	Negative	Juncus effusus	Vascular	3
KD02	Negative woody	Salix cinerea (*unwooded springs only)	Vascular	5
KD02	Positive	Carex lepidocarpa	Vascular	3
KD02	Positive	Chara vulgaris	Charophyte	1
KD02	Positive	Pellia endiviifolia	Bryophyte	3
KD02		Arrhenatherum elatius	Vascular	1
KD02		Bryum dichotomum	Vascular	0.1
KD02		Pohlia sp.	Bryophyte	0.1
KD02		Potentilla sterilis	Vascular	0.3
KD03		Agrostis stolonifera	Vascular	7
KD03		Cardamine flexuosa	Vascular	0.3
KD03		Cirsium palustre	Vascular	5
KD03		Equisetum palustre	Vascular	5
KD03		Mentha aquatica	Vascular	5
KD03		Oxyrrhynchium hians	Bryophyte	1
KD03		Scrophularia auriculata	Vascular	3
KD03	Negative	Brachythecium rivulare	Bryophyte	20
KD03	Negative	Cratoneuron filicinum	Bryophyte	3
KD03	Negative	Epilobium hirsutum	Vascular	1
KD03	Negative woody	Hedera hibernica (*unwooded springs only)	Vascular	1
KD03	Negative woody	Rubus fruticosus agg. (*unwooded springs only)	Vascular	7
KD03	Positive	Didymodon tophaceus	Bryophyte	3
KD03	Positive	Festuca rubra	Vascular	5
KD03	Positive	Pellia endiviifolia	Bryophyte	1
KD03		Calystegia sepium	Vascular	0.5
KD03		Eurhynchium striatum	Bryophyte	3

*Negative indicator species in unwooded springs only

PLOT PHOTOS

Plot	Plot photo	Tufa formation/ vegetation close
KD01		

APPENDIX B – PETRYIFYING SPRING DETAILED PLOT RESULTS

Plot	Plot photo	Tufa formation/ vegetation close
KD02		
KD03		

NEGATIVE ACTIVITIES

Pressure
PK01 Mixed source pollution to surface and ground waters (limnic and terrestrial)
PA05 PA25 Agriculture activities not referred to above (soil landscaping and disturbance)

TARGET VALUES FOR CONDITION ASSESSMENT

Criteria	Target value
Species assessment criteria	
High quality indicator species	n/a (included with positive indicator species)
Positive indicator species	3 species AND no loss from baseline number of species
Invasive species	Absent
Negative herbaceous indicator species	Total cover should not be dominant or abundant
Negative bryophyte indicator species	No one species dominant or abundant; if ≥ 2 species present, then fails if ≥ 2 are frequent or 1 is abundant
Negative woody indicator species	Absent (except in wooded springs)
Spring water composition and flow	
Nitrate level	No increase from baseline and not above 5 mg/l ($\geq 2-5$ mg/l = borderline fail)
Phosphate level	No increase from baseline and not above 0.015 mg/l

APPENDIX B – PETRIFYING SPRING DETAILED PLOT RESULTS

Criteria	Target value
Water flow	No alteration of natural flow
Impacts of grazing	
Field layer height	Height between 10 and 50cm*
Trampling/dung	Impact should not be abundant/dominant
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
>2 Fail	Red – Unfavourable Bad

*Where vegetation is naturally bryophyte dominated, expert judgement may be used to pass a plot with lower vegetation height



APPENDIX C: WATER CHEMISTRY RESULTS

Client: Denyer Ecology
11 Dargle View
Rathfarnham
Rathfarnham
D16 XY51
IRELAND

Certificate Code: AR-25-M3-020597-01

Page Number: Page 1 of 2

PO reference:

Certificate of Analysis

Sample number	966-2025-00021926	Received on	11/06/2025
Your sample reference	KD01	Analysis started on	11/06/2025
Sample Matrix	Ground water		
Sample Condition on Arrival	Satisfactory	Sample Date	11/06/2025
Time Sampled	10:15		

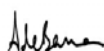
Test Code Analyte	SUB ⁵ Analysis Started	Method	LOQ ³	SPEC ²	Result	Units	ACCRED ⁴
Alkalinity as CaCO₃ [M30D3]							
Alkalinity as CaCO ₃	12/06/25 10:17	EW175	30		353	mg/l	
Alkalinity Bicarbonate as HCO₃ [M30F7]							
Alkalinity Bicarbonate as HCO ₃	26/06/25 10:08	EW175	30		431	m/l	
Ammonia as NH₃ (Calc) - Gallery [M3000]							
Ammonia as NH ₃ (Calc) - Gallery	12/06/25 10:17	EW175	0.01		0.0130	mg/l	C6
Ammonium as NH₄ (calc) - Gallery [M300T]							
Ammonium as NH ₄ (calc) - Gallery	12/06/25 10:17	EW175	0.01		0.0140	mg/l	C6
Calcium - Dissolved [M3165]							
Calcium (Ca)	13/06/25 15:33	EW188	1.08		151	mg/l	
Chloride mg/L - Gallery [M300S]							
Chloride mg/L - Gallery	12/06/25 10:17	EW175	5		25.2	mg/l	C6
Conductivity at 20°C (Robotic Method) [M3052]							
Conductivity at 20°C	11/06/25 19:59	EW152R	5		740	µS/cm	C6
Magnesium - Dissolved [M3174]							
Magnesium (Mg)	13/06/25 15:33	EW188	1.11		15.3	mg/l	C6
Nitrate as NO₃ (Calc) - Gallery [M300L]							
Nitrate as NO ₃ (Calc) - Gallery	12/06/25 10:17	EW175	4.4		19.8	mg/l	C6
pH (Robotic Method) [M3051]							
pH	11/06/25 19:59	EW152R	4		7.2		C6
Phosphate (Ortho/MRP) as PO₄ (Calc) - Gallery [M300M]							
Phosphate (Ortho/MRP) as PO ₄ (Calc) - Gallery	12/06/25 10:17	EW175	0.03		<0.03	mg/l	C6
Potassium - Dissolved [M3180]							
Potassium (K)	13/06/25 15:33	EW188	0.15		1.47	mg/l	C6
Sodium - Dissolved [M3184]							
Sodium (Na)	13/06/25 15:33	EW188	1.5		9.76	mg/l	C6
Sulphate mg/L - Gallery [M300N]							
Sulphate mg/L - Gallery	12/06/25 10:17	EW175	1		47.8	mg/l	C6

⁴ Accreditation Information

C6: ISO/IEC 17025:2017 INAB 138-T

NOTES

Signed: _____



26/06/2025

Aoife De Barra - Organics & Instrumentation Team Lead CIE016

Client: Denyer Ecology
11 Dargle View
Rathfarnham
Rathfarnham
D16 XY51
IRELAND

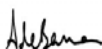
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3. LOQ = Limit of Quantification or lowest value that can be reported.
4. ACCRED = Indicates accreditation for the test, a blank field indicates not accredited.
5. * indicates the test was sub-contracted, "D" indicates the analysis was performed in Dublin and "C" indicates the analysis performed in Cork.
6. The sampling date was not communicated; this may impact the validity of the results unless provided.
- 7A. This test was conducted outside of recommended best practice holding time; this may impact the validity of the result while the accreditation status of the test result will stay unaffected.
- 7B. No time of sampling was supplied, a default time of 00:00:00 will be assumed for holding time calculations unless provided. This may impact the validity of the results.
- 7C. Your sample arrived at the laboratory already outside of the recommended best practice holding time; this may impact the validity of the result while the accreditation status of the test result will stay unaffected.
- 7D. The sample was received close to the recommended best practice holding time; this may impact the validity of the result while the accreditation status of the test result will stay unaffected.
8. This notification is based on the numerical result for the test without consideration of the uncertainty of measurement of the result, unless otherwise agreed in writing. Uncertainty of measurement has been calculated for all INAB accredited tests and is available upon request.
9. Report is issued as per our standard T&C of sale.

Signed: _____



Aoife De Barra - Organics & Instrumentation Team Lead CIE016

26/06/2025

Client: Denyer Ecology
11 Dargle View
Rathfarnham
Rathfarnham
D16 XY51
IRELAND

Certificate Code: AR-25-M3-020598-01

Page Number: Page 1 of 2

PO reference:

Certificate of Analysis

Sample number	966-2025-00021927	Received on	11/06/2025
Your sample reference	KD02	Analysis started on	11/06/2025
Sample Matrix	Ground water		
Sample Condition on Arrival	Satisfactory	Sample Date	11/06/2025
Time Sampled	11:00		

Test Code Analyte	SUB ⁵ Analysis Started	Method	LOQ ³	SPEC ²	Result	Units	ACCRED ⁴
Alkalinity as CaCO₃ [M30D3]							
Alkalinity as CaCO ₃	12/06/25 10:17	EW175	30		347	mg/l	
Alkalinity Bicarbonate as HCO₃ [M30F7]							
Alkalinity Bicarbonate as HCO ₃	26/06/25 10:09	EW175	30		423	m/l	
Ammonia as NH₃ (Calc) - Gallery [M3000]							
Ammonia as NH ₃ (Calc) - Gallery	12/06/25 10:17	EW175	0.01		0.0500	mg/l	C6
Ammonium as NH₄ (calc) - Gallery [M300T]							
Ammonium as NH ₄ (calc) - Gallery	12/06/25 10:17	EW175	0.01		0.0520	mg/l	C6
Calcium - Dissolved [M3165]							
Calcium (Ca)	13/06/25 15:33	EW188	1.08		149	mg/l	
Chloride mg/L - Gallery [M300S]							
Chloride mg/L - Gallery	12/06/25 10:17	EW175	5		27.4	mg/l	C6
Conductivity at 20°C (Robotic Method) [M3052]							
Conductivity at 20°C	11/06/25 19:59	EW152R	5		758	µS/cm	C6
Magnesium - Dissolved [M3174]							
Magnesium (Mg)	13/06/25 15:33	EW188	1.11		15.8	mg/l	C6
Nitrate as NO₃ (Calc) - Gallery [M300L]							
Nitrate as NO ₃ (Calc) - Gallery	12/06/25 10:17	EW175	4.4		6.42	mg/l	C6
pH (Robotic Method) [M3051]							
pH	11/06/25 19:59	EW152R	4		7.4		C6
Phosphate (Ortho/MRP) as PO₄ (Calc) - Gallery [M300M]							
Phosphate (Ortho/MRP) as PO ₄ (Calc) - Gallery	12/06/25 10:17	EW175	0.03		<0.03	mg/l	C6
Potassium - Dissolved [M3180]							
Potassium (K)	13/06/25 15:33	EW188	0.15		1.54	mg/l	C6
Sodium - Dissolved [M3184]							
Sodium (Na)	13/06/25 15:33	EW188	1.5		10.3	mg/l	C6
Sulphate mg/L - Gallery [M300N]							
Sulphate mg/L - Gallery	12/06/25 10:17	EW175	1		66.8	mg/l	C6

⁴ Accreditation Information

C6: ISO/IEC 17025:2017 INAB 138-T

NOTES

Signed: _____



26/06/2025

Aoife De Barra - Organics & Instrumentation Team Lead CIE016

Client: Denyer Ecology
11 Dargle View
Rathfarnham
Rathfarnham
D16 XY51
IRELAND

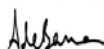
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Aoife De Barra - Organics & Instrumentation Team Lead CIE016

26/06/2025

Client: Denyer Ecology
11 Dargle View
Rathfarnham
Rathfarnham
D16 XY51
IRELAND

Certificate Code: AR-25-M3-020599-01

Page Number: Page 1 of 2

PO reference:

Certificate of Analysis

Sample number	966-2025-00021928	Received on	11/06/2025
Your sample reference	KD03	Analysis started on	11/06/2025
Sample Matrix	Ground water		
Sample Condition on Arrival	Satisfactory	Sample Date	11/06/2025
Time Sampled	11:45		

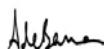
Test Code Analyte	SUB ⁵ Analysis Started	Method	LOQ ³	SPEC ²	Result	Units	ACCRED ⁴
Alkalinity as CaCO₃ [M30D3]							
Alkalinity as CaCO ₃	12/06/25 10:17	EW175	30		351	mg/l	
Alkalinity Bicarbonate as HCO₃ [M30F7]							
Alkalinity Bicarbonate as HCO ₃	26/06/25 10:10	EW175	30		428	m/l	
Ammonia as NH₃ (Calc) - Gallery [M3000]							
Ammonia as NH ₃ (Calc) - Gallery	12/06/25 10:17	EW175	0.01		0.727	mg/l	C6
Ammonium as NH₄ (calc) - Gallery [M300T]							
Ammonium as NH ₄ (calc) - Gallery	12/06/25 10:17	EW175	0.01		0.770	mg/l	C6
Calcium - Dissolved [M3165]							
Calcium (Ca)	13/06/25 15:33	EW188	1.08		146	mg/l	
Chloride mg/L - Gallery [M300S]							
Chloride mg/L - Gallery	12/06/25 10:17	EW175	5		29.6	mg/l	C6
Conductivity at 20°C (Robotic Method) [M3052]							
Conductivity at 20°C	11/06/25 19:59	EW152R	5		754	µS/cm	C6
Magnesium - Dissolved [M3174]							
Magnesium (Mg)	13/06/25 15:33	EW188	1.11		16.8	mg/l	C6
Nitrate as NO₃ (Calc) - Gallery [M300L]							
Nitrate as NO ₃ (Calc) - Gallery	12/06/25 10:17	EW175	4.4		7.24	mg/l	C6
pH (Robotic Method) [M3051]							
pH	11/06/25 19:59	EW152R	4		7.2		C6
Phosphate (Ortho/MRP) as PO₄ (Calc) - Gallery [M300M]							
Phosphate (Ortho/MRP) as PO ₄ (Calc) - Gallery	12/06/25 10:17	EW175	0.03		0.384	mg/l	C6
Potassium - Dissolved [M3180]							
Potassium (K)	13/06/25 15:33	EW188	0.15		1.71	mg/l	C6
Sodium - Dissolved [M3184]							
Sodium (Na)	13/06/25 15:33	EW188	1.5		12.1	mg/l	C6
Sulphate mg/L - Gallery [M300N]							
Sulphate mg/L - Gallery	12/06/25 10:17	EW175	1		60.0	mg/l	C6

⁴ Accreditation Information

C6: ISO/IEC 17025:2017 INAB 138-T

NOTES

Signed: _____



26/06/2025

Aoife De Barra - Organics & Instrumentation Team Lead CIE016

Client: Denyer Ecology
11 Dargle View
Rathfarnham
Rathfarnham
D16 XY51
IRELAND

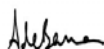
Certificate Code: AR-25-M3-020599-01

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26/06/2025

Client: Denyer Ecology
11 Dargle View
Rathfarnham
Rathfarnham
D16 XY51
IRELAND

Certificate Code: AR-25-M3-035681-01

Page Number: Page 1 of 2

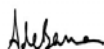
PO reference:

Certificate of Analysis

Sample number	966-2025-00041173	Received on	20/10/2025
Your sample reference	KD02	Analysis started on	20/10/2025
Sample Matrix	Ground water		
Sample Date	20/10/2025	Time Sampled	10:44

Test Code Analyte	SUB ⁵ Analysis Started	Method	LOQ ³	SPEC ²	Result	Units	ACCRED ⁴
Alkalinity as CaCO₃ [M30D3]							
Alkalinity as CaCO ₃	21/10/25 13:06	EW175	30		345	mg/l	
Alkalinity Bicarbonate as HCO₃ [M30F7]							
Alkalinity Bicarbonate as HCO ₃	03/11/25 16:31	EW175	30		421	mg/l	
Ammonia as NH₃ (Calc) - Gallery [M3000]							
Ammonia as NH ₃ (Calc) - Gallery	21/10/25 13:06	EW175	0.01		<0.01	mg/l	C6
Ammonium as NH₄ (calc) - Gallery [M300T]							
Ammonium as NH ₄ (calc) - Gallery	21/10/25 13:06	EW175	0.01		<0.01	mg/l	C6
Calcium - Dissolved [M3165]							
Calcium (Ca)	23/10/25 09:34	EW188	1.08		151	mg/l	C6
Chloride mg/L - Gallery [M300S]							
Chloride mg/L - Gallery	21/10/25 13:06	EW175	5		25.9	mg/l	C6
Conductivity at 20°C (Robotic Method) [M3052]							
Conductivity at 20°C	20/10/25 19:17	EW152R	5		753	µS/cm	C6
Magnesium - Dissolved [M3174]							
Magnesium (Mg)	23/10/25 09:34	EW188	1.11		15.9	mg/l	C6
Nitrate as NO₃ (Calc) - Gallery [M300L]							
Nitrate as NO ₃ (Calc) - Gallery	21/10/25 13:06	EW175	4.4		<4.4	mg/l	C6
pH (Robotic Method) [M3051]							
pH	20/10/25 19:17	EW152R	4		7.6		C6
Phosphate (Ortho/MRP) as PO₄ (Calc) - Gallery [M300M]							

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Certificate Code: AR-25-M3-035681-01

Page Number: Page 2 of 2

PO reference:

Certificate of Analysis

Sample number	966-2025-00041173	Received on	20/10/2025
Your sample reference	KD02	Analysis started on	20/10/2025
Sample Matrix	Ground water		
Sample Date	20/10/2025	Time Sampled	10:44

Test Code Analyte	SUB ⁵ Analysis Started	Method	LOQ ³	SPEC ²	Result	Units	ACCRED ⁴
Phosphate (Ortho/MRP) as PO4 (Calc) - Gallery Potassium - Dissolved [M3180]	21/10/25 13:06	EW175	0.03		<0.03	mg/l	C6
Potassium (K) Sodium - Dissolved [M3184]	23/10/25 09:34	EW188	0.15		1.84	mg/l	C6
Sodium (Na) Sulphate mg/L - Gallery [M300N]	23/10/25 09:34	EW188	1.5		10.1	mg/l	C6
Sulphate mg/L - Gallery	21/10/25 13:06	EW175	1		71.6	mg/l	C6

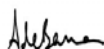
⁴ Accreditation Information

C6: ISO/IEC 17025:2017 INAB 138-T

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Signed: _____



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03/11/2025

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11 Dargle View
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Rathfarnham
D16 XY51
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Certificate Code: AR-25-M3-035682-01

Page Number: Page 1 of 2

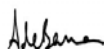
PO reference:

Certificate of Analysis

Sample number	966-2025-00041174	Received on	20/10/2025
Your sample reference	KD03	Analysis started on	20/10/2025
Sample Matrix	Ground water		
Sample Date	20/10/2025	Time Sampled	11:00

Test Code Analyte	SUB ⁵ Analysis Started	Method	LOQ ³	SPEC ²	Result	Units	ACCRED ⁴
Alkalinity as CaCO₃ [M30D3]							
Alkalinity as CaCO ₃	21/10/25 13:06	EW175	30		343	mg/l	
Alkalinity Bicarbonate as HCO₃ [M30F7]							
Alkalinity Bicarbonate as HCO ₃	03/11/25 16:31	EW175	30		418	mg/l	
Ammonia as NH₃ (Calc) - Gallery [M3000]							
Ammonia as NH ₃ (Calc) - Gallery	21/10/25 13:06	EW175	0.01		0.0100	mg/l	C6
Ammonium as NH₄ (calc) - Gallery [M300T]							
Ammonium as NH ₄ (calc) - Gallery	21/10/25 13:06	EW175	0.01		0.0110	mg/l	C6
Calcium - Dissolved [M3165]							
Calcium (Ca)	23/10/25 09:34	EW188	1.08		148	mg/l	C6
Chloride mg/L - Gallery [M300S]							
Chloride mg/L - Gallery	21/10/25 13:06	EW175	5		28.4	mg/l	C6
Conductivity at 20°C (Robotic Method) [M3052]							
Conductivity at 20°C	20/10/25 19:17	EW152R	5		751	µS/cm	C6
Magnesium - Dissolved [M3174]							
Magnesium (Mg)	23/10/25 09:34	EW188	1.11		16.8	mg/l	C6
Nitrate as NO₃ (Calc) - Gallery [M300L]							
Nitrate as NO ₃ (Calc) - Gallery	21/10/25 13:06	EW175	4.4		5.91	mg/l	C6
pH (Robotic Method) [M3051]							
pH	20/10/25 19:17	EW152R	4		7.2		C6
Phosphate (Ortho/MRP) as PO₄ (Calc) - Gallery [M300M]							

Signed: _____



03/11/2025

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Page Number: Page 2 of 2

PO reference:

Certificate of Analysis

Sample number	966-2025-00041174	Received on	20/10/2025
Your sample reference	KD03	Analysis started on	20/10/2025
Sample Matrix	Ground water		
Sample Date	20/10/2025	Time Sampled	11:00

Test Code Analyte	SUB ⁵ Analysis Started	Method	LOQ ³	SPEC ²	Result	Units	ACCRED ⁴
Phosphate (Ortho/MRP) as PO4 (Calc) - Gallery Potassium - Dissolved [M3180]	21/10/25 13:06	EW175	0.03		<0.03	mg/l	C6
Potassium (K) Sodium - Dissolved [M3184]	23/10/25 09:34	EW188	0.15		1.76	mg/l	C6
Sodium (Na) Sulphate mg/L - Gallery [M300N]	23/10/25 09:34	EW188	1.5		11.9	mg/l	C6
Sulphate mg/L - Gallery	21/10/25 13:06	EW175	1		65.3	mg/l	C6

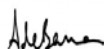
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03/11/2025

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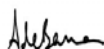
PO reference:

Certificate of Analysis

Sample number	966-2025-00041172	Received on	20/10/2025
Your sample reference	KD01	Analysis started on	20/10/2025
Sample Matrix	Ground water		
Sample Date	20/10/2025	Time Sampled	10:15

Test Code Analyte	SUB ⁵ Analysis Started	Method	LOQ ³	SPEC ²	Result	Units	ACCRED ⁴
Alkalinity as CaCO₃ [M30D3]							
Alkalinity as CaCO ₃	21/10/25 13:06	EW175	30		353	mg/l	
Alkalinity Bicarbonate as HCO₃ [M30F7]							
Alkalinity Bicarbonate as HCO ₃	03/11/25 16:31	EW175	30		431	mg/l	
Ammonia as NH₃ (Calc) - Gallery [M3000]							
Ammonia as NH ₃ (Calc) - Gallery	21/10/25 13:06	EW175	0.01		0.0310	mg/l	C6
Ammonium as NH₄ (calc) - Gallery [M300T]							
Ammonium as NH ₄ (calc) - Gallery	21/10/25 13:06	EW175	0.01		0.0330	mg/l	C6
Calcium - Dissolved [M3165]							
Calcium (Ca)	30/10/25 16:14	EW188	1.08		118	mg/l	C6
Chloride mg/L - Gallery [M300S]							
Chloride mg/L - Gallery	21/10/25 13:06	EW175	5		24.7	mg/l	C6
Conductivity at 20°C (Robotic Method) [M3052]							
Conductivity at 20°C	20/10/25 19:17	EW152R	5		754	µS/cm	C6
Magnesium - Dissolved [M3174]							
Magnesium (Mg)	30/10/25 16:14	EW188	1.11		16.3	mg/l	C6
Nitrate as NO₃ (Calc) - Gallery [M300L]							
Nitrate as NO ₃ (Calc) - Gallery	21/10/25 13:06	EW175	4.4		17.8	mg/l	C6
pH (Robotic Method) [M3051]							
pH	20/10/25 19:17	EW152R	4		7.1		C6
Phosphate (Ortho/MRP) as PO₄ (Calc) - Gallery [M300M]							

Signed: _____



04/11/2025

Aoife De Barra - Organics & Instrumentation Team Lead CIE016

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11 Dargle View
Rathfarnham
Rathfarnham
D16 XY51
IRELAND

Certificate Code: AR-25-M3-035812-01

Page Number: Page 2 of 2

PO reference:

Certificate of Analysis

Sample number	966-2025-00041172	Received on	20/10/2025
Your sample reference	KD01	Analysis started on	20/10/2025
Sample Matrix	Ground water		
Sample Date	20/10/2025	Time Sampled	10:15

Test Code Analyte	SUB ⁵ Analysis Started	Method	LOQ ³	SPEC ²	Result	Units	ACCRED ⁴
Phosphate (Ortho/MRP) as PO4 (Calc) - Gallery Potassium - Dissolved [M3180]	21/10/25 13:06	EW175	0.03		<0.03	mg/l	C6
Potassium (K) Sodium - Dissolved [M3184]	30/10/25 16:14	EW188	0.15		1.79	mg/l	C6
Sodium (Na) Sulphate mg/L - Gallery [M300N]	30/10/25 16:14	EW188	1.5		9.72	mg/l	C6
Sulphate mg/L - Gallery	21/10/25 13:06	EW175	1		55.0	mg/l	C6

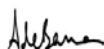
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