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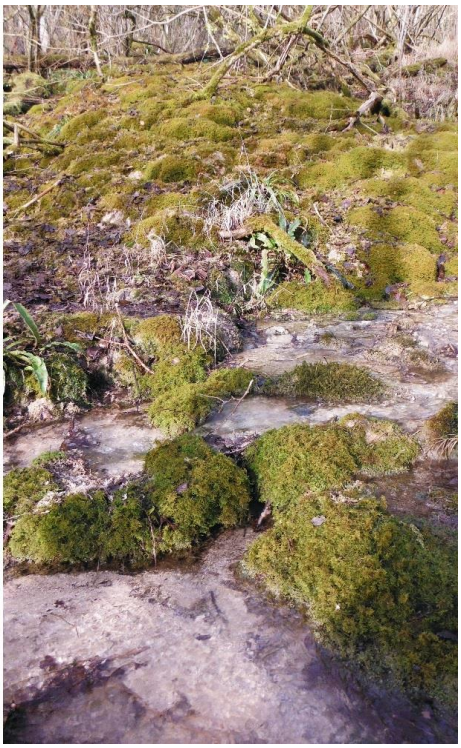
# Survey, characterisation and condition assessment of *Palustriella* dominated springs 'H7220 Petrifying springs with tufa formation (*Cratoneurion*)' in Gloucestershire, England.

Open Report OR/17/020



BRITISH GEOLOGICAL SURVEY

INTERNAL REPORT OR/17/020

# Survey, characterisation and condition assessment of *Palustriella* dominated springs 'H7220 Petrifying springs with tufa formation (*Cratoneurion*)' in Gloucestershire, England.



*Keywords*

Habitats Directive, Bryophytes, Travertine, Tufa, Nitrate.

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Midger Woods, Kingscote Woods and Aust Cliff.

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# Foreword

This report is the product of a Natural England (NE) contract with British Geological Survey (NERC) and Jonathan Graham (independent botanist). The objective of this project was to survey and report on the Habitats Directive Annex 1 Habitat 'H7220' within Gloucestershire, England, UK.

# Acknowledgements

The authors would like to thank the following; Iain Diack, Natural England who commissioned this report and managed the contract. We would also like to thank the various landowners that granted access during the survey including: the National Trust, Keith Mills Southern Forestry / Bathurst Estate and Karen and Phil Colebourn for access to Minchinhampton Stream. The following are thanked for sharing their local knowledge: Chris Uttley (Stroud Council), Richard Spyvee (Gloucestershire Wildlife Trust), Hannah Townley (Natural England), Jude Smith (Natural England), Ann Skinner and Rupert Higgins. Jane Hall, Centre for Ecology and Hydrology for advice on applying critical loads. We also thank Thomas Barlow and Michael Watts from the inorganic laboratories at the British Geological Survey, Keyworth and Debbie White, British Geological Survey Wallingford. Gareth Farr published with the permission of the Executive Director of the British Geological Survey (NERC).

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# Summary


- Twenty-two Gloucestershire sites were surveyed between 18th and 29th January 2017.

- Gloucestershire, due to its geology, often steep topography, very high levels of saturated calcium carbonate associated with springs of the Stroud Valley area in particular and large areas of woodland, has a large potential for the H7220 petrifying spring habitat.

- Fifteen sites (68%) are identified as having the European Annex 1 habitat H7220, Petrifying springs with tufa formation (*Cratoneuron*) while 7 sites had tufa formation without H7220.

- The total estimated area for H7220 habitat surveyed within Gloucestershire is 2 ha ranging in size from just 0.0001 ha (Sedbury Cliff) to 0.76 ha (Alder Carr) with the greatest length being some 600 m (Dowdeswell).

- The H7720 feature has been assessed as being in favourable condition for all of the 15 sites where it has been shown to occur although shading (planted conifers) and water quality (Nitrogen) have been highlighted as having potential for negative impact.

- No plants of conservation concern were recorded as directly associated with H7220 vegetation although the following were recorded more generally from sites: the aquatic moss *Fissidens rivularis* (Slade Brook), 6 Red data Book England (Near Threatened) flowering plants; 8 flowering plants generally considered to be ancient woodland indicators.

- Spring and seepages (particularly when calcareous and/or wooded) are of great importance for invertebrates (crane flies, soldier flies and some specialized snails and water beetles). These habitats are widespread in the UK (and include the H7720 habitat) but their associated invertebrate fauna is poorly known.

- Observations suggest that *Palustriella commutata* starts growth on firm substrates, mainly stones or living roots, as opposed to deadwood or rotting organic matter and is associated with slower flows and often more gently sloping sites.

- Restoration of H7720 is considered for two sites and restoration techniques discussed.

# 1. Introduction

## 1.1 AIMS AND SCOPE OF PROJECT

The primary aim was to undertake an active survey to identify sites within Gloucestershire that could be described as the Habitats Directive Annex 1 habitat '*H7220 Petrifying springs with tufa formation (Cratoneurion)* ' with the details being added to an inventory of all known H7220 habitats in England to support the GIS inventories for Biodiversity Action Plan (BAP) Priority Habitats (www.natureonthemap.org.uk).

## 1.2 DEFINITION OF PETRIFYING SPRINGS WITH TUFA FORMATION

The habitat 'H7220 Petrifying springs with tufa formation *(Cratoneurion*)' is defined in the Interpretation Manual of European Union Habitats (European Commission, 2013) as;

- Hard water springs with active formation of tufa. These formations are found in such diverse environments as forests or open countryside. They are generally small (point or linear formations) and dominated by bryophytes (*Cratoneurion commutati*).

- Confirms that this vegetation type corresponds (in the UK) to the UK National Vegetation Classification (NVC) types "M37 *Cratoneuron commutatum-Festuca rubra* spring community" and "M38 *Cratoneuron commutatum-Carex nigra* spring community" as described by Rodwell (1998).

- Lists the following plant species: *Arabis soyeri, Pinguicula vulgaris, Saxifraga aizoides; Cochlearia pyrenaica* (in sites with heavy metals); *Carex appropinquata, Epilobium davuricum, Juncus triglumis* (in the Boreal region). Mosses: *Catoscopium nigritum, Palustriella commutata, Palustriella falcata, Cratoneuron filicinum, Eucladium verticillatum, Hymenostylium recurvirostrum* and *Hamatocaulis vernicosus, Philonotis calcarea, Scorpidium revolvens, S. cossonii, Palustriella decipiens, Bryum pseudotriquetum* (in the Boreal region).

- For the purposes of this report, the habitat 'H7220 Petrifying springs with tufa formation *(Cratoneurion*)' is defined as spring vegetation dominated by either/ or both of the pleurocarpous mosses *Palustriella commutata, Palustriella falcata* (formerly treated as the single species *Cratoneuron commutatum*). Both these mosses are often, but not exclusively associated with tufa. For more details on the definition and interpretation of H7220 Petrifying springs with tufa formation *(Cratoneurion*)' in the UK, refer to Graham and Farr (2014).

## 1.3 TUFA FORMATION

Tufa formation occurs after dissolution by water of rocks rich in calcium carbonate (Banks & Jones, 2012). Once the groundwater emerges at the surface, via a spring or seepage or as river base flow, interactions with the atmosphere cause the loss or evasion of $CO_2$ and the resultant precipitation of calcium carbonate, as tufa:

$$Ca^{2+} + 2\ HCO_3^- \leftrightarrow CaCO_3 + CO_2 + H_2O$$

The principal sources of calcium carbonate for the sites within this study are the calcareous bedrock aquifers of the Jurassic Oolites, Carboniferous Limestone, Devonian sandstones and Lower Lias mudstones. Tufa can precipitate with varying success rates over a variety of substrates. Tufa can precipitate both on dead (leaves, twigs and logs) and living organic material (bryophytes, liverworts, tree roots etc.) and inorganic material such as stones. Figure 1-1 provides an illustration of rapid tufa formation on Beech leaves at Cranham Wood.

**Figure 1-1 Rapid tufa deposition on Beech leaves at Cranham Wood**

## 1.4 TUFA CLASSIFICATION

Tufa can occur in two broad geochemical categories. The first is associated with thermal waters (thermogene) and the second associated with meteoric waters (meteogene). Meteogene tufas are the most widely distributed (Pentecost and Viles, 1994) and cover all the examples within this report. Tufa fabric can be visible with the naked eye (mesofabric) or in more detail under the microscope (microfabric). There are many factors that influence tufa fabrics including; temperature, flow rate, $CO_2$ evasion rate, supersaturation with respect to calcite, ion transport mechanisms, plant growth and animal burrows (Pentecost, 2005). Fabrics have also been the basis of several classification schemes which emphasize the influence of plants (Pentecost and Viles, 1994) on the formation of a variety of tufa fabrics. Bryophytes and algae can influence tufa fabrics through the trapping and binding of calcite (Pentecost, 1993). Tufa morphologies, unlike most erosional or destructive land surface processes are frequently constructive in nature (Pentecost, 2005) and their morphologies are defined in 'British travertines: a review' (Pentecost, 1993), summarised in

Table 1 and Figure 1-2.

| Classification | Setting | Type | Description |
|---|---|---|---|
| Deposits on gentle slopes (*c.* <10°) | Marsh | Paludal | Surface coatings of tufa on vegetation, marshy locations or alluvial valley bottoms (e.g. Cranham Wood, Alder Carr, Midger Wood) |
| | Lake | Laucustrine crusts | e.g. Malham Tarn (no lacustrine sites identified in this study) |
| Deposits on steep slopes (*c.* >10°) | Cliffs | Cascades (cliffs) | Very slow seepage of calcareous water on cliff faces (e.g. Aust and Sedbury Cliff) |
| | River | Cascades (river) | On waterfalls and steep ground (e.g. Strawberry Bank Cascade, Bathurst Estate, Alder Carr, Cranham Wood). |
| | | Barrages | Spanning streams or rivers and forming back fill barrages, ponds and pools (including: Slade Brook, Dowdeswell, Strawberry Bank, Kingscote & Horsley Wood, Woodchester Park and Workmans Wood) |
| | | Fluvial Crusts | Formed in running water in small and larger rivers, smooth and sheet like or nodular and coralloid (includes most of the alluvial sites mentioned in this study) |
| | | Springheads | Dominated by bryophytes and often forming headwaters to river systems with cascades, barrages and fluvial crusts (includes the springheads and seepages that supply most sites within this study). |

**Table 1 Classification of tufa deposits described in this report, after Pedley (1990) and Pentecost & Viles (1994)**

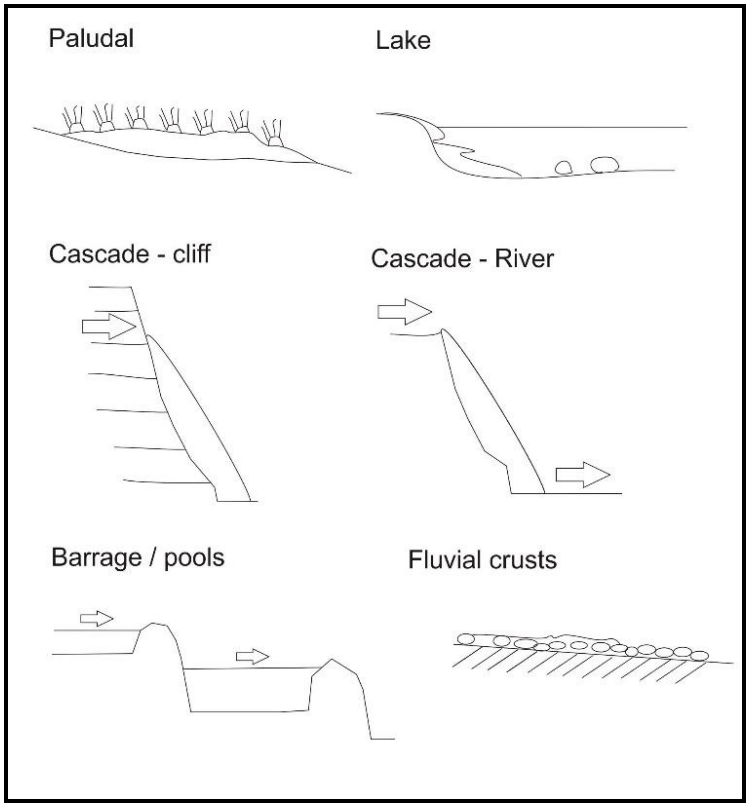



**Figure 1-2 Common tufa morphologies in the UK, not to scale (Modified from Pentacost & Viles, 1994)**

## 1.5 RECENT EUROPEAN WORK ON H7220

Recent research into the H7220 habitat includes; Heery, 2007 & Heery et al, 2014 (Ireland); Farr, Graham and Stratford, 2014 (Wales, UK); Graham & Farr, 2014 (Wales); Lyons, 2015 (Ireland); Lyons and Kelly, 2016 (monitoring guidelines in Ireland); Couvreur et al., 2016 (Belgium); Royal Hoskoning DHV, 2016 (nitrate and phosphate threshold values). There is an active EU LIFE project called 'Springday; Conservation and restoration of petrifying spring habitats (H7220) in Estonia', due for completion in May 2018 (NAT/EE/000860 http://www.loodushoid.ee/SPRINGDAY_348.htm).

## 1.6 INVERTEBRATES ASOCIATED WITH CALCAREOUS SPRINGS AND SEEPAGES

The present survey included only a botanical and hydrogeological assessment of sites. However, the broad habitats present (calcareous springheads and associated seepages, streams in both open habitat and woodland) are very important for invertebrates and therefore warrant the brief assessment below based on a literature review.

Woodland seepages are probably the most widespread, and yet little known seepage habitat in Britain for invertebrates (Boyce, 2002). The woodland seepages included in this survey have great variation in form including: open seepages dominated by tall stands of Pendulous Sedge *Carex pendula* with other wetland species such as Hemp-agrimony *Eupatorium cannabinum*, Water Mint *Mentha aquatica* and Greater Horse-tail *Equisetum telmateia*; open rocky spring heads (often with tufa); open "mossy" cascades (dominated by bryophytes such as *Palustriella commutata, Pellia endiviifolia, Conocephalum conicum*) with tufa dams and shallow pools; seepages with significant fallen deadwood and exposed tree roots (often with tufa); heavily shaded seepages with bare mud, detritus and little or no vegetation.

Woodland seepages that are heavily shaded and have a poorly developed ground flora (with much open mud and detritus) are frequently considered, with perhaps the exception of some shade tolerant fern and bryophyte species, to be of low conservation value. However, Boyce (2012) draws particular attention to the perils of relying too heavily on botanical criteria in assessing invertebrate communities of seepages. Two groups, in particular (crane flies and soldier flies) are associated with such shaded and open habitats and include many species of conservation concern.

Boyce (2012) lists invertebrates of conservation concern for woodland seepages of which 62% are crane flies (*Tipulidae* and *Ptychopteridae*). Crane flies generally have soft-bodied larvae that thrive in cool, saturated, shaded conditions. Although they occur in seepages with a wide range of chemistry, some rare species (such as *Gonomyia abbreviata, Gonomyia bifida, Molophilus corniger, Orimarga virgo, Paradelphomyia ecalcarata, Ptychoptera longicauda* and *Ptychoptera scutellaris)* are clearly associated with calcareous seepages (Boyce, 2012). In addition, Godfrey (2012; 2014) surveyed calcareous seepages in Somerset and recorded the UK BAP species *Lipsothrix nervosa*, Red Data Book species *Ellipteroides alboscutellata* (a species requiring constant flushing of base-rich waters with most records coming from tufa-rich seepages in woodland) and the Red Data Book species *Gonomyia abbreviata* (restricted to small shaded streams in woods on calcareous soils).

Soldier flies (*Stratiomyidae*) also mostly occur in open habitats with many species of conservation concern occurring within seepages with *Oxycera analis* and *Oxycera leonina* appearing to be restricted to calcareous seepages in woodland and at woodland edges (Boyce 2012).

Neutral to calcareous seepages are associated with several molluscs of conservation concern. Four rare species (*Acicula fusca, Leiostyla anglica, Spermodea lamellate, Phenacolimax major*) are closely associated with seepages dominated by Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium* (found amongst *Chrysosplenium* plants and in saturated leaf litter) while three rare

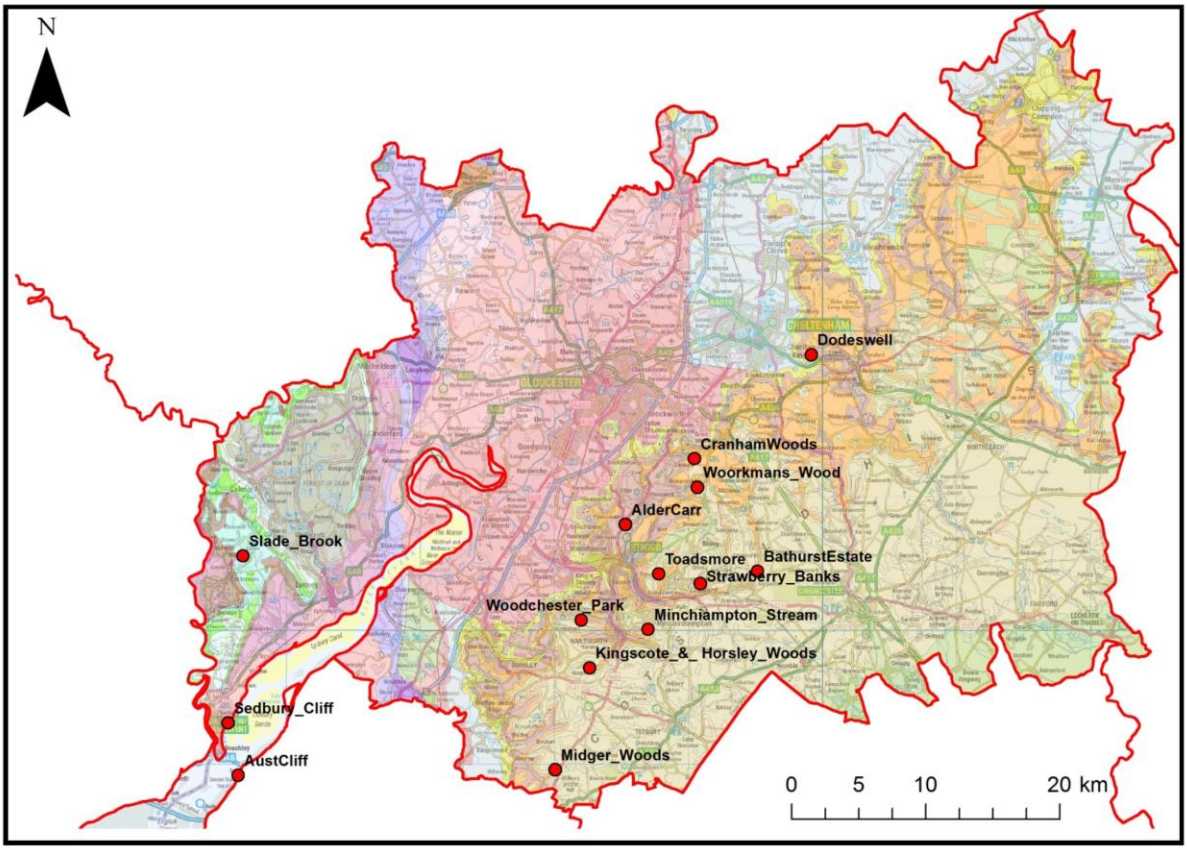
species *(Catinella arenaria*, *Vertigo genesii*, *Vertigo geyeri*) are associated with more strongly calcareous seepages (Boyce 2012). The rare Gloucestershire snails *Ena montana*, *Phenacolimax major*, *Acicula fusca* and *Macrogastra rolphii* are noted as being associated with wet bryophyte-rich flushes within Cotswold Commons and Beechwoods Site of Special Scientific Interest (SSSI).

A number of rare water beetles are also associated with calcareous springs including *Hydroporus ferrugineus*, *Hydroporus longulus*, *Hydroporus marginatus*, *Agabus biguttatusis* (Boyce 2012). *Hydroporus ferrugineus* is semi-subterranean occurring in springs, groundwater-fed trickles, *H. longicornis* is known from woodland flushes and *Agabus biguttatusis* occurs under stones or amongst gravel in springs (Hammond, 2017). In addition, the rare riffle beetle *Riolus subviolaceus* occurs on the underside of tufa-encrusted stones (Hammond, 2017) and is recorded from calcareous woodland springs in Somerset (Godfrey, 2014).

The shallow calcareous and rocky water courses that frequently occur close to springs over limestone continue to be an important habitat for the survival of relict populations of the native White-clawed Crayfish *Austropotamobius pallipes*.

## 1.7 SITE SELECTION

Sites were selected by Iain Diack (Natural England), Chris Uttly (Stroud Council) and Richard Spyvee (Gloucestershire Wildlife Trust) from both a selection of designated and non-designated sites. Figure 1-3 shows the location and geological setting for each site.




| Site | Easting | Northing | Geology | Notes |
|---|---|---|---|---|
| Alder Carr | 385297 | 207895 | **Jurassic:** Whitby Mudstone Formation | Springs at break of topgraphic slope |
| Aust Cliff | 356427 | 189190 | **Jurassic-Triassic** Blue Lias Formation overlying Penarth Groupoverlying Triassic Blue Anchor | Seepage across cliff face |
| Bathurst Estate | 395150 | 204409 | **Jurassic**: Great Oolite Group overlying Fuller's Earth Formation overlying Salperton Limestone Formation | Springs within Fullers Earth Formation |
| Cranham Woods | 390447 | 212803 | **Jurassic**: Great Oolite Group - limestone and mudstone over lying Inferior Oolite Group | Spring within Inferior Oolite Group |
| Dodeswell | 399177 | 220573 | **Jurassic**: Inferior Oolite Group overlying Birdport Sandstone Formation | Spring at junction of two formations |
| Kingscote and Horsley Woods (Sites 1-4) | 382634 | 197202 | **Kingscote Wood: Jurassic:** Great Oolite Group, Fullers Earth Formation overlying Inferior Oolite | Main spring near junction of two formations |
| | 383514 | 197603 | **Horsley Wood: Jurassic:** Inferior Oolite Group | Springs rising from Inferior Oolite Group |
| Minchiampton Stream | 386997 | 200066 | **Jurassic:** Great Oolite Group, Fullers Earth Formation overlying Inferior Oolite Group | Main spring near junction of two formations |
| Midger Woods (Sites 1 & 2) | 380054 | 189602 | **Jurassic:** Great Oolite Group overlying the Fullers Earth Formation | Springs rise within Fullers Earth Formation |
| Sedbury Cliff | 355645 | 193093 | **Jurassic-Triassic** Blue Lias Formation overlying Penarth Group overlying Triassic Blue Anchor | Seepage across cliff face |
| Slade Brook | 356774 | 205546 | **Devonian - Carboniferous:** Carboinferous Limestone Supergroup overlying Devonian Tintern Sandstone | Springs issue from Devonian strata |
| Strawberry Banks | 390892 | 203500 | **Jurassic**: Great Oolite Group (Fullers Earth Foramtion) overlying Inferior Oolite Group | Main spring at junction of two formations |
| Toadsmore | 387783 | 204209 | **Jurassic:** Great Oolite group overlying Inferior Oolite | Main spring near junction of two |
| Woodchester Park (Sites 1-3) | 382005 | 200757 | **Jurassic:** Great Oolite Group overlying Fullers Earth Formation | Springs issue from Fullers Earth Formation |
| Woorkmans Wood (Sites 1-3) | 390664 | 210676 | **Jurassic**: Great Oolite Group (inlcuding: Througham Tilestone Formation - Limestone; Kellaways | Springs issue near contact of Great and linferior Oolite |

**Figure 1-3 Location of tufa forming sites described in this report (*Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL* and British Geological Survey Data 1:50,000).**

# 2. Methods

Twenty two sites were surveyed between 18th and 29th January 2017 by Gareth Farr (hydrogeologist) and Jonathan Graham (botanist) working in partnership at all times.

## 2.1 BOTANICAL SURVEY METHODS

A complete plant species list (flowering plants and bryophytes) was obtained for each site including precise habitat notes on the occurrence of individual species within flushes (such as whether species occurred on stone, dead wood, living tree roots, within or beside channels etc.). In addition, notes were made on species groups occurring at different parts of sites (such as those associated with open springheads or wooded cascades etc.). Flowering plants, bryophytes and lichens were identified (where possible) in the field but where there was uncertainty, specimens were collected and determined microscopically. The location of species of note **or** species occurring locally within a site **or** species occurring in discrete locally dominant patches were more precisely noted. A detailed map was drawn in the field for each site noting locations of individual springheads, runnels and tufa, and particular effort was made to accurately delimit areas of *Palustriella* dominated vegetation. A particular study was made of species associated with (or appearing to be actively associated with the formation of) tufa. Nomenclature adopted follows Stace (2010) for most flowering plants; Cope & Gray (2009) for grasses; M.O. Hill, T.H. Blackstock, D.G. Long and G.P. Rothero, (2018) for bryophytes and The British Lichen Society (2017) for lichens.

## 2.2 ELEVATION AND ORIENTATION

Elevations as maOD (meters above ordnance datum) were measured from 10 m DTM (digital terrane model) LiDAR, using ARC map and the dominant orientation (NW, NE, SE or SW) of each site was recorded. For the larger sites that form down a slope, a maximum and minimum elevation were recorded and average for the site produced.

## 2.3 GEOLOGY AND HYDROGEOLOGY

At each site the principal source of water, mainly springs or seepages were identified. Springs and seepages were attributed to mapped geological units using the published British Geological Survey 1: 50,000 Bedrock and Superficial maps. Where there was more than one potential aquifer (e.g. two concurrent formations that are likely to be in hydraulic continuity) then both units have been attributed. Future site specific investigation may refine the knowledge of the source aquifers, residence time of groundwater and hydrogeological conceptual models. Fieldwork was undertaken in January (winter), and the visual flow estimates (to the nearest 1 l/s) are likely to represent the higher end of flow at each site. Due to the timing of the survey it was not possible to provide evidence for either minimum or maximum (drought – flood / winter - summer) flow conditions.

## 2.4 WATER CHEMISTRY

Water samples were collected at each site for inorganic chemical analysis. Each sample was collected as close to the source of water, often a springhead or seepage face, as possible. Care was taken to only collect samples that represented water associated with tufa formation and supply to the main tufa forming bryophytes. Field parameters for pH, electrical conductivity and temperature were measured on ‘Metter Toldeo - SevernGo’ field meters. The meters were calibrated each day for both pH and electrical conductivity, using a two point calibration of pH 4 and 7 and 760 and 1413 µscm respectively. The samples were filtered using a 0.45 µm filter into two separate 35 ml plastic bottles. The water samples were frozen on the day of collection and sent to the UCAS accredited British Geological Survey Inorganic Laboratory (Nottingham) for ICP-MS and IC analysis of major ions, nutrients, alkalinity and trace elements. An ionic balance was performed on each analysis. In addition to the field readings a Lab electrical conductivity, pH and alkalinity were measured. The data set with limits of detection for each parameter are included in the Appendix.

### 2.5 ATMOSPHERIC DEPOSITION

We assigned a value for nitrogen deposition to each of the sites in this study using UK atmospheric deposition 5x5 km modelled data based on the CBED (concentration based estimated deposition) methodology. Data for Annex 1 habitats and designated sites in the UK can be accessed on APIS (air pollution information systems) www.apis.ac.uk . Using the 5x5 km modelled data we report values for average, $NH_3$, $NO_X$ and total Nitrogen as kg N $ha^{-1}$ $year^{-1}$ for each of the study sites. Critical loads, agreed in a UNECE (European Nature Information System) workshop in 2010 (Hall et al 2015), set values for each EUNIS class where data exists. Values for UK habitats can also be viewed on the APIS website at http://www.apis.ac.uk/indicative-critical-load-values. Methods for calculating critical loads and their exceedances in the UK are reported in Hall et al 2015. However in the UK there are no specific critical loads for the H7220 Petrifying springs habitat, so for the current Annex 1 assessments the EUNIS class D4.2 critical loads are applied. The current critical load range for this habitat is 15-25 kg N/ha/yr, with a recommended value of 15 kg N/ha/yr for site-based assessments (pers. com. Jane Hall, Centre for Ecology and Hydrology 14/3/17). We report the modelled nitrogen deposition values for each site and undertake a broad assessment, to see how many of the petrifying springs sites exceed the recommended site relevant critical load of 15 kg N/ha/yr.

# 3. Site Descriptions

### 3.1 OVERVIEW OF VEGETATION

All twenty two sites surveyed had tufa and in many cases tufa formations were extensive and relate to the very high levels of saturated calcium carbonate associated with springs of the Stroud Valley area in particular. Hedenäs & Kooijman (2004) note that *Palustriella commutata* grows under very high mineral levels. Fifteen of these sites (68%) had tufa associated with the moss *Palustriella commutata* and are classed as having the habitat 'H7220 Petrifying springs with tufa formation *(Cratoneurion*)' although the extent of the H7220 habitat varied considerably within different sites.

The majority of sites identified with H7220 habitat (15) comprise spring systems in relatively steep sided wooded valleys over limestone where the channels are frequently rocky and include small falls and gorges. Many of these woodlands are ancient woodland sites. A single site identified with a small area of H7220 habitat (Sedbury Cliff) comprises a sea cliff seepage but was essentially similar in being a seepage in scrub woodland on the cliff face.

The 15 sites identified with H7220 habitat compare well with lowland Welsh woodland and sea cliff sites (Group 2 sites, Graham & Farr, 2014) and with wooded spring head sites in Ireland (Group 2: *Palustriella commutata-Geranium robertianum* spring heads, Lyons & Kelly, 2016).

In terms of National Vegetation Classification (NVC), most sites surveyed with *Palustriella commutata* would fall within the M37 *Cratoneuron commutatum – Festuca rubra* spring community. However, there are subtle differences between *Palustriella commutata* dominated vegetation within woodland and the more open communities associated with spring heads extending above the woodland (such as the grazed channels at Toadsmoor and Strawberry Bank). Such sites closely match descriptions of hillside springheads and seepages in Ireland (Group 4 *Palustriella commutata-Agrostis stolonifera* springheads, Lyons and Kelly, 2016).

Table 2 lists plants of conservation concern recorded from sites based on A Vascular Plant Red List for England (Stroh et al. 2014) for flowering plants, A Provisional Red Data Book of Gloucestershire Bryophytes (Lansdown 2014) for bryophytes, Identifying ancient woodland using vascular plant indicators (Peterken, 2000), Ancient Woodland Species (Woodland Trust, 2017) for ancient woodland indicator species. None of the species listed are associated directly with *Palustriella commutata* and the H7220 habitat but they do serve as habitat quality indicators for sites and adjoining woodland.

The aquatic moss *Fissidens rivularis* (Slade Brook) is of interest. This is a nationally scarce species of National Responsibility in Gloucestershire (Lansdown 2014). At Slade Brook it was recorded from tufa-encrusted stones within the brook (pH 7.4) which is an unusual habitat for this species within the UK. Typically this species occurs on neutral to acid rocks (Atherton et. al, 2010) although it will occur rarely on limestone (Smith, 2004).

The combination of high humidity associated with seepages and occurrence of seepages within open woodland at many of the sites surveyed has resulted in good development of epiphytic bryophytes.

| **SPECIES** | **English name** | **Status** | **Sites** |
|---|---|---|---|
| *Fissidens rivularis* | River Pocket-moss | Least Concern (National Responsibility) | Slade Brook |
| *Fragaria vesca* | Wild Strawberry | Near Threatened | Strawberry Bank |
| *Oxalis acetosella* | Wood Sorrell | Near Threatened (Ancient Woodland Indicator) | Dowdeswell<br>Midger Wood (both sites)<br>Strawberry Bank<br>Woodchester Park sites 1 and 3 |
| *Sanicula europaea* | Wood Sanicle | Near Threatened | Alder Carr<br>Midger Wood site 2<br>Strawberry Bank |
| *Senecio aquaticus* | Marsh Ragwort | Near Threatened | Kingscote & Horsley Wood site 1 |
| *Valeriana dioica* | Marsh Valerian | Near Threatened | Strawberry Bank |
| *Valeriana officinalis* | Valerian | Near Threatened (Ancient Woodland Indicator) | Slade Brook |
| *Allium ursinum* | Wild Garlic | Ancient Woodland Indicator | Alder Carr<br>Bathurst Estate<br>Cranham Wood<br>Dowdeswell<br>Kingscote and Horsley Wood site 1<br>Midger Wood (both sites)<br>Minchinhampton Brook<br>Slade Brook<br>Strawberry Bank<br>Woodchester Park sites 2 and 3<br>Workman's Wood sites 2 and 3 |
| *Dipsacus pilosus* | Small Teasel | Ancient Woodland Indicator | Dowdeswell<br>Kingscote Wood site 3 |
| *Galium odoratum* | Sweet Woodruff | Ancient Woodland Indicator | Cranham Woods<br>Dowdeswell<br>Midger Wood site 3<br>Slade Brook<br>Strawberry Bank,<br>Woodchester Park 1 and 3 |
| *Lysimachia nemorum* | Yellow Pimpernel | Ancient Woodland Indicator | Midger Wood site 3 |
| *Polystichum aculeatum* | Hard-fern | Ancient Woodland Indicator | Slade Brook |
| *Primula vulgaris* | Primrose | Ancient Woodland Indicator | Bathurst estate<br>Midger Wood site 1<br>Strawberry Bank<br>Woodchester Park site 1 |

**Table 2 Plants of conservation concern**

## 3.2 ALDER CARR

Alder Carr (SO853078) is small area of seepages within a shaded stand of Alder dominated woodland closely adjoining the Painswick Stream (Figure 3-1). The site is underlain by the Jurassic Lias Group and Inferior Oolite Group and the main seepages occur on the northern side of the site at the base of a small slope. The main seepage area (Figure 3-2) is semi-shaded and has scattered small stands of the moss *Palustriella commutata* mostly associated with stones and tufa formation (Figure 3-3) and other bryophytes including *Brachythecium rivulare*, *Cratoneuron filicinum* and *Pellia endiviifolia*. Leaf litter is frequent and is dominated by Alder leaves.

Below the seepage face and main springhead, more extensive marginal stands of vegetation have developed including tall stands dominated by Pendulous Sedge *Carex pendula* and more open stands dominated by Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium.* A moderate number of other species are present on the banks of the channels created by the springs including Hart's-tongue Fern *Asplenium scolopendrium,* Wavy Bitter-cress *Cardamine flexuosa*, Lesser Celandine *Ficaria verna* and the bryophytes *Conocephalum conicum, Fissidens taxifolius, Plagiomnium rostratum.*

Where the springs join the river and the ground levels out, wet swampy vegetation has developed (Figure 3-4) dominated by Pendulous Sedge, occasional Wild Angelica *Angelica sylvestris*, Cuckoo Flower *Cardamine pratense*, Yellow Iris *Iris pseudacorus* and very locally Greater Horse-tail *Equisetum telmateia*, Marsh Marigold *Caltha palustris*.

At the margins of the main area of springs (mainly on higher ground), Ash, Beech and Hazel woodland predominates with occasional Pedunculate Oak and Wych Elm. An open understory occurs in many places with Holly, Ivy and Honeysuckle. A woodland ground flora has a broad number of species (at low cover) including False Brome *Brachypodium sylvaticum*, Remote Sedge *Carex remota*, Wood Sedge *Carex sylvatica*, Herb Bennet *Geum urbanum*, Ground Ivy *Glechoma hederacea*, Nettle *Urtica dioica*, Red Campion *Silene dioica*, Rough-leaved Meadow-grass *Poa trivialis* and the common bryophytes *Brachythecium rutabulum, Thamnobryum alopecurum, Kindbergia praelonga, Lophocolea bidentata, Oxyrrhynchium hians, Plagiomnium undulatum.* Locally the ground flora includes the ancient woodland indicators Dog's Mercury *Mercurialis perennis*, Yellow Archangel *Lamiastrum galeobdolon* and Wild Garlic *Allium ursinum.*

Where the tops of rotting logs rise above the level of flush water, ferns are prominent including Broad Buckler-fern *Dryopteris dilatata*, Male Fern *Dryopteris filix-mas* and the bryophytes *Mnium hornum, Rhizomnium punctaum, Plagiothecium succulentum*.

The bases of larger trees, such as Ash and Oak, support the epiphytic bryophytes *Hypnum cupressiforme, Rhynchostegium confertum, Isothecium myosuroides* while the humid conditions have allowed rich epiphytic bryophyte communities to develop on Hazel branches with *Bryum capillare, Cryphaea heteromalla, Frullania dilatata, Metzgeria furcata, Orthotrichum affine, Radula complanata, Ulota bruchii*.

Close to the riverbank in a less shaded area (SO85380790) where a spring has backed up slightly and a stand to Fool's Water-cress *Apium nodiflorum* has developed associated with Creeping Buttercup *Ranunculus repens* and Clustered Dock *Rumex conglomeratus*. The small moss *Didymodon sinuosus* occurs on stones in this area along with the robust moss *Platyhypnidium ripariodes* at the immediate river's edge.

The H7220 feature (area of flushing with tufa and frequent patches of *Palustriella commutata)* covers most of the site (measured using GIS to cover an area of 0.76 ha) starting just below the seepage face and spring south to the margin of the river bank where a number of larger stands of *Palustriella commutata* are associated with tufa blocks on the steeper gradient of the river bank (Figure 3-5).

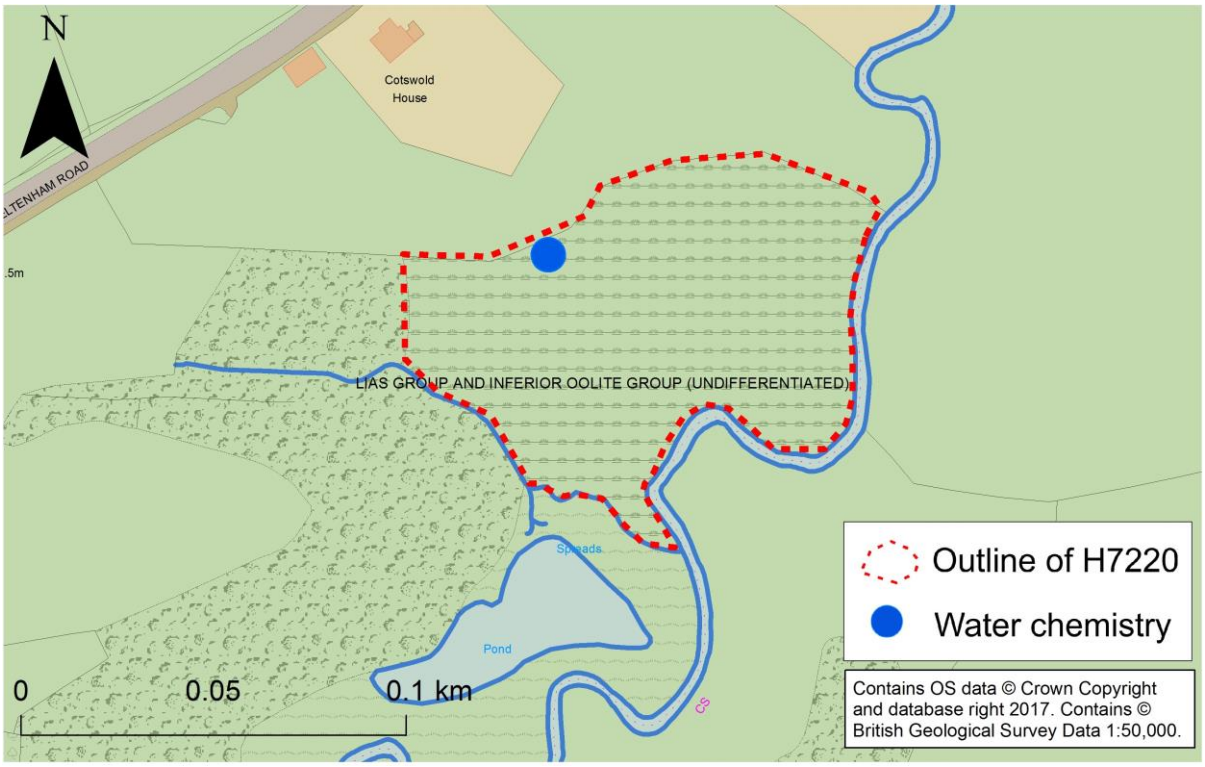



**Figure 3-1 Alder Carr location map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-2 Alder Carr springhead with tufa, leaf litter and patches of *Palustriella commutata* on stones**

**Figure 3-3 *Palustriella commutata* with *Conocephalum conicum* (stone with tufa) and Alder leaf litter**

**Figure 3-4 Swampy vegetation dominated by Pendulous Sedge, close to river**

**Figure 3-5 Tufa with Hart's-tongue Fern, *Palustriella commutata* and *Pellia endiviifolia* near river**

## 3.3 AUST CLIFF

This site comprises seepages across the base of a cliff face at the east side of the Seven estuary south of the original Seven road bridge (ST56558960) (Figure 3-6) with Jurassic – Triassic strata including the Blue Anchor Formation, Penarth Group and Blue Lias. The interbedded nature of these low permeability rocks create the ideal situations for slow diffuse cliff face seepages. This cliff area is generally open although there are adjoining stands of rough grassland dominated by Cock's-foot *Dactylis glomerata* with Bramble, Dog Rose, Wild Privet, Gorse and Hawthorn scrub.

Seepages occur on vertical rock faces along a length of ~10 m and are associated with extensive tufa formation (Figure 3-7). Where these dripping rock faces are exposed without too much shade from adjoining scrub (west-facing cliff), large cushions of the moss *Eucladium verticillatum* dominate along with occasional cushions of *Didymodon tophaceus* (Figure 3-8). Both these mosses are actively associated with tufa formation. Occasional flowering plants (mostly seedlings) are also present including Ribwort Plantain *Plantago lanceolata*, Glaucous Sedge *Carex flacca*.

Where seepages on rock faces are partially shaded by adjoining scrub (north-facing cliff) (Figure 3-9), additional species include Ivy and the bryophytes *Aneura pinguis, Calliergonella cuspidata, Cratoneuron filicinum, Pellia endiviifolia, Riccardia chamedryfolia*. Large cushions of *Eucladium verticillatum* have formed on the West facing part of the cliff (Figure 3-10; Figure 3-11).

At the base of the cliff where the slope is less steep, seepages support an additional number of wetland plants including Lesser Pond-sedge *Carex acutiformis*, Greater Horse-tail *Equisetum telmateia*, Hemp-agrimony *Eupatorium cannabinum*, Meadowsweet *Filipendula ulmaria*, Reed Canary-grass *Phalaris arundinacea* and Common Reed *Phragmites australis*. There is no H7220 feature at this site although there is extensive tufa formation.

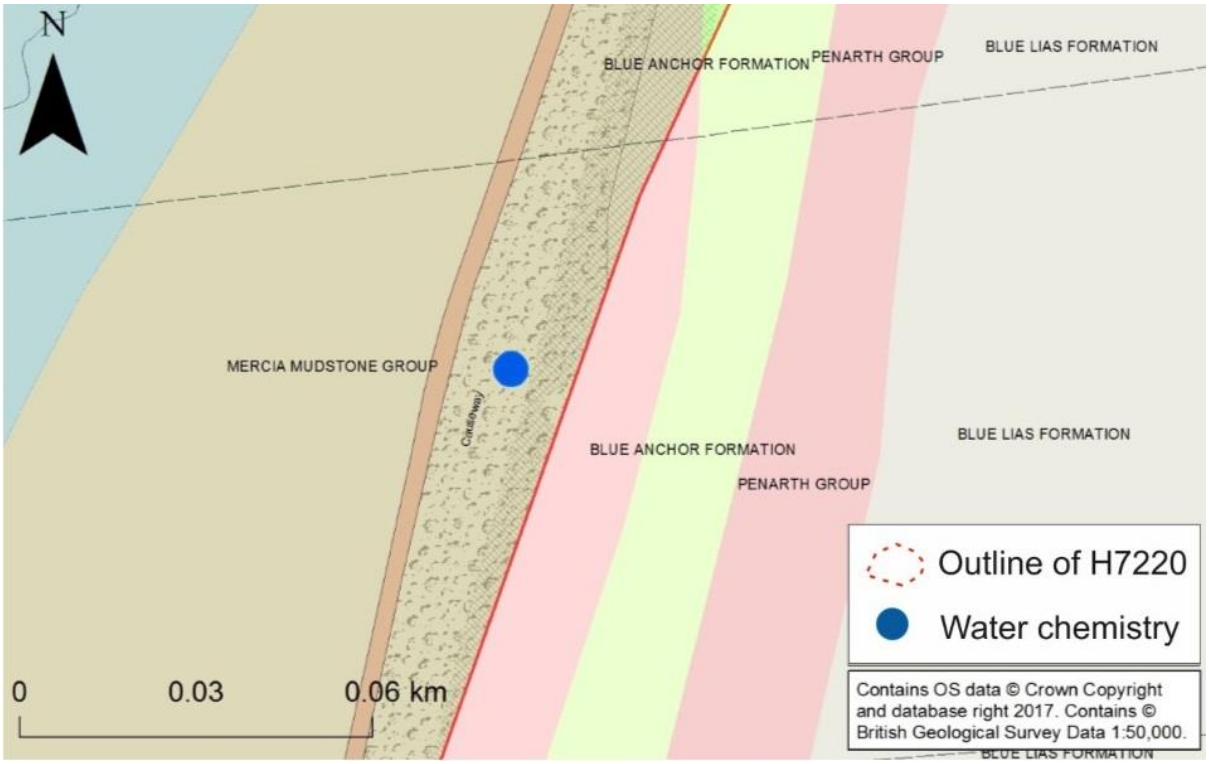



**Figure 3-6 Aust Cliff location map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-7 Seepages on low cliff (with tufa and cushions of *Eucladium verticillatum*) surrounded by rough grassland, Bramble and Hawthorn scrub**

**Figure 3-8 Seepages on low west-facing cliff with extensive tufa and *cushions of Eucladium verticillatum***

**Figure 3-9 Shaded north-facing part of low cliff with Ivy and large cushions of *Eucladium verticillatum, Pellia endiviifolia***

**Figure 3-10 Close up of large cushions of *Eucladium verticillatum* with tufa (west-facing cliff)**

**Figure 3-11 Close up of large cushion of *Eucladium verticillatum* showing seepages and active tufa formation (west-facing cliff)**

## 3.4 BATHURST ESTATE

An area of springs and seepages (S095150440) within an ancient woodland (Hen Wood) that has an open canopy of Field Maple, Hazel, Beech, Ash and locally (adjoining seepages) Goat willow. Underlain by the Jurassic Salperton Limestone Formation, Fullers Earth Formation and Great Oolite Group. The seepages join into one main stream that discharges to a small river (River Frome) via a culvert (under a public footpath) and via some 19th Century, stone built water control features (Figure 3-12)

Several springheads discharge a number of seepages from the base of large blocks of limestone (Figure 3-13; Figure 3-14). These rocky springheads have abundant Hart's-tongue Fern *Asplenium scolopendrium* and the moss *Thamnobryum alopecurum*. Where water seeps through the limestone, shaded vertical rock faces have tufa deposits with cushions of *Eucladium verticillatum* and *Pellia endiviifolia*. Both these bryophytes appear active in tufa formation and larger and ancient blocks of limestone close to the springheads support Ivy and a number of interesting bryophytes including *Ctenidium molluscum, Tortella tortuosa, Anomodon viticulosus*, *Fissidens dubius* and *Neckera crispa*. Two other bryophytes *(Frullania tamarisci* and *Plagiochila porelloides*) occur locally on both the tops of large boulders and on the lower trunks and roots of larger trees (mainly Ash).

Below the springheads, small rocky runnels occur (with increased flow). Stands of the moss *Palustriella commutata* appear along with Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium*, Pendulous Sedge *Carex pendula*, Wild Garlic *Allium ursinum*, the bryophytes *Brachythecium rivulare, Conocephalum salebrosum, Cratoneuron filicinum,* and locally (on tufa-encrusted stones and tree roots) *Plagiomnium rostratum, Jungermannia atrovirens*. Towards the centre of the site, many of spring channels come together and form a complex of separate channels and tufa dams with frequent large cushions of *Palustriella commutata* (Figure 3-15). Very locally there are patches of the mosses *Calliergonella cuspidata* and *Didymodon fallax* on open more illuminated rocky areas.

Towards the margins of the springs, on higher ground and away from the flushing water, a rich woodland flora is present with False Brome *Brachypodium sylvaticum*, Remote Sedge *Carex remota*, Wood Sedge *Carex sylvatica*, Tufted Hair-grass *Deschampsia cespitosa*, Broad Buckler-fern *Dryopteris dilatata*, Male Fern *Dryopteris filix-mas*, Herb Robert *Geranium robertianum*, Ground Ivy *Glechoma hederacea*, Soft Shield-fern *Polystichum setiferum*, Sweet Violet *Viola odorata* and bryophytes *Cirriphyllum crassinervium, Eurhynchium striatum, Fissidens taxifolius, Plagiochila asplenioides, Plagiomnium undulatum, Rhytidiadelphus triquetrus, Thuidium tamariscinum*. Locally, the ancient woodland indicators Bluebell *Hyacinthoides non-scripta*, Yellow Archangel *Lamiastrum galeobdolon*, Primrose *Primula vulgaris* also occur.

Below one springhead, seepages have backed up into a small pool (to 20 cm water depth) which is dominant by stands of Water-cress *Nasturtium officinale* sensu. lato. (Figure 3-17).

Due to the increased humidity in close proximity to the flushed areas, fallen and rotting tree trunks and branches support a good number of bryophytes including *Dicranum scoparium, Mnium hornum, Rhizomnium punctaum, Lophocolea bidentata* and locally *Lepidozia reptans, Nowellia carvifolia* (these last two species being local within Gloucestershire). Similarly, tree bases and roots of larger trees (mainly Ash) support the common mosses *Kindbergia praelonga, Brachythecium rutabulum, Hypnum cupressiforme, Zygodon viridissimus, Homalothecium sericeum, Isothecium alopecuroides, Isothecium myosuroides and Neckera complanata,* while the upper trunks and twigs of smaller Ash, Hazel, Field Maple and Goat Willow have *Frullania dilatata, Metzgeria furcata, Metzgeria violacea, Orthotrichum affine, Radula complanata and Ulota bruchii.*

Towards the base of the site (where spring lines converge into a single stream), soil, leaf litter and much tufa has washed down (Figure 3-18). In this slightly more nutrient enriched area, Creeping Buttercup *Ranunculus repens* and the liverwort *Lunularia cruciata* are present. In addition, the robust

moss Platyhypnidium ripariodes is associated with increased flow in this area closely adjoining the River Frome.

The H7220 feature (area of flushing with tufa and frequent patches of *Palustriella commutata*) covers most of the site and is estimated using GIS to cover an area of about 0.3 ha from just below the springheads to shortly before the main channel joins the River Frome.

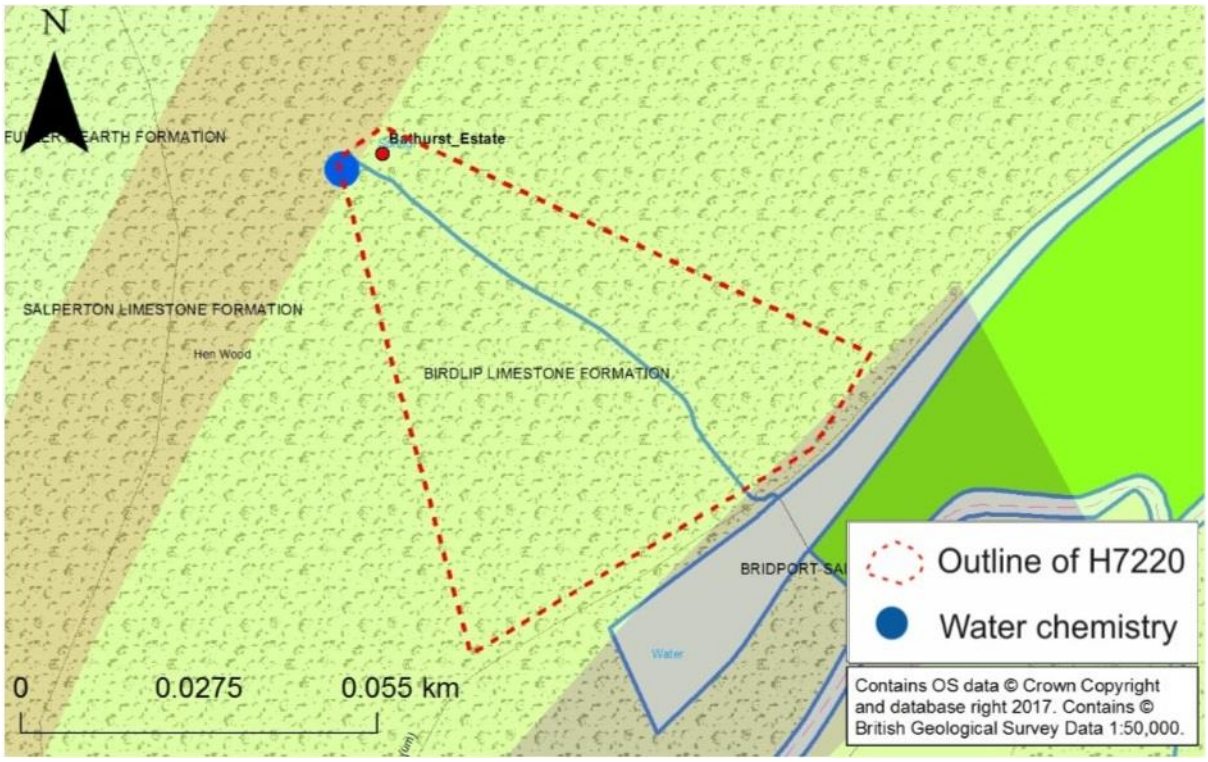



**Figure 3-12 Bathurst Estate Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-13 Area of main springheads with limestone blocks and tufa, frequent Hart's-tongue Fern**

**Figure 3-14 Close up of seepages below large block of limestone with Hart's-tongue Fern and *Thamnobryum alopecurum***

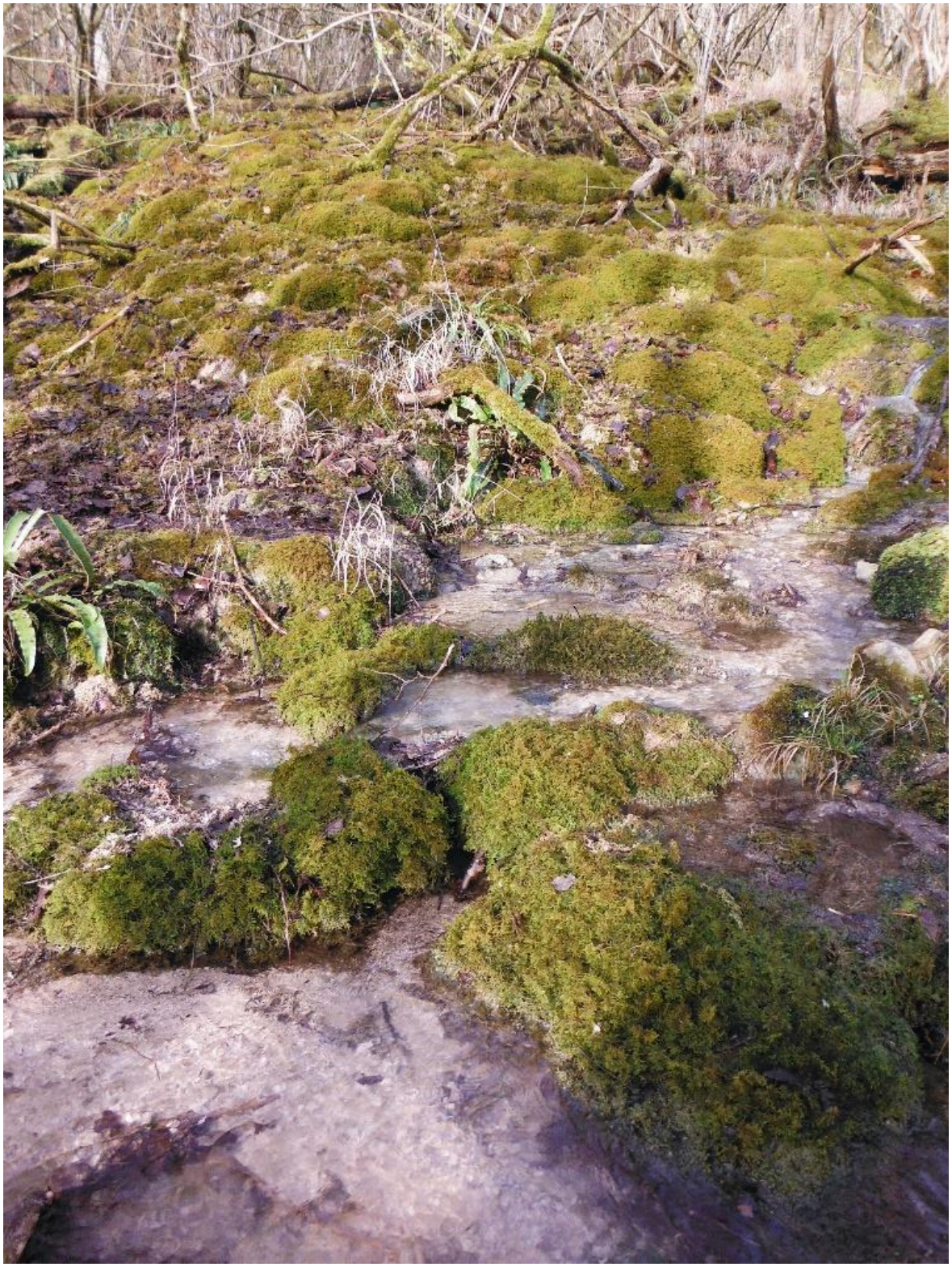


**Figure 3-15 Complex of separate channels, tufa dams and pools with frequent large cushions of *Palustriella commutata***

**Figure 3-16 Close up of large cushions of *Palustriella commutata* associated with tufa formation**

**Figure 3-17 Small pool dominated by Water-cress closely below main springhead**

**Figure 3-18 Spring discharge forms a single tufa depositing stream that discharges to the River Frome**

## 3.5 CRANHAM WOOD

Cranham Wood is an ancient Ash and Beech woodland and is underlain by the Jurassic Great Oolite Group and the Inferior Oolite Group. It is part of Cotswold Commons and Beechwoods Site of Special Scientific Interest (SSSI) and National Nature Reserve (NNR).

The site (SO90441277 to SO90511282: Figure 3-19) has formed down the valley side, and is supplied by a single strong spring and adjacent seepage, which may be associated with the Inferior Oolite aquifer. The site is formed from a series of tufa dams and pools that cascade down the side of the valley forming a 'fan' shape (Figure 3-20) and a channel flows around the main tufa area to the west. The remaining water seeps through the tufa dams and pools and exits at the base of the feature, re-joining the side channel and developing into to a runnel that passes through a culvert below the footpath/track before joining the Painswick Stream in the base of the valley.

The spring and seepages emerge from below large blocks of limestone within Beech dominated woodland that has occasional Ash and Sycamore (Figure 3-21). The shaded developing rocky channels support stands of Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium,* Wavy Bitter-cress *Cardamine flexuosa*, Water Mint *Mentha aquatica*, Remote Sedge *Carex remota*, Hart's-tongue Fern *Asplenium scolopendrium,* Pendulous Sedge Carex pendula and bryophytes *Cratoneuron filicinum, Pellia endiviifolia and Brachythecium rivulare*. The tiny moss *Fissidens pusillus* is locally frequent on tufa-encrusted stones within the channel.

Immediately below the rocky springhead, the moss *Palustriella commutata* quickly becomes abundant and is associated with active tufa formation, where a large fan of dams and associated pools has formed (Figure 3.4.2). In addition to dominant stands of *Palustriella commutata*, Hart's-tongue Fern is particularly abundant along with regular cushions of *Eucladium verticillatum* with *Conocephalum conicum, Plagiomnium rostratum* (e.g. Figure 3-22; Figure 3-23). The moss *Calliergonella cuspidata* occurs very locally in open areas. Occasionally, sections of the tufa dome have eroded and (where sufficiently illuminated), a number of additional bryophytes have colonised the exposed tufa including *Amblystegium serpens var. serpens, Barbula unguiculata* and *Didymodon insulanus*.

The raised banks of the main channels and surrounding woodland are typically dominated by the shade-tolerant mosses *Kindbergia praelonga, Fissidens bryoides, Oxyrrhynchium hians* and in many places there is a dense layer of leaf litter and dead wood (primarily from Beech). However, there are a number of characteristic Ash woodland ground flora species present at low cover including Soft Shield-fern *Polystichum setiferum*, Wood Sedge *Carex sylvatica*, Tufted Hair-grass *Deschampsia cespitosa*, Male Fern *Dryopteris filix-mas*, Herb Robert *Geranium robertianum*, Herb Bennet *Geum urbanum, Ivy Hedera helix ssp. helix*, seedling Holly, Rough-leaved Meadow-grass *Poa trivialis*, Creeping Buttercup *Ranunculus repens*, seedling Yew, Dog Violet *Viola riviniana* and the bryophytes *Eurhynchium striatum, Brachythecium rutabulum, Fissidens taxifolius, Lophocolea bidentata, Plagiomnium undulatum, Thamnobryum alopecurum.* Locally, the ancient woodland indicators Sweet Woodruff *Galium odoratum*, Yellow Archangel *Lamiastrum galeobdolon*, Wild Garlic *Allium ursinum* also occur and the moss *Ctenidium molluscum* was recorded, on the bank beside the springhead.

Although humidity is high, probably associated with the wide extent of flushing at the middle of the site, the heavy shading by the Beech canopy and lack of saplings have restricted development of epiphytic bryophytes. However, a small number of species were recorded (mostly from semi-mature Ash trunks) including *Hypnum cupressiforme, Metzgeria furcata, Orthotrichum affine, Rhynchostegium confertum* and *Ulota bruchii*.

The H7220 feature, area of flushing with tufa and frequent patches of *Palustriella commutata*, covers most of the site, from just below the springhead (SO90441277) to just above the culvert and associated track before joining the main valley stream (SO90511282). The site is measures about 70 m from top to base and covers an area about 0.3 ha.

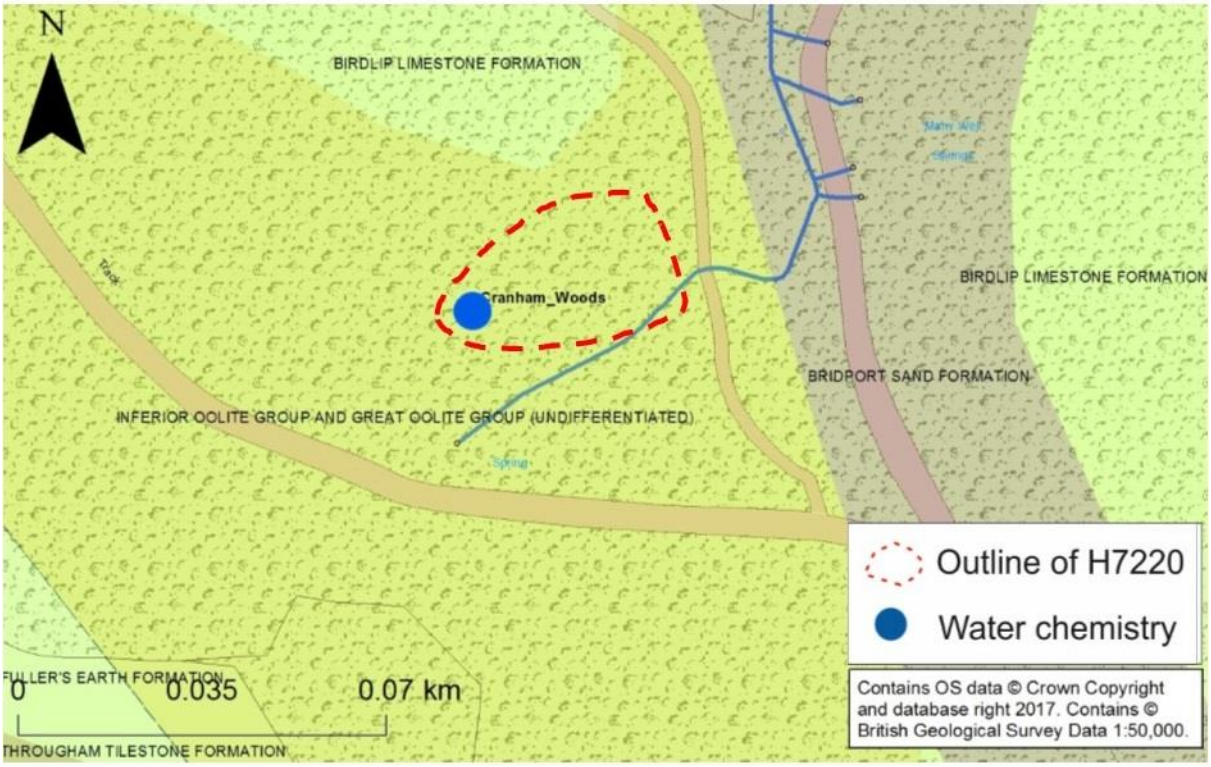



**Figure 3-19 Cranham Wood Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-20 Base of site looking up slope towards the tufa dome, marked out by high frequency of Hart's-tongue Fern**

**Figure 3-21 One of several springheads with good flow at the time of survey, leaf litter particularly Beech is abundant**

**Figure 3-22 Tufa block with abundant *Palustriella commutata*, *Eucladium verticillatum* with Hart's-tongue Fern – middle part of site**

**Figure 3-23 Lower part of site with frequent cushions of *Palustriella commutata*, Harts'-tongue Fern and abundant leaf litter, dead wood (Beech).**

## 3.6 DOWDESWELL

This site comprises a 0.6 km stream which rises from a springhead (SO99172057) close to the Cotswold Way footpath and discharges into the River Chelt at Scobb Grove, (SO99682014) to the east (Figure 3-24). Much of the stream channel is steep and descends through an area of ancient woodland that has been extensively planted with conifers. The site is underlain by the Jurassic Whitby Mudstone Formation, however the spring feeding the site issues from close to the contact with the overlying Jurassic Inferior Oolite Group.

The springhead (Figure 3-25) is rocky with much evidence of tufa and is heavily shaded by an adjoining Western Red Cedar plantation. Vegetation at the springhead is sparse with only localised Pendulous Sedge *Carex pendula* and the shade tolerant liverwort *Pellia endiviifolia.* The minute moss *Fissidens pusillus* is locally frequent on tufa-encrusted stones in the channel.

A short distance below the springhead, the canopy opens out and cushions of the moss *Palustriella commutata* appear on stones (actively associated with tufa formation) and Pendulous Sedge, Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium,* mosses *Cratoneuron filicinum, Brachythecium rivulare* are associated with the developing shallow channel. The banks and stones (raised above the water level) support Hart's-tongue Fern *Asplenium scolopendrium* and mosses *Thamnobryum alopecurum, Plagiomnium rostratum, Fissidens taxifolius*.

Towards the central part of the site, the gradient is less steep and the stream divides into several channels where there is a complex array of tufa dams, frequent cushions of the moss *Palustriella commutata,* mixed stands of the liverworts *Pellia endiviifolia, Conocephalum conicum* and Pendulous Sedge. All three of these bryophytes appear to be actively associated with tufa formation and a particularly large block of tufa was noted (Figure 3-26). An open area (SO99302035) is of interest in

supporting a number of additional wetland species including Wild Angelica *sylvestris*, Cuckoo Flower *Cardamine pratense*, Greater Horse-tail *Equisetum telmateia*, Hemp-agrimony *Eupatorium cannabinum* and the moss *Calliergonella cuspidata.*

Where the stream passes through planted conifers, including Douglas Fir, Norway Spruce and Western Red Cedar, the ground flora tends to be heavily shaded (Figure 3-27). In these situations, tufa dams are present but with almost a complete absence of vegetation except for occasional marginal patches of Pendulous Sedge where some light manages reach the ground (Figure 3-28). However, sections of the stream that pass through native broadleaved woodland (with Field Maple, Hazel, Hawthorn, Beech, Ash, Holly, Pedunculate Oak, Goat Willow and Elder), have a moderately rich ground flora. A broad range of species are present including; Bugle *Ajuga reptans*, Lords-and-ladies *Arum maculatum*, False Brome *Brachypodium sylvaticum*, Remote Sedge *Carex remota*, Wood Sedge *Carex sylvatica*, Wild Clematis *Clematis vitalba*, Tufted Hair-grass *Deschampsia cespitosa*, Broad Buckler-fern *Dryopteris dilatata*, Male Fern *Dryopteris filix-mas*, Lesser Celandine *Ficaria verna*, Herb Robert *Geranium robertianum*, Herb Bennet *Geum urbanum*, Ground Ivy *Glechoma hederacea*, Ivy *Hedera helix ssp. helix*, Rough-leaved Meadow-grass *Poa trivialis*, Soft Shield-fern *Polystichum setiferum*, Bramble *Rubus fruticosus agg.*, Red Campion *Silene dioica*, Greater Stitchwort *Stellaria holostea* and the common bryophytes *Eurhynchium striatum, Lophocolea bidentata, Thuidium tamariscinum, Cirriphyllum piliferum* and *Amblystegium serpens var. serpens.* Locally towards the lower part of the stream, a number of ancient woodland indicators occur including Sweet Wood-ruff *Galium odoratum*, Yellow Archangel *Lamiastrum galeobdolon*, Dog's Mercury *Mercurialis perennis*, Wild garlic *Allium ursinum* and Wood Sorrell *Oxalis acetosella.*

Towards the lower part of the site (close to its junction with the River Chelt), the stream has cut out a deeper channel below a small waterfall (tufa cascade) at SO99502026 (Figure 3-29) with much deposited leaf litter and clay-rich sediment. Some of this deposited material is likely to have come from a small and eroded side stream just above this waterfall. The humid and steep sided banks of this section (Figure 3-30) are dominated by ferns and a number of bryophytes often characteristic of clay-rich banks including *Atrichum undulatum, Fissidens taxifolius, Oxyrrhynchium hians, Plagiochila asplenioides* and very locally *Fissidens bryoides* and *Calypogeia fissa*. Due to the increased water flow in this section, cushions of the moss *Palustriella commutata* (and associated tufa) become scarcer and are replaced by the characteristic stream and river moss *Platyhypnidium riparioides*. In close proximity to the River Chelt, occasional plants of Water Figwort *Scrophularia auriculata* and Small Teasel *Dipsacus pilosus* (a local Gloucestershire species and ancient woodland indicator) occur.

The humid conditions provided by both the woodland canopy and stream have allowed good growth of epiphytic bryophytes. Tree bases and roots of larger trees (Oak, Ash and Beech) support the common mosses *Kindbergia praelonga, Brachythecium rutabulum, Rhynchostegium confertum, Hypnum cupressiforme* and very *locally Neckera complanata Plagiochila porelloides.* Twigs and branches of smaller trees (particularly where well illuminated) support a large number of additional species including *Cryphaea heteromalla, Frullania dilatata, Metzgeria furcata, Metzgeria violacea, Orthotrichum affine, Orthotrichum lyellii, Orthotrichum pulchellum, Radula complanata, Ulota bruchii, Urtica dioica* and *Zygodon viridissimus*. The common lichen *Evernia prunastri* is also a frequent associate.

Rotting logs and tree stumps support Male and Broad Buckler ferns, the mosses *Mnium hornum, Rhizomnium punctatum* and locally the moss *Plagiothecium succulentum.*

The H7220 feature (area of flushing with tufa and frequent patches of *Palustriella commutata*) covers a large part of the site, at least 600 m in length and an estimated 0.12 ha covering an area from just below the springhead (SO99172054) to just below the small waterfall (SO99522025) (Figure 3-24).

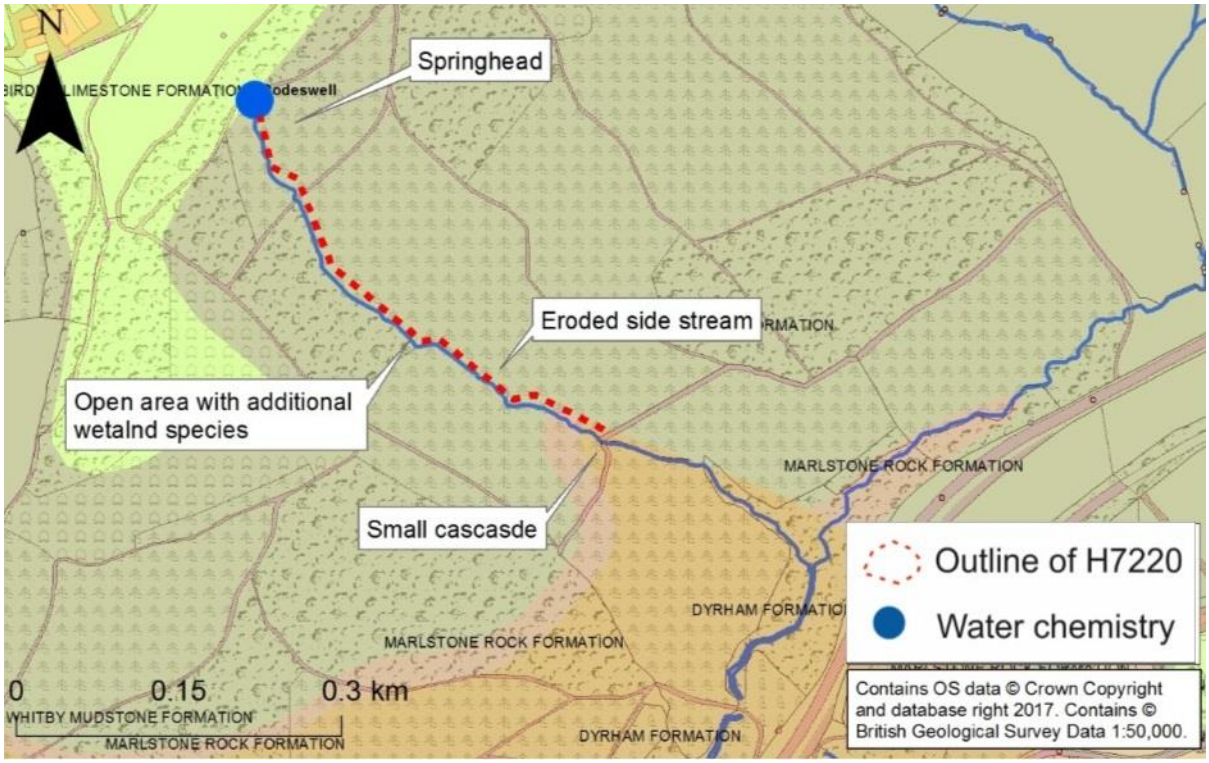



**Figure 3-24 Dowdeswell Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-25 Main springhead with *Pellia endiviifolia*, marginal Pendulous Sedge, leaf litter and fallen twigs (conifers), tufa covered stones**

**Figure 3-26 Large tufa block (covered with actively tufa forming bryophytes *Pellia endiviifolia*, *Conocephalum conicum*), upper area of main spring channels dominated by Pendulous Sedge**

**Figure 3-27 Heavily shaded upper section of main channel (Douglas Fir Plantation) with tufa dams but virtually no vegetation except for localised marginal stands of Pendulous Sedge where some light reaches the ground**

**Figure 3-28 Open central section of main channel with a complex array of tufa dams, frequent clumps of *Palustriella commutata* on stones and actively forming tufa, Pendulous Sedge**

**Figure 3-29 Tufa cascade (SO99502026) with Pendulous Sedge and broad marginal stands of *Palustriella commutata***

**Figure 3-30 Steep sided river banks (River Chelt) with abundant leaf litter and ferns (particularly Soft Shield-fern)**

## 3.7 KINGSCOTE & HORSLEY WOODS (SITES 1-4)

Kingscote and Horsley Woods (ST830971) (Figure 3-31) are adjoining ancient Ash and Beech woodlands that have been modified, in a few places, by the planting of conifers. Both woodlands are notified as Kingscote and Horsley Woods Site of Special Scientific Interest (SSSI) and Kingscote Wood is designated as a National Nature Reserve (NNR). The main geological formations include the Jurassic Fullers Earth Formation, Great Oolite Group and Inferior Oolite Group.

A series of springs arise from an area of open farmland around Binley Farm cottages (ST81379709) and form a stream that descends a small valley through Kingscote Wood. A series of side springs join the main developing valley stream, the most significant of which are a spring at ST82639712, series of springs within Nurbridge Wood (ST83089677), a spring at ST83499759 and distant springs in the area close to Sealey Wood (ST82139789) that connect to Horsley Wood. The combination of these inflows create a valley stream (with a deeply cut channel below) which continues eastwards through the woodland, passing the village of Horsley and joining the Nailsworth Stream at ST85029980.

**Site 1** (ST83399761 to ST83589757) comprises a small stream formed from a springhead, within open pasture above Horsley Wood. This spring water descends a steep slope through the woodland to join the main stream in the valley bottom. The stream passes through two culverts associated with tracks.

The springhead had a good flow at the time of the survey with stands of Fool's *Watercress Apium nodiflorum* (within channel) and marginal emergent wetland vegetation with Hard Rush *Juncus inflexus*, Marsh Thistle *Cirsium palustre*, Marsh Ragwort *Senecio aquaticus*, Clustered Dock *Rumex conglomeratus*, Tufted hair-*grass Deschampsia cespitosa*, Brooklime *Veronica beccabunga*, a Willowherb *Epilobium sp.,* Rough-leaved Meadow-grass *Poa trivialis*, Creeping Buttercup *Ranunculus repens*, Floating Sweet-grass *Glyceria fluitans* and the bryophytes *Pellia endiviifolia,*

*Brachythecium rivulare, Cratoneuron filicinum, Calliergonella cuspidata* (Figure 3-32). The raised margins of the channel (including ant hills) locally support a few species characteristic of unimproved grassland such as Germander Speedwell *Veronica chamaedrys*, Self-heal *Prunella vulgaris* and the moss *Pseudoscleropodium purum*.

The developing stream and seepages pass briefly through a very small area of tufa dams, shaded by Hawthorn, Ivy and Bramble scrub, before crossing a stock fence and steep bank of track to continue into the woodland. Immediately below the stock fence, adjoining a track at the upper edge of the woodland, a large tufa block has developed on the steep northern bank of the track with stands of the moss *Palustriella commutata* (actively associated with tufa formation) and occasional cushions of *Eucladium verticillatum* (Figure 3-33). The tiny moss *Fissidens pusillus* was also recorded on tufa-encrusted stones below. The area of the track is muddy and slightly eroded as a result of the stream and flushes above regularly washing over its surface.

The section of stream, below the track, is moderately shaded by the woodland canopy but supports marginal stands of Pendulous Sedge *Carex pendula*, Hart's-tongue Fern *Asplenium scolopendrium,* Wavy Bitter-cress *Cardamine flexuosa,* Male Fern *Dryopteris filix-mas* and the moss *Thamnobryum alopecurum*. Cushions of *Palustriella commutata* continue to be present at the margins of the channel (very locally) associated with tufa-encrusted tree roots, stones and occasionally fallen dead wood.

The stream passes through a second culvert, associated with the lower track, and connects through densely shaded woodland to the main stream in the valley bottom (Figure 3-34). The raised banks of the main channel and surrounding woodland are dominated by Bramble, fallen dead and leaf litter (mainly Beech) but do locally support a small number of woodland species including: False Brome *Brachypodium sylvaticum*, Herb Robert *Geranium robertianum*, Herb Bennet *Geum urbanum*, seedling Holly, seedling Sycamore, Hedge Woundwort *Stachys sylvatica*, Sweet Violet *Viola odorata* and the common bryophytes *Amblystegium serpens var. serpens, Brachythecium rutabulum, Ctenidium molluscum, Fissidens taxifolius, Kindbergia praelonga, Plagiomnium undulatum* and *Rhynchostegium confertum.*

Due to heavy shading by the canopy and the relatively few trees close to the stream channel, only a few epiphytic bryophytes are recorded from this site (all on a semi-mature Ash), and include *Anomodon viticulosus, Hypnum cupressiforme, Lophocolea heterophylla, Neckera complanata, Orthotrichum affine.* This site has a number of artificial log dams as part of enhancement works (Figure 3-35).

The H7220 feature at Site 1 (area of flushing with tufa and frequent patches of *Palustriella commutata*) is limited (40 m, 0.008 ha) occurring from the N bank of the first track (ST83509759) to shortly below the culvert and second track (ST83549758).

**Site 2** (ST82929702) comprises an upper section of the main valley stream (below the area of springs near Binley Farm cottages) close to where it enters the south edge of Kingscote Wood (Nurbridge Wood). At the edge of the woodland, the stream widens briefly into an open depression with marginal Crack Willow trees. This rounded and flush area (with deposited silt and loose tufa fragments) may relate to a 19th century dammed water holding structure (Figure 3-36). In this area, occasional patches of Fool's Water-cress *Apium nodiflorum* occur in the channel with occasional marginal stands of Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium*, Pendulous Sedge *Carex pendula*, Hart's-tongue Fern *Asplenium scolopendrium* and the bryophytes *Pellia endiviifolia, Brachythecium rivulare.*

The outfall of this flushed area continues down a gentle slope into dense Oak, Ash, Beech and Hazel woodland and the shaded stream channel supports only small marginal stands of Pendulous Sedge, Hart's-tongue Fern, Broad Buckler-fern *Dryopteris dilatata*, Male Fern *Dryopteris filix-mas* and the common bryophytes *Oxyrrhynchium hians* and *Plagiomnium undulatum* (Figure 1.6). The raised banks of this channel and surrounding woodland are dominated by Bramble, fallen dead and leaf litter (mainly Beech) but do locally support a small number of woodland species including Cow Parsley *Anthriscus sylvestris*, Herb Robert *Geranium robertianum,* Herb Bennet *Geum urbanum*, Ivy *Hedera helix ssp. helix*, Rough-leaved Meadow-grass *Poa trivialis* and bryophytes *Amblystegium serpens var.*

*serpens, Brachythecium rutabulum* and *Eurhynchium striatum.* The ancient woodland indicator Yellow Archangel *Lamiastrum galeobdolon* was seen in one place.

Due to heavy shading by the canopy and the relatively few trees close to the stream channel, only a few epiphytic bryophytes were recorded from this site. The mosses *Hypnum cupressiforme, Rhynchostegium confertum* were recoded from the trunks of semi-mature Oak and Beech while the upper branches and twigs of Hazel locally support *Frullania dilatata, Orthotrichum affine* and *Ulota bruchii.*

There is no H7220 feature at Site 2 although there is extensive tufa formation on stones within the channel.

**Site 3** (ST8275397126) comprises a small area of seepages within a dense area of Beech woodland, where a springhead arises from a collapsed historic brick and concrete water collecting tank (Figure 3-38). Spring water still flows from the well and for a distance of about 10 m down slope before dissipating (Figure 3-39) forming a series of small tufa dams with dominant stands of the moss *Palustriella commutata* (actively associated with tufa formation). Hart's-tongue Fern *Asplenium scolopendrium* and the liverwort *Pellia endiviifolia* are also prominent. Other species occur at low cover including Soft Shield-fern *Polystichum setiferum* and the bryophytes *Brachythecium rivulare, Conocephalum conicum, Cratoneuron filicinum, Didymodon sinuosus, Eucladium verticillatum, Fissidens taxifolius, Homalothecium sericeum* (concrete at springhead), *Lophocolea bidentata, Thamnobryum alopecurum.* A single patch of the robust liverwort *Plagiochila asplenioides* was noted.

The raised banks beside the flush and surrounding woodland are heavily shaded by the dense canopy and are covered with a deep leaf litter (Beech Leaves). The ground flora is consequently poorly developed and comprises only seedling Holly *Ilex aquifolium* and a small number of mainly shade tolerant mosses such as *Amblystegium serpens var. serpens, Brachythecium rutabulum, Kindbergia praelonga.*

The H7220 feature at Site 3 (area of flushing with tufa and frequent patches of *Palustriella commutata*) covers all of this small site (4 m, 0.0004 ha) (ST8275397126).

**Site 4** (ST82639711 to ST82679729) comprises an open springhead (in pasture above the south margin of Kingscote wood) that forms a wide area of seepages in the woodland below. These seepages gather, pass through a culvert associated with track and a single channel then joins the main stream in the valley bottom.

The springhead arises from the break of slope in tussocky grassland with Tufted Hair-grass *Deschampsia cespitosa* and Hard Rush *Juncus inflexus*. There is a small pool dominated by Fool's Water-cress *Apium nodiflorum* (Figure 3-40).

Below the spring (and associated pool), a stream and seepages pass through a stock fence and descend down the slope into Kingscote Wood. This upper section of the woodland is open and scrubby with Wild Clematis, Hazel, Elder and there are wide areas of muddy seepages beneath with the bryophytes *Brachythecium rivulare, Pellia endiviifolia* and *Cratoneuron filicinum* on stones and tree roots (Figure 1.10). Further down the slope, two rocky streams develop and form a wide fan-shaped area of flushing with a complex array of tufa dams, pools and dominant stands of the moss *Palustriella commutata* (actively associated with tufa formation) (Figure 3-41). Other species present include Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium*, Pendulous Sedge *Carex pendula*, Wild Angelica *Angelica sylvestris*, Hart's-tongue Fern *Asplenium scolopendrium*, Wavy Bitter-cress *Cardamine flexuosa*, Creeping Buttercup *Ranunculus repens*, Clustered Dock *Rumex conglomeratus* and the large liverwort *Conocephalum conicum*. Greater Horse-tail *Equisetum telmateia* occurs very locally.

Raised banks beside the main channels and the surrounding areas support Beech, Ash and Hazel woodland and have a characteristic ground flora with Lords-and-Ladies *Arum maculatum*, Remote Sedge *Carex remota*, False Brome *Brachypodium sylvaticum*, Male Fern *Dryopteris filix-mas*, Herb Bennet *Geum urbanum*, ground Ivy *Glechoma hederacea*, Ivy *Hedera helix ssp. helix*, Bramble, Red

Campion *Silene dioica*, Nettle *Urtica dioica* and bryophytes *Thamnobryum alopecurum, Plagiomnium undulatum, Kindbergia praelonga, Amblystegium serpens var. serpens, Oxyrrhynchium hians* and *Ctenidium molluscum*. The ancient woodland indicators Wild Garlic *Allium ursinum*, Yellow Archangel *Lamiastrum galeobdolon* and Dog's Mercury *Mercurialis perennis* occur locally.

The high humidity associated with the wide area of flushing, open canopy (particularly in the upper part of the site) and frequency of young trees close to the stream channels has allowed good development of epiphytic bryophytes. The mosses *Hypnum cupressiforme, Homalothecium sericeum, Brachythecium rutabulum* were recoded from the trunks of semi-mature Ash and Beech while the upper branches and twigs of Ash, Hazel, Elder support *Frullania dilatata, Orthotrichum affine, Cryphaea heteromalla, Radula complanata* and *Zygodon viridissimus*. In addition, the Jelly Ear fungus *Auricularia auricula-judae* was recorded from Elder.

The two streams converge and pass through a culvert and associated track (Figure 3-42) and a single channel (Figure 3-43) then continues for a short distance connecting to the main valley stream at the bottom of the wood. Where the streams converge and enter the culvert a small series of water falls have stands of the moss *Platyhypnidium riparioides* on rocks and a shaded dripping rock face has cushions of the moss *Eucladium verticillatum*. The minute aquatic moss *Fissidens pusillus* was also present (in many places) on tufa-encrusted stones within the channel.

Small Teasel *Dipsacus pilosus* (an uncommon Gloucestershire plant and ancient woodland indicator) was recorded from beside the main channel in open woodland in the lower part of the site (below the culvert and associated track).

The H7220 feature at Site 4 (area of flushing with tufa and frequent patches of *Palustriella commutata*) covers the entire site estimated to be about 130 m from spring head to river covering an area of approximately 0.01 ha (ST82629711 to ST82679729).

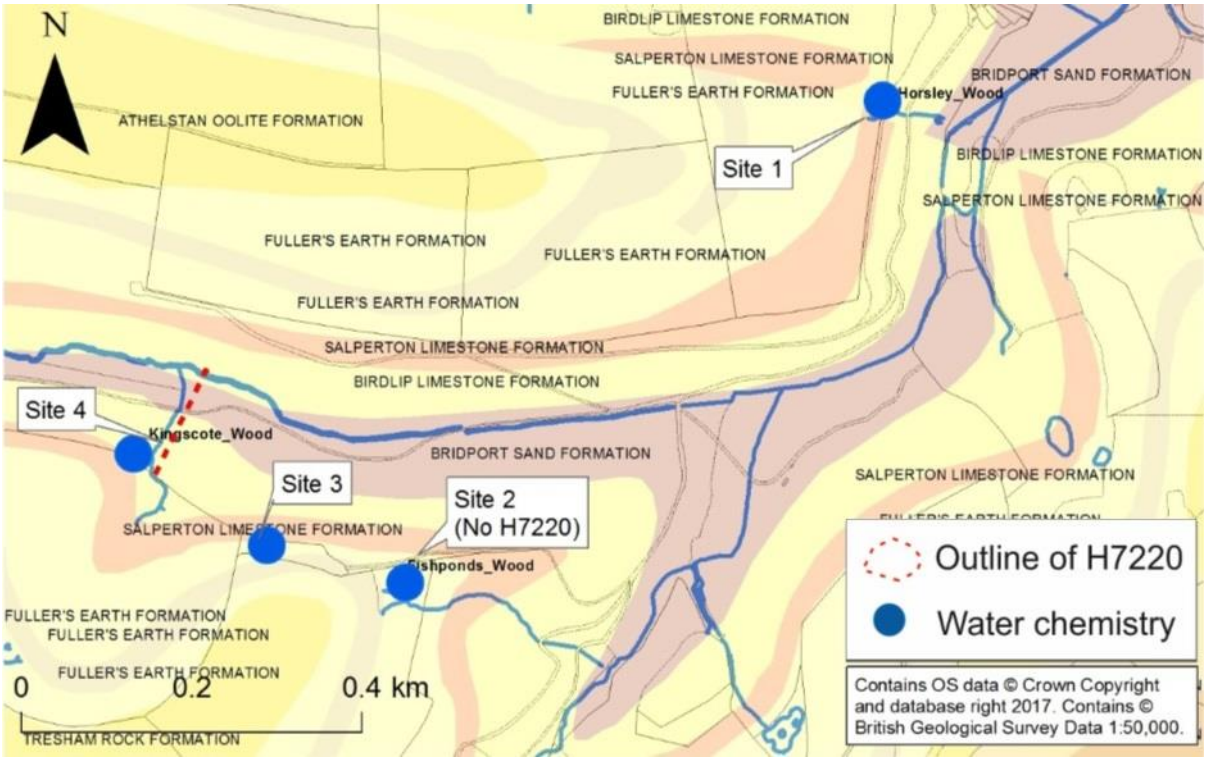



**Figure 3-31 Kingscote and Horsey Woods Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-32 Site 1 - Main springhead (ST83399761) in open pasture above woodland**

**Figure 3-33 Site 1 – Tufa block below stock fence with frequent *Palustriella commutata* (bank of track at upper edge of woodland)**

**Figure 3-34 Site 1 – Stream in more open section of woodland (above culvert and associated second track). The artificial log dam is part of enhancement works and provides a safe cover over the culvert**

**Figure 3-35 Site 1 – Heavily shaded section of stream with abundant dead wood (below culvert and associated second track) showing occasional marginal stands of Pendulous Sedge, Hart's-tongue Fern**

**Figure 3-36Site 2 – Stream at south-western margin of Kingscote Wood (Nurbridge Wood) with wide area of seepages that may relate to a 19th century dammed water holding area.**

**Figure 3-37 Site 2- Lower part of rocky stream (with frequent tufa-covered stones on bed) and marginal stands of pendulous sedge, Hart's-tongue and Male Fern**

**Figure 3-38 Site 3 – Springhead with collapsed historic brick and concrete water collecting tank**

**Figure 3-39 Site 3 – Rocky seepages with tufa (below collapsed historic brick and concrete water collecting tank) with abundant *Palustriella commutata* (on rocks) and Hart's-tongue Fern.**

**Figure 3-40 Site 4 – Upper part of site with muddy seepages and tufa, hanging stems of Wild Clematis, Hart's-tongue Fern, Pendulous Sedge (just below stock fence)**

**Figure 3-41 Site 4 – Main area of flushes with two small streams and frequent tufa dams with *Palustriella commutata*, marginal stands of Pendulous Sedge and Hart's-tongue Fern (above culvert and associated track)**

**Figure 3-42 Site 4 – New culvert and associated track looking north (left) and section of old culvert blocked with tufa**

**Figure 3-43 Site 4 – Lower part of channel (below culvert and close to outfall to main valley stream) with tufa dams, *Palustriella commutata*, marginal stands of Pendulous Sedge and Hart's-tongue Fern**

## 3.8 MICHINAMPTON STREAM

Minchinhampton stream site comprises a number of springheads in both open and wooded areas, below Derhams House (SO86850040) (Figure 3-44) which connect to a large artificially created pond (SO87020015). The outfall of this pond forms a stream which cuts down through a steep wooded valley immediately south of Minchinhampton (for 200 m) connecting to the brook (ST87109986) further down the valley which follows the north margin of Gatcoombe Wood.

Open springheads (such as the one at SO86950035) (Figure 3-45) occur in pasture and are dominated by Water-cress *Nasturtium officinale sensu. lato*., Fools Water-cress *Apium nodiflorum* with occasional Clustered Dock *Rumex conglomeratus*, a Willowherb *Epilobium sp*., Tufted Hair-grass *Deschampsia cespitosa*, Creeping Buttercup *Ranunculus repens*, Water Figwort *Scrophularia auriculata*, Teasel *Dipsacus fullonum*, Brooklime *Veronica beccabunga* and the bryophytes *Cratoneuron filicinum, Brachythecium rivulare.*

A spring (SO86920009) and large section of the main stream, below an artificial pond (SO87020015) lie within open woodland dominated by Ash and Field Maple with Wild Clematis, Hazel, Holly, Hawthorn, Ivy and Bramble. The running water channels are rocky, with tufa formation, and support Pendulous Sedge *Carex pendula*, Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium*, Hart's-tongue Fern *Asplenium scolopendrium*, Wavy Bitter-cress *Cardamine flexuosa,* Lesser Celandine *Ficaria verna* and bryophytes *Cratoneuron filicinum, Brachythecium rivulare, Conocephalum conicum, Pellia endiviifolia*. A small area of the main stream with waterfalls and small boulders has large stands of the moss *Thamnobryum alopecurum* and fruiting stands of the moss *Plagiomnium rostratum* (Figure 3-46). Locally the ancient woodland indicators Wild Garlic *Allium ursinum* and Dog's Mercury *Mercurialis perennis* are present.

On raised banks or boulders (adjoining the water channels) and in the surrounding woodland, a large number of characteristic open Ash woodland species are also present including Herb Robert *Geranium robertianum*, Herb Bennet *Geum urbanum*, Male Fern *Dryopteris filix-mas*, Nettle *Urtica dioica*, Dandelion *Taraxacum sp*. and bryophytes *Cirriphyllum piliferum, Fissidens taxifolius, Plagiomnium undulatum, Lophocolea bidentata*. The moss *Mnium hornum* occurs locally on rotting logs and the roots of larger trees and Greater Horsetail *Equisetum telmateia* occurs in one place (spring line at SO86950013).

The lower section of the main stream is full of small stones (many with tufa) as well as loose tufa (figure 1.5). In this area, the increased water flows support occasional stands of the robust moss *Platyhypnidium riparioides* (on larger stones) and the small aquatic mosses *Fissidens crassipes, Fissidens rufulus* occur on shaded tufa-encrusted stones within the channel. This section of the channel is more deeply cut and has banks (formed of deposited clay-rich washings and leaf litter) which support stands of the bryophytes *Oxyrrhynchium hians, Fissidens viridulus, Lunularia cruciata*.

The area of flushes and small waterfalls (lower wooded part of main stream) is particularly humid and has prominent epiphytic bryophytes (Figure 3-48). The bases and roots of larger trees (mainly Ash) support the common mosses *Kindbergia praelonga, Brachythecium rutabulum*, Amblystegium serpens var. serpens, *Hypnum cupressiforme, Zygodon viridissimus, Homalothecium sericeum, Rhynchostegium confertum* while the upper trunks and twigs of smaller trees (Hawthorn, Elder, Field Maple) have *Cryphaea heteromalla, Frullania dilatata, Metzgeria furcata, Metzgeria violacea, Microlejeunea ulicina, Orthotrichum affine, Orthotrichum lyellii, Radula complanata* and *Ulota bruchii*.

The sides of a small channel from a single springhead SO87020036 (within pasture) has been reinforced with concrete and the non-native Wilson's Honeysuckle *Lonicera nitida* has been planted locally at the margins of the wooded area of the stream.

There is no H7220 feature at this site. There is extensive tufa formation on stones within the channel however the moss *Palustriella commutata* was not recorded.

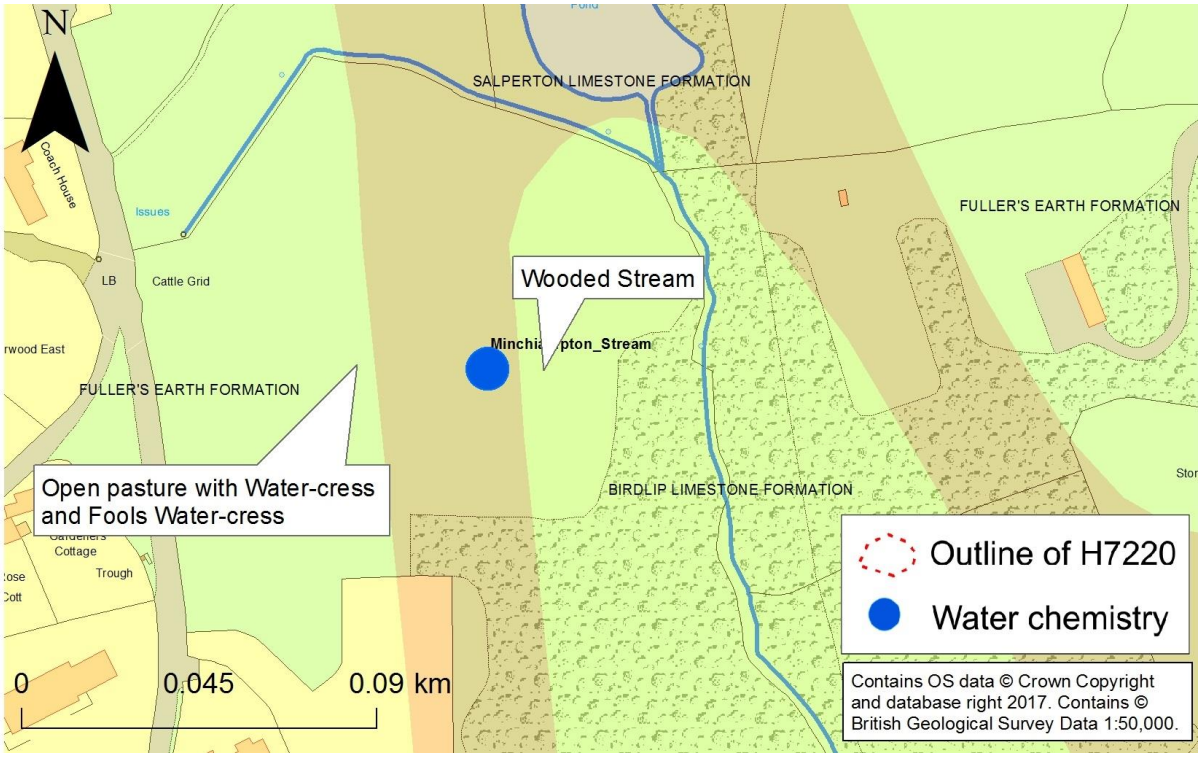



**Figure 3-44 Minchinhampton Stream Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-45 Open side spring within pasture with frequent Water-cress and Fool's Water-cress**

**Figure 3-46 Wooded stream (with small falls and tufa) below artificial pond with frequent Ivy and Hart's-tongue Fern. Small side stream (rocky runnel) discharging (left)**

**Figure 3-47 Pipe draining surface runoff from tennis court discharging to main stream (wooded stream below artificial pond)**

**Figure 3-48 Hawthorn adjoining main stream in lower wooded section showing the abundance of epiphytic bryophytes**

**Figure 3-49 Lower rocky section of main stream with frequent tufa**

## 3.9 MIDGER WOOD (SITES 1 & 2)

Midger Wood (ST79918953) is an ancient woodland dominated by Ash and Beech with Hazel, Hawthorn, Holly, Pedunculate Oak and Crab Apple within a steep sided stream valley. It is notified as a Site of Special Scientific Interest (SSSI). A series of springs arise from the break of slope, near the junction of the Great Oolite Group and the underlying Fullers Earth Formation, within the wooded "Saddlewood Roughs" area (ST79898985) and form a stream running south-west where it joins (via a series of old mill ponds) a lager stream running through the Lower Kilcott valley. The stream within Midger Wood has a number of spring fed side springs including a significant spring flow from the area named as "White Well" (Figure 3-50).

**Site 1** (ST80058961 - ST80078954) comprises a small side stream in open woodland with two small springheads. The springheads associated with this side stream (Figure 3-51) are rocky with frequent marginal stands of Hart's-tongue Fern *Asplenium scolopendrium* and the moss *Thamnobryum alopecurum*. Within the channel are the bryophytes *Cratoneuron filicinum, Brachythecium rivulare, Pellia endiviifolia* and locally on shaded stones the mosses *Eucladium verticillatum, Didymodon tophaceus, Rhynchostegiella teneriffae*. Several metres below the springheads, cushions of the moss *Palustriella commutata* appear on stones in conjunction with actively forming tufa, and occasionally on tree roots. From this point and below other associated species occur at low cover including Pendulous Sedge *Carex pendula*, Wavy Bitter-cress *Cardamine flexuosa*, Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium* and the bryophytes *Conocephalum conicum, Plagiomnium rostratum.*

The two springheads converge at centre of the site (Figure 3-52) and there are a series of rocky falls (with frequent *Palustriella commutata*) below which the dams and pools widen out into a fan shape (Figure 3-53) before joining with the main valley stream. In this area, the robust moss *Platyhypnidium ripariodes* occurs in small quantity associated with the increased flow and the deeper cut banks of the stream (with washed soil and leaf litter) and the surrounding woodland supports a characteristic Ash woodland ground flora with False Brome *Brachypodium sylvaticum*, Tufted Hair-grass *Deschampsia cespitosa*, Broad Buckler-fern *Dryopteris dilatata*, Male fern *Dryopteris filix-mas*, Lesser Celandine *Ficaria verna*, Herb Robert *Geranium robertianum*, Ivy *Hedera helix ssp. helix*, Bramble and bryophytes *Eurhynchium striatum, Fissidens taxifolius, Lophocolea bidentate, Plagiochila asplenioides, Plagiomnium undulatum, Thuidium tamariscinum.* The ancient woodland indicators Wild Garlic *Allium ursinum*, Yellow Archangel *Lamiastrum galeobdolon*, Dog's Mercury *Mercurialis perennis*, Primrose *Primula vulgaris*, Bluebell *Hyacinthoides non-scripta* are also present.

Due to the increased humidity in close proximity to the streams, rotting tree stumps and fallen branches support a good number of bryophytes including *Lophocolea heterophylla, Mnium hornum, Rhizomnium punctaum, Orthodontium lineare Nowellia carvifolia* (a species local within Gloucetershire) and Wood Sorrel *Oxalis acetosella* (an ancient woodland indicator) was noted on a fallen rotting tree in one place. Similarly, tree bases and roots of larger trees (mainly Ash) support Common Polypody *Polypodium vulgare*, the common mosses *Kindbergia praelonga, Brachythecium rutabulum, Hypnum cupressiforme, Zygodon viridissimus, Homalothecium sericeum, Isothecium myosuroides, Neckera complanata* and the liverwort *Frullania tamarisci* (a species local within Gloucetershire). The upper trunks and twigs of smaller Ash and Hazel have *Cryphaea heteromalla, Frullania dilatata, Metzgeria furcata, Orthotrichum affine, Radula complanata, Ulota bruchii* and the small liverwort *Lejeunea carvifolia* (a species local within Gloucetershire) was recorded from a Hazel in one place.

The H7220 feature at Site 1 (area of flushing with tufa and frequent patches of *Palustriella commutata*) occurs throughout the site measuring about 60 m from the springheads (ST80058961) to the tufa fan near the main stream (ST80078954) and covering a total area of about 0.08 ha.

**Near the "White Well"** spring (ST80178962), there is a 19th Century stone walled water holding area, which discharges to the main valley stream. A disused Ram pump is located near the outflow from the spring (Figure 3-54 Figure 3-55). Above the water holding area is a small (6x4 m) silted up seepage (ST80188963) frequently labelled on maps as the "White Well spring" that may have formerly been a connecting water channel. Today this area supports mainly wetland species with Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium*, Bugle *Ajuga reptans*, Hart's-tongue Fern *Asplenium scolopendrium*, Pendulous Sedge *Carex pendula*, Greater Horsetail *Equisetum telmateia*, Lesser

Celandine *Ficaria verna*, Creeping Buttercup *Ranunculus repens* and bryophytes *Brachythecium rivulare, Palustriella commutata, Plagiomnium ellipticum, Plagiomnium undulatum.*

**Site 2** (ST79958946 - ST79938949) comprises a wide area of flushing within woodland and adjoining the south-east side of the main valley stream. This broad area of flushing is formed from a series of springheads and discharges to the south-east bank of the river where there are considerable tufa block deposits associated with large stands of bryophytes.

In contrast to site 1, the springheads of site are not particularly rocky and have only a few associated species such as Harts-tongue Fern *Asplenium scolopendrium* and the liverwort *Pellia endiviifolia* (Figure 3-56). The channels immediately below the springheads descend a gentle slope and the slow seepage of water has resulted in a good depth of deposited soil, leaf litter and loose tufa fragments. Where these developing wide muddy channels are in close proximity to living trees, rotting tree stumps and fallen branches, the increased structure of the habitat supports a rich characteristic open wet Ash woodland ground flora with Bugle *Ajuga reptans*, Wild Angelica *Angelica sylvestris*, Wavy Bitter-cress *Cardamine flexuosa*, Pendulous Sedge *Carex pendula*, Remote Sedge *Carex remota*, Tufted Hair-grass *Deschampsia cespitosa*, Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium*, Broad Buckler-fern *Dryopteris dilatata*, Male Fern *Dryopteris filix-mas*, Creeping Buttercup *Ranunculus repens*, Hemp-agrimony *Eupatorium cannabinum*, (a species often associated with ancient woodland) and bryophytes *Brachythecium rivulare, Calliergonella cuspidata, Conocephalum conicum, Cratoneuron filicinum* (Figure 3-57). The ancient woodland indicators Wild Garlic *Allium ursinum* and Yellow Pimpernel *Lysimachia nemorum* occur locally.

Cushions of the moss *Palustriella commutata* (actively associated with tufa formation) are frequent throughout the areas of flushing which are loosely attached to tree bases, fallen logs and occasional surface stones. Occasional cushions of *Eucladium verticillatum* also occur on surface stones.

The less frequently inundated raised banks of channels and the surrounding woodland have Honeysuckle *Lonicera periclymenum*, Wood Sedge *Carex sylvatica*, Herb Robert *Geranium robertianum*, Bramble, Sweet Violet *Viola odorata*, Ivy *Hedera helix ssp. helix* and bryophytes *Cirriphyllum crassinervium, Cirriphyllum piliferum, Eurhynchium striatum, Plagiochila asplenioides, Plagiomnium undulatum, Thamnobryum alopecurum, Thuidium tamariscinum, Oxyrrhynchium hians*. The ancient woodland indicators Dog's Mercury *Mercurialis perennis*, Wood Sanicle *Sanicula europaea*, Sweet Woodruff *Galium odoratum* and Wood Sorrel *Oxalis acetosella* also occur locally.

The wide area of seepages and small channels are particularly humid and where trees, rotting tree stumps and fallen branches occur within the channel, these are very rich in epiphytes (Figure 3-58). Larger living tree bases and support the common mosses *Brachythecium rutabulum*, Amblystegium serpens var. serpens, *Hypnum cupressiforme, Zygodon viridissimus, Homalothecium sericeum, Rhynchostegium confertum* and locally the liverwort *Frullania tamarisci* (a species local within Gloucestershire). The upper trunks and twigs of smaller trees (Hazel and Ash) have *Frullania dilatata, Metzgeria furcata, Metzgeria temporata, Orthotrichum affine, Radula complanata, Ulota bruchii* and the lichen *Pertusaria sp.* Rotting stumps occasionally support the moss *Mnium hornum* and fallen tree trunks (where they cross seepages) are important for stands of Common Polypody *Polypodium vulgare*, the dog lichen *Peltigera sp.* and unusually the moss *Fissidens adianthoides*.

At the lowest part of the site, seepages run over the south-east bank of the main valley stream and have formed considerable vertical tufa block deposits with large stands of the mosses *Palustriella commutata, Fissidens adianthoides* and *Eucladium verticillatum* (Figure 3-58). All three of these mosses appear actively associated with tufa formation.

The adjoining main valley stream is rocky with abundant loose and deposited tufa and the robust moss *Platyhypnidium riparioides* occurs locally on stones associated with the increased flow.

The H7220 feature at Site 2 (area of flushing with tufa and frequent patches of *Palustriella commutata*) occurs throughout the site which measures about 50 m from just below the springheads (ST79938949) to the tufa blocks on the south-east bank of the main valley stream (ST80078954) covering a total area estimated at 0.02 ha.

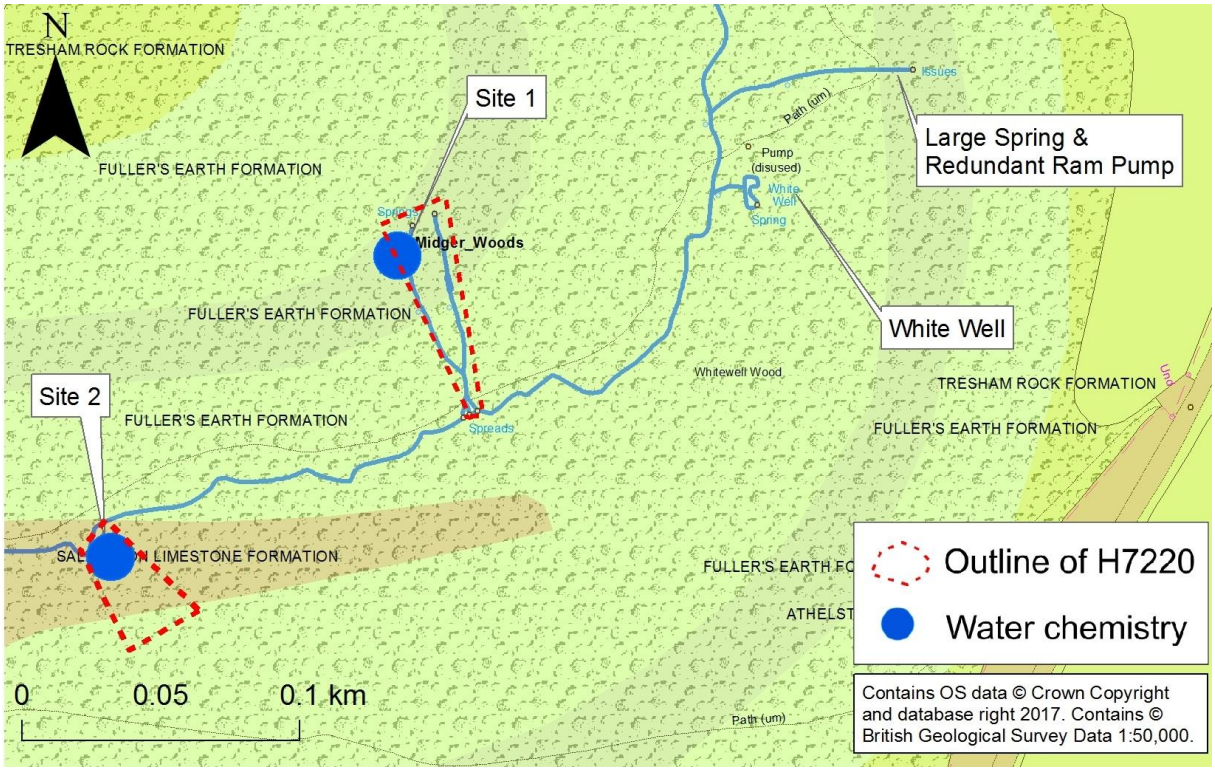



**Figure 3-50 Midger Wood Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-51 Site 1 - Main springhead with Hart's-tongue Fern and prominent *Thamnobryum alopecurum***

**Figure 3-52 Site 1 - Central part of site showing convergence of water discharging from the two separate springheads into a single stream with frequent cushions of *Palustriella commutata* (mainly on stones) and tufa within the channel**

**Figure 3-53 Site 1 - Lower part of stream at the point where it joins the main valley stream with a wide 'fan' of low profile tufa barrages and frequent stands of *Palustriella commutata***

**Figure 3-54 Significant spring in the "White Well" area with abundant Opposite-leaved Golden-saxifrage and Hart's-tongue Fern, Pendulous Sedge (left) and derelict 'ram' pump**

**Figure 3-55 Stone built 19th century water holding area adjoining main valley stream and in close proximity to Ram pump and associated building ("White Well" Springs area).**

**Figure 3-56 Site 2 - One of several springheads feeding a large area of seepages**

**Figure 3-57 Site 2 Central area of site with wide area of flushing. Cushions of *Palustriella commutata* are present within and at the margins of the channel with *Thamnobryum alopecurum* occurring on tree bases and raised areas. The fallen tree is rich in epiphytic bryophytes including *Dicranum scoparium* and unusually *Fissidens adianthoides*.**

**Figure 3-58 Site 2 - Large tufa block on south-east side of main valley river (right) with large stands of *Fissidens adianthoides, Palustriella commutata* and *Eucladium verticillatum***

**Figure 3-59 Site 2 - Close up of outfall (tufa block with prominent mixed stand of *Fissidens adianthoides* and *Palustriella commutata*)**

## 3.10 SEDBURY CLIFF

This site comprises cliffs formed from late Triassic to Early Jurassic strata (ST55579308; Figure 3-60) the low permeability sediments creating ideal conditions for slow diffuse seepage of groundwater from the cliff face. The sea cliffs in this area are covered by dense scrub dominated by Bramble, Ivy with Wild Clematis and very locally the uncommon Gloucestershire plant Wild Madder *Rubia peregrine* (Figure 3-61). Occasional trees are also present including Ash, Hawthorn and the non-native species Buddleja and Holm Oak

Seepages occur intermittently on vertical rock faces. We visited one of these seepages, which occurred across a 10 m section of the cliff face associated with tufa formation. Where these exposed dripping rock faces are heavily shaded by adjoining scrub, the small shade tolerant moss *Eucladium verticillatum* is the dominant (and actively associated with tufa formation)(Figure 3-62). However, where rock faces are more open and receive more light, the other bryophytes *Didymodon tophaceus, Dicranella varia, Barbula convoluta* and *Leicolea turbinata* occur.

Where stronger seepages occur (Figure 3-63), hanging stands of the moss *Palustriella commutata* are present (also actively associated with tufa formation) along with a number of wetland plants such as Pendulous Sedge *Carex pendula*, Hoary Willowherb *Epilobium parviflorum*, Greater Horse-tail *Equisetum telmateia*, Hemp-agrimony *Eupatorium cannabinum* and bryophytes *Brachythecium rivulare, Calliergonella cuspidata, Pellia endiviifolia* and *Cratoneuron filicinum.* Also associated with the wetter seepages are occasional small trees of Grey Willow *Salix cinerea*.

The high cover of scrub and proximity to the estuary provide humid conditions ideal for the growth of epiphytic bryophytes. Tree bases and roots of larger trees (Ash and Hawthorn) support the common mosses *Brachythecium rutabulum, Bryum capillare, Rhynchostegium confertum, Hypnum cupressiforme* and *Amblystegium serpens var. serpens* while twigs and branches of smaller trees (particularly Buddleja) support a large number of additional species including *Frullania dilatata, Metzgeria furcata, Orthotrichum affine* and *Zygodon viridissimus*. Also, the Common Polypody *Polypodium vulgare* was noted as an epiphyte on an Ash trunk.

Lower down the cliff, deeper soil with leaf litter has developed as a result of landslips and washing down of material (including clay). In these areas, a number of other species are present including Harts-tongue Fern *Asplenium scolopendrium* and bryophytes *Fissidens bryoides, Fissidens taxifolius, Lunularia cruciata, Lophocolea bidentata, Oxyrrhynchium hians* and *Barbula unguiculata.* These cliffs are clearly unstable and fallen tufa blocks were noted from several parts of the cliff as well as mixed with pebbles of the beech below.

The accessible H7220 feature at this site (stands of *Palustriella commutata* and tufa) is limited to a small area measuring no more than 1 $m^2$ or 0.0001 ha of the vertical cliff face (ST55579308).

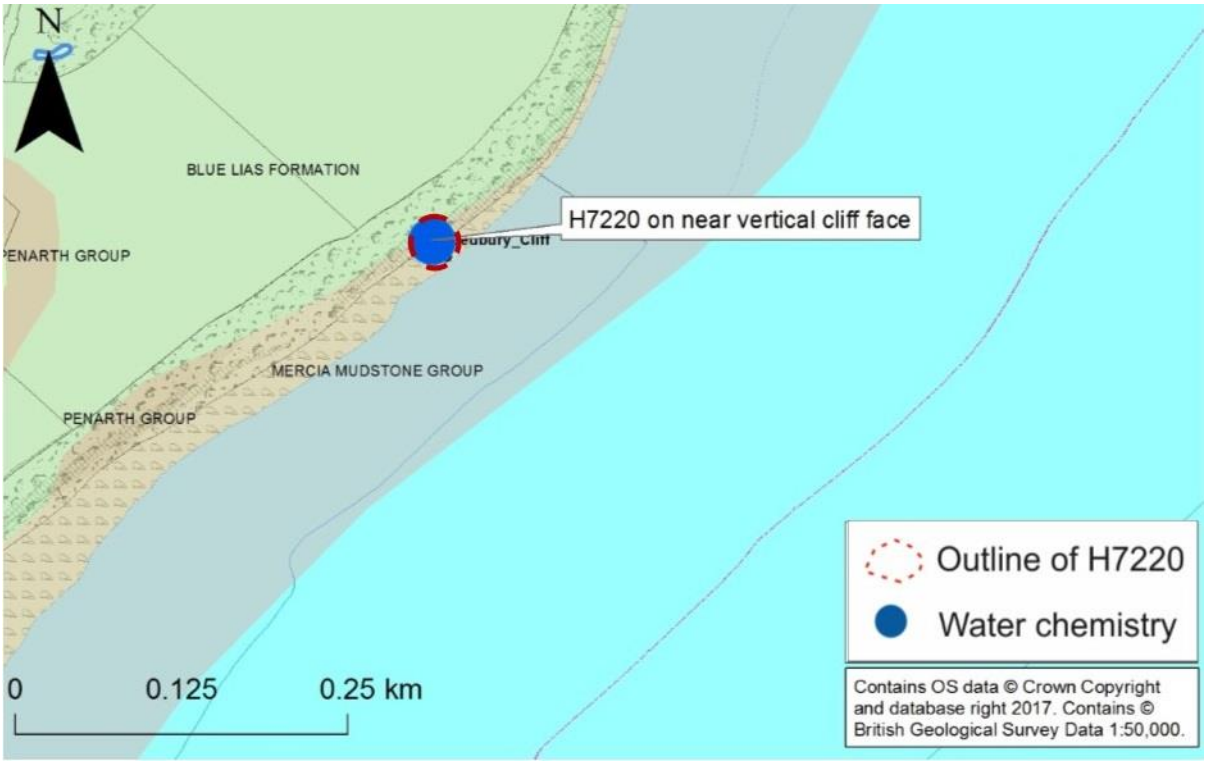



**Figure 3-60 Sedbury Cliff Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-61 Scrub on sea cliffs (dominated by bramble and Ivy) with Ash, Hawthorn, Holm Oak and Buddleja**

**Figure 3-62 Near vertical cliff face seepages with extensive tufa on vertical cliff face dominated by *Eucladium verticillatum* with marginal Bramble, Pendulous Sedge, Hoary Willowherb.**

**Figure 3-63 Semi-shaded and more vegetated vertical cliff face with *Eucladium verticillatum* (actively forming tufa) and Ivy, Pendulous Sedge, Hemp-agrimony**

## 3.11 SLADE BROOK

Slade Brook (SO566054) is a Site of Special Scientific Interest (SSSI) located in the Forest of Dean and is of national important for its active tufa formation. The Slade Brook (Figure 3-64) is located in a small valley or gorge. The Carboniferous Limestone Avon Group forms the higher elevation land in the area however the Salde Brook cuts down into the Devonian Tintern Sandstone formation which can be seen in outcrop in the base of the valley.

The site comprises a 1.4 km section of the Slade Brook which is formed from several springs in the east and flows west to Brook Farm adjoining Stowe Road. Tufa is actively deposited over a 700 m length of stream, with the main sequence of dams, totalling at least 60, being about 300 m in length (Pentacost et al., 2000). The dams range from 1 to 10 m wide and 2 – 46 cm in height and can contain pools that are up to 60 cm depth (Pentacost et al., 2000).

The eastern part of the site (Slade Wood and Slade Bottom) comprises ancient Beach, Ash and Elm woodland with an understory of Hazel, Holly, Elder, Ivy and Bramble. Large areas (away from the stream) have been planted with Douglas Fir which are now semi-mature although a number of larger Ash and Beech are still present adjoining the steam (particularly within steeper sections below where there are shallow gorges).

The main spring (SO56760553: Figure 3-65) emerges from a culvert in Slade Wood and has the moss *Palustriella commutata* growing mostly on the tops of stones within the stream, very occasionally on living tree roots and is associated with active tufa formation. Associated species include Pendulous Sedge *Carex pendula*, Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium*, Hart's-tongue Fern *Asplenium scolopendrium* and the bryophytes *Cratoneuron filicinum*, *Pellia endiviifolia* (both also associated with tufa formation), *Fissidens taxifolius*, *Brachythecium rivulare* and *Conocephalum conicum*. The area of flushing with *Palustriella commutata* continues for a short distance before ending at a small outfall into the main stream.

Just below this small outfall (SO567605516), the flow of the stream increases dramatically due to the input of two vigorous springs, which appear to be issuing directly from the Devoniain Tintern Sandstone (SO56740549). The increased water flow has acted to cut a number of shallow gorges with cascades below (SO56740549) (Figure 3-66). Tufa is frequent within the cascades, on stones and on the river bed along with the robust moss *Platyhypnidium riparioides*. Large shaded stream-side limestone boulders and tree roots support luxuriant stands of bryophytes with *Thamnobryum alopecurum*, *Lophocolea bidentata* and occasional *Plagiochila porelloides* and *Cirriphyllum crassinervium*. Locally, the mosses *Rhynchostegiella teneriffae*, *Plagiomnium rostratum* and *Fissidens rivularis* (a Gloucestershire Red Data Book species) occur on rocks and tufa at the edge of the stream.

Above the shallow gorges of Slade Wood and continuing below (Slade Bottom), shaded lime-rich clay banks support many woodland plants including Lords-and-ladies *Arum maculatum*, Harts-tongue Fern, Wood Sedge *Carex sylvatica*, Broad Buckler-fern *Dryopteris dilatata*, Soft Shield-fern *Polystichum setiferum*, Rough-leaved Meadow-grass *Poa trivialis*, Common Dog-violet *Viola riviniana* and bryophytes *Eurhynchium striatum*, *Oxyrrhynchium hians*, *Plagiochila asplenioides*, *Rhynchostegiella pumila*, *Plagiomnium undulatum.* Occasionally, there are small stands of the moss *Thuidium tamariscinum* and ancient woodland indicators Bluebell *Hyacinthoides non-scripta*, Sweet Wood-ruff *Galium odoratum.* More gently sloping and wetter margins of the stream below additionally support stands of Lesser Celandine *Ficaria verna*, Wavy Bitter-cress *Cardamine flexuosa*, Remote Sedge *Carex remota*, Tufted Hair-grass *Deschampsia cespitosa*, the moss *Cirriphyllum piliferum* and the ancient woodland indicators Wild Garlic *Allium ursinum*, Common Valerian *Valeriana officinalis.* Associated with the increasingly gentle gradient, tufa dams become frequent (SO56730546) (Figure 3-67).

A humid block of limestone with boulders and seepages below (SO56750548) is of interest in having occasional stands of the ancient woodland indicator Hard Fern *Polystichum aculeatum* and the mosses *Tortella tortuosa*, *Mnium marginatum* (an uncommon species within Gloucestershire), *Anomodon viticulosus*.

The area of woodland surrounding the shallow gorges of Slade Wood and continuing below (Slade Bottom) is very humid. Wide orange-coloured tufa dams become prominent (SO56310550) (Figure 3-68) and stream side native broad-leaved trees are rich in epiphytic bryophytes. Tree bases and roots support the common mosses *Kindbergia praelonga*, *Brachythecium rutabulum*, *Rhynchostegium*

*confertum* (although these do occur on boulders as well), *Isothecium myosuroides* and *Hypnum cupressiforme*. The Upper trunks and twigs of smaller Ash, Hazel and Beech have *Orthotrichum affine, Radula complanata, Frullania dilatata, Ulota bruchii* while *Metzgeria furcata, Orthotrichum lyellii* and *Zygodon viridissimus* are more associated with larger Ash trees. The lower trunk of a large beech immediately beside a small cascade (SO56630543) is of note in having the mosses *Homalothecium sericeum, Homalia trichomanoides* and the small liverwort *Lejeunea carvifolia*.

Rotting logs and tree stumps support the bryophytes *Lophocolea heterophylla, Mnium hornum, Nowellia curvifolia, Plagiothecium succulentum, Rhizomnium punctaum* and very locally steep mildly acid clay stream banks support small colonies of the liverwort *Calypogeia arguta*. The flat tops of limestone blocks within the widening river (just upstream of where a side spring joins the brook at SO56700544) have prominent stands of the liverwort *Chiloscyphus polyanthus* (in some cases appearing to be associated with tufa formation) (Figure 3-69) and a non-fruiting bryophyte likely to be the moss *Dichodontium flavescens* occurs on rocks beside the stream nearby.

Below Slade Bottom, the gradient of the stream valley becomes less steep and opens into grass fields. Here, the woodland is confined to the immediate stream sides and becomes increasingly dominated by Alder. At this point, a number of small islands occur as the stream channel splits (SO56100550: Figure 3-70) that are dominated by Tufted Hair-grass *Deschampsia cespitosa* and locally Bracken *Pteridium aquilinum*. Shaded clay banks support the additional species Nipplewort *Lapsana communis* and the mosses *Atrichum undulatum, Polytrichastrum formosum*.

At Brook Farm (SO55550557), a series of overflows divert the stream into two connected ponds and a narrow strip of streamside woodland has a few planted non-native species including Wilson's Honeysuckle *Lonicera nitida* and Western Red Cedar *Thuja plicata* in close proximity to buildings.

A small stone building (SO56710546) may have contained a ram pump or similar part of a localised water supply network. It is not in use and water is issuing from the base of this structure.

The Slade Brook is rightfully well known for its impressive and extensive tufa dams, however the H7220 feature at this site (area of flushing with tufa and frequent patches of *Palustriella commutata*) is relatively small. The H7220 feature occurs along the south margin of the stream between SO56740554 and SO567605516 where it ends at a small outfall into the main stream, a length of approximately 30 metres or 0.01 ha.

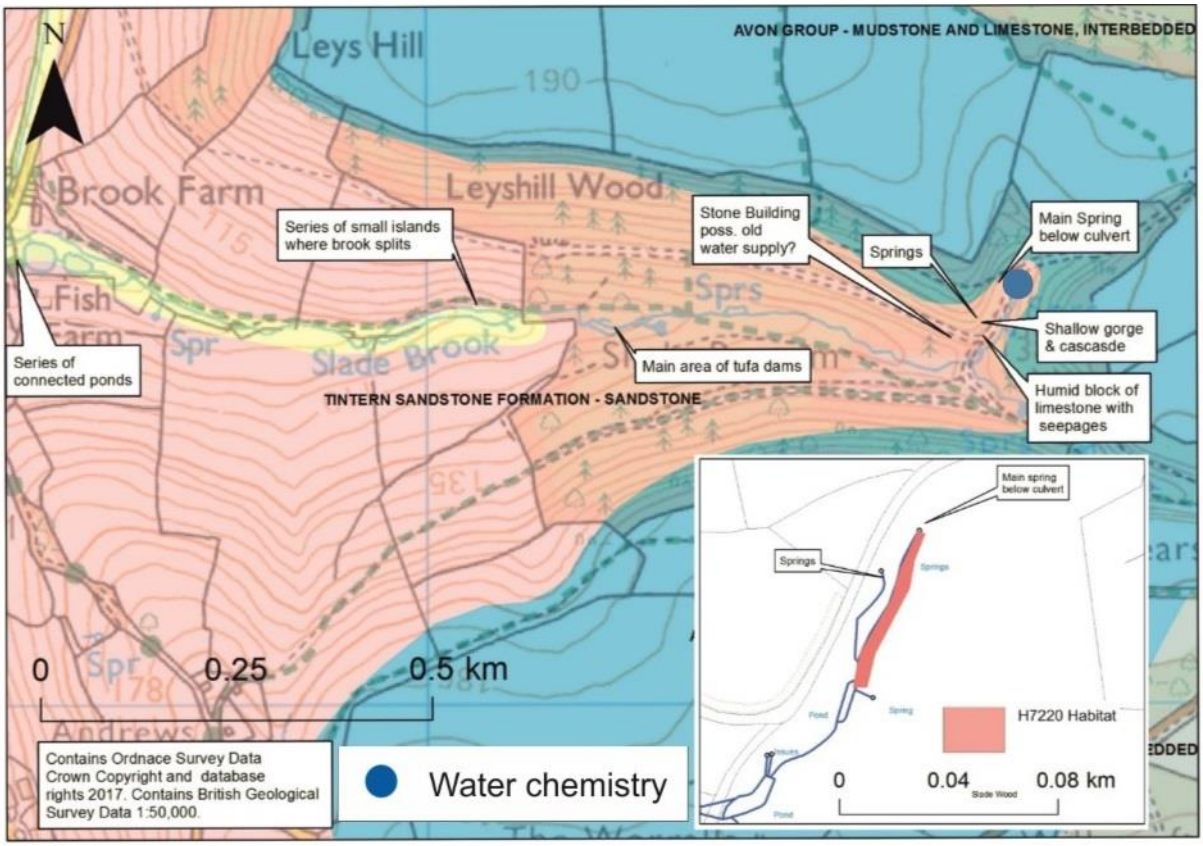



**Figure 3-64 Slade Brook Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-65 Springhead (left) with *Palustriella commutata* (stones), Ivy, Hart's-tongue and Male Ferns; the rare aquatic moss *Fissidens rivularis* (right) growing unuasally on tufa**

**Figure 3-66 Small gorge with *Platyhypnidium ripariodes, Thamnobryum alopecurum*; marginal stands of Ivy and Hart's-tongue Fern**

**Figure 3-67 Tufa dams (Slade Wood) with *Platyhypnidium ripariodes*; marginal mixed stands of *Thamnobryum alopecurum*, Ivy, Herb Robert, Hart's-tongue Fern, *Pellia endiviifolia and Conocephalum conicum***

**Figure 3-68 Wide orange-coloured tufa dams (Slade Bottom) mostly formed without the association of bryophytes.**

**Figure 3-69 Liverwort *Chiloscyphus polyanthus* growing over the flat surface of a stone with tufa within the channel of Slade Brook (SO56700544)**

**Figure 3-70 Fenced island (in distance where stream channel splits) with Tufted hair-grass and occasional Bracken; stones and boulders with *Cratoneuron filicinum, Pellia endiviifolia* and *Conocephalum conicum*.**

## 3.12 STRAWBERRY BANK

Strawberry Bank (Figure 3-71) comprises a springhead (SO91120429) which runs southwards down a side valley with areas of unimproved calcareous grassland and woodland. The lower section of the developing stream cuts through a series of small gorges within a larger area of ancient woodland (Oldhills Wood, SO9002) before connecting to the larger River Frome in the valley bottom. There are two significant side springs, which form near the junction of the Jurassic Great Oolite Group and the Inferior Oolite Group, joining the main channel from the north-west. The east bank of the upper valley (north-west of Oldhills Wood) lies within Strawberry Bank Site of Special Scientific Interest (SSSI).

One of the main side channels was surveyed. The springhead of this channel (SO90670357: Figure 3-72) is rocky and surrounded by Ash, Hawthorn, Holly, Goat Willow, Ivy and Bramble scrub. The shaded rocky banks underneath have localised stands of Hart's-tongue Fern *Asplenium scolopendrium,* the moss *Thamnobryum alopecurum* and few plants of Wild Strawberry *Fragaria vesca*. The small shade tolerant moss *Eucladium verticillatum* was noted on tufa-encrusted vertical rocks.

As the stream opens out of the scrub, marginal stands of Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium* appear along with the bryophytes *Brachythecium rivulare, Cratoneuron filicinum, Pellia endiviifolia*. The stream channel widens just above a dammed 19th century water holding area (Figure 3-73 and Figure 3-74) and has formed a complex of tufa dams on the break of slope with *Palustriella commutata* (actively associated with tufa formation), *Conocephalum conicum*. The historic water holding area below (Figure 3-74) is filled with tufa and has deeper water (to 20 cm) with emergent stands of Fool's Water-cress *Apium nodiflorum*. In addition, there is a 19th century Ram within a concrete housing in close proximity to this historic water holding area.

Above and below the 19th century water holding area, the main stream channel passes through pony-grazed pasture (Figure 3-73) and the grazed flushed margins support a large number of wetland plants including Wild Angelica *Angelica sylvestris*, Hard Rush *Juncus inflexus*, Water Mint *Mentha aquatica*, Cuckoo Flower *Cardamine pratense*, Marsh Thistle *Cirsium palustre*, Square-stemmed St Johns-wort *Hypericum tetrapterum*, Greater Willowherb *Epilobium hirsutum*, Greater Horse-tail *Equisetum telmateia*, Hemp-agrimony *Eupatorium cannabinum*, Marsh Valerian *Valeriana dioica*, Clustered Dock

*Rumex conglomeratus*, Creeping Buttercup *Ranunculus repens*, Meadowsweet *Filipendula ulmaria* and the mosses *Calliergonella cuspidata, Palustriella commutata*. The open water channels additionally have several emergent species including Watercress *Nasturtium officinale* sensu. lato., Brooklime *Veronica beccabunga*, Floating Sweet-grass *Glyceria fluitans* and Water Forget-me-not *Myosotis scorpioides.* Raised areas (including ant hills) within and along the margins of the flushes support unimproved herb-rich grassland species such as Red Fescue *Festuca rubra*, Salad Burnet *Poterium sanguisorba*, Cowslip *Primula veris*, Self-heal *Prunella vulgaris* and Knapweed *Centaurea nigra*.

This side stream joins the main side valley steam (SO90890349) which descends steeply through a series of small cut gorges and water falls (Figure 3-76). In this area, *Palustriella commutata* becomes less dominant (occurring more often as marginal cushions on rocks) and is replaced locally by *Platyhypnidium ripariodes* (a species characteristic of increased water flow) as well as large stands of *Thamnobryum alopecurum*. The tiny aquatic moss *Fissidens pusillus* is abundant on tufa-encrusted rock faces while stones of the bed occasionally support the similar species *Fissidens crassipes*. The bryophytes *Didymodon sinuosus, Plagiomnium rostratum* also occur beside the stream and in one place (on the top of a streamside boulder) the moss *Fissidens dubius* was recorded.

In the lower part of Oldhills Wood (a mainly Ash, Beech and Hazel woodland), the stream gradient becomes more gentle (Figure 3-77) and high wooded banks locally support a characteristic Ash woodland ground flora with Wavy Bitter-cress *Cardamine flexuosa*, Lords-and-Ladies *Arum maculatum*, Lesser Celandine *Ficaria verna*, Broad Buckler-fern *Dryopteris dilatata*, Herb Robert *Geranium robertianum*, Herb Bennet *Geum urbanum*, Rough-leaved Meadow-grass *Poa trivialis*, Soft Shield-fern *Polystichum setiferum* and the bryophytes *Cirriphyllum piliferum, Ctenidium molluscum, Eurhynchium striatum, Fissidens taxifolius, Lophocolea bidentata, Oxyrrhynchium hians, Plagiomnium undulatum, Rhytidiadelphus triquetrus, Thuidium tamariscinum, Amblystegium serpens var. serpens, Brachythecium rutabulum* and *Kindbergia praelonga.* The ancient woodland indicators: Wild Garlic *Allium ursinum*, Sweet Woodruff *Galium odoratum*, Yellow Archangel *Lamiastrum galeobdolon*, Wood Sorrel *Oxalis acetosella*, Wood Sanicle *Sanicula europaea*, Primrose *Primula vulgaris* also occur locally.

Humidity is high around the areas of wider flushing and where there are closely adjoining trees epiphytic bryophytes are well developed. The trunks of larger trees (mainly Ash and Beech) support *Homalothecium sericeum, Hypnum cupressiforme, Isothecium alopecuroides, Isothecium myosuroides, Anomodon viticulosus* and *Neckera complanata* while branches and twigs of smaller trees (mainly Ash, Hazel and Hawthorn) have *Cryphaea heteromalla, Frullania dilatata, Metzgeria furcata, Orthotrichum affine, Orthotrichum pulchellum, Radula complanata, Ulota bruchii*. Small plants of the common moss *Mnium hornum* were recorded from tree roots in one place. The stream channel in this lower section of Oldhills Wood has deep marginal sediment and abundant leaf litter, fallen dead wood (mostly Beech).

During this survey, Dippers (a rare bird in Gloucestershire) were observed feeding along the steeper section of the main river channel (within the small gorges and falls in the upper part of Oldhills Wood).

The H7220 feature at this site (area of flushing with tufa and frequent patches of *Palustriella commutata*) occurs across a moderate part of site for a distance of about 180 m covering an estimated area of 0.05 ha from just below the springhead (SO90700353) to the upper part of Oldhills Wood (SO90890349).

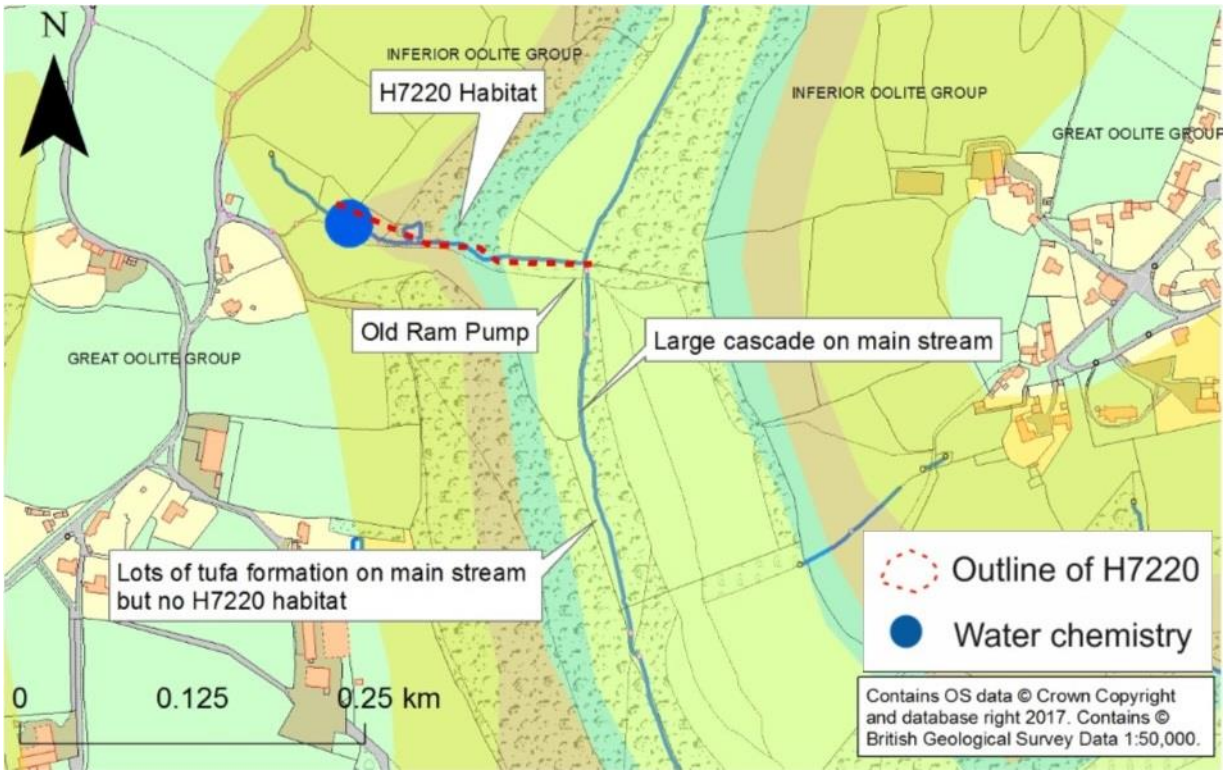



**Figure 3-71 Strawberry Bank Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3.11.2. Rocky springhead with Hart's-tongue Fern surrounded by Ash, Hawthorn and Bramble scrub.**

**Figure 3-72 Widened channel with a complex of tufa dams and frequent Opposite-leaved Golden-saxifrage, *Palustriella commutata, Conocephalum conicum* (just above 19th century water holding area).**

**Figure 3-73 Open pony-grazed area with wetland plants, localised areas of *Palustriella commutata* and tall wetland herbs adjoining stream (above 19th century water holding area)**

**Figure 3-74 Open banked area with tufa blocks (remnants of dammed 19th century water holding area).**

**Figure 3-75 First set of tufa dams with frequent *Palustriella commutata* on break of slope below 19th century water holding area**

**Figure 3-76 One of several small gorges with falls as the stream breaks slope and descends into the upper part of Oldhills Wood**

**Figure 3-77 Main stream showing good flow along gentle gradient in lower part of Oldhills Wood close to its junction with River Frome below**

## 3.13 TOADSMOOR

Toadsmoor (Figure 3-78) comprises of several springheads that issue near the junction of the Jurassic Great Oolite and the underlying Inferior Oolite. Below Middle Lypiatt (SO87710421) and Meadow Cottage (SO87710421). These springs form a channel which flows eastwards through unimproved pasture and scrub before converging with the main brook at (SO87960421) and continuing along Toadsmoor Woods before joining Toadsmoor Pond in the valley bottom. The stream passes through a culvert associated with a track close to its discharge into Toadsmoor Pond.

The springhead below Meadow Cottage and stream below was surveyed. The springhead rises in grazed pasture and has occasional emergent stands of Fool's Water-cress *Apium nodiflorum*. As the stream descends a steeper gradient tufa dams appear (often semi-shaded by adjoining Hawthorn and Elder scrub) with stands of Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium,* Hart's-tongue Fern *Asplenium scolopendrium,* Wavy Bitter-cress *Cardamine flexuosa*, frequent stands of the moss *Palustriella commutata* (actively associated with tufa formation) and the associated bryophytes *Brachythecium rivulare, Conocephalum conicum, Plagiomnium rostratum, Cratoneuron filicinum, Pellia endiviifolia*. Small stands of Fool's Water-cress continue to be present within the regular shallow pools created by the tufa dams. In one place, the stream bank has a shaded overhang with cushions of the moss *Eucladium verticillatum* on a small vertical tufa-encrusted rock face and a more open and disturbed bank nearby (with tufa fragments) had the common mosses *Barbula unguiculata* and *Phascum cuspidatum*.

Further down the slope the stream passes down the west margin of a small wetland area (SO87750421) (Figure 3-79) locally dominated by Lesser Pond-sedge *Carex acutiformis* with a large number of associated wetland species including Cuckoo Flower *Cardamine pratense,* Marsh Thistle *Cirsium palustre*, Wild Angelica *Angelica sylvestris*, Greater Willowherb *Epilobium hirsutum*, Tufted Hair-grass *Deschampsia cespitosa,* Hemp-agrimony *Eupatorium cannabinum*, Meadowsweet *Filipendula ulmaria*, Floating Sweet-grass *Glyceria fluitans*, Square-stemmed St John's-wort *Hypericum tetrapterum*, Yellow Iris *Iris pseudacorus*, Hard Rush *Juncus inflexus*, Water Mint *Mentha aquatica*, Water Forget-me-not *Myosotis scorpioides*, Clustered Dock *Rumex conglomeratus*, Brooklime *Veronica beccabunga*, Fleabane *Pulicaris dysenterica,* Creeping Buttercup *Ranunculus repens* and Water Figwort *Scrophularia auriculata*.

Just below this small wetland area, a stock fence crosses the stream (SO87770421) (Figure 3-80). The area immediately above the fence line is shaded by adjoining Hawthorn scrub, has poorly developed vegetation and has deposits of muddy sediment along with much fallen dead wood. At the point of the fence line (and just below) there are open and muddy tufa dams as well as evidence of erosion by stock that appear to regularly use this area to cross the stream (Figure 3-81).

Below this stock crossing point, the stream descends a steep slope towards its confluence with the other spring line at SO87960420. This section of stream passes through both open (pasture) as well as areas of Hawthorn, Bramble scrub and there are frequent tufa dams with occasional cushions of *Palustriella commutata*. Open margins of the stream regularly support narrow bands of emergent wetland vegetation (figure 1.8) dominated by Hard Rush and shaded sections have an additional number of mainly woodland species including Cleavers *Galium aparine,* Ground Ivy *Glechoma hederacea,* Ivy *Hedera helix ssp. helix,* Male Fern *Dryopteris filix-mas*, Rough-leaved Meadow-grass *Poa trivialis*, Nettle *Urtica dioica* and bryophytes *Brachythecium rutabulum, Kindbergia praelonga, Oxyrrhynchium hians, Plagiomnium undulatum, Fissidens taxifolius*. Cowslip *Primula veris* occurs locally in open areas of scrub.

Below the confluence with the main side valley spring line (SO87960420), the flow of the stream increases as it descends closely along the west margin of Toadsmoor Woods (Figure 3-84). The centre of the shaded channel is rocky (with tufa) and the minute moss *Fissidens pusillus* is locally abundant on tufa-encrusted stones. The raised shaded banks (formed from muddy sediment) locally support the liverwort *Lunularia cruciata* and Yellow Archangel *Lamiastrum galeobdolon* (an indicator of ancient woodland) was seen in one place. The stream finally passes through a culvert (associated with a track) and discharges shortly into Toadsmoor Pond.

Humidity is high around the areas of wider flushing and tufa dams and where scrub closely adjoins these features, epiphytic bryophytes are well developed. The trunks of larger trees (Ash and Hawthorn) support *Homalothecium sericeum, Hypnum cupressiforme, Isothecium myosuroides, Bryum capillare, Anomodon*

*viticulosus* and *Frullania dilatata* while branches and twigs of smaller trees (Hawthorn and Elder) have *Cryphaea heteromalla, Orthotrichum affine, Ulota bruchii.*

There is a disused Ram pump at the site.

The H7220 feature at this site (area of flushing with tufa and frequent patches of *Palustriella commutata*) occurs across a large part of site over 230 m from just below the springhead (SO87730421) to the margins of Toadsmoor Wood (SO87960420) an estimated area of 0.07 ha.

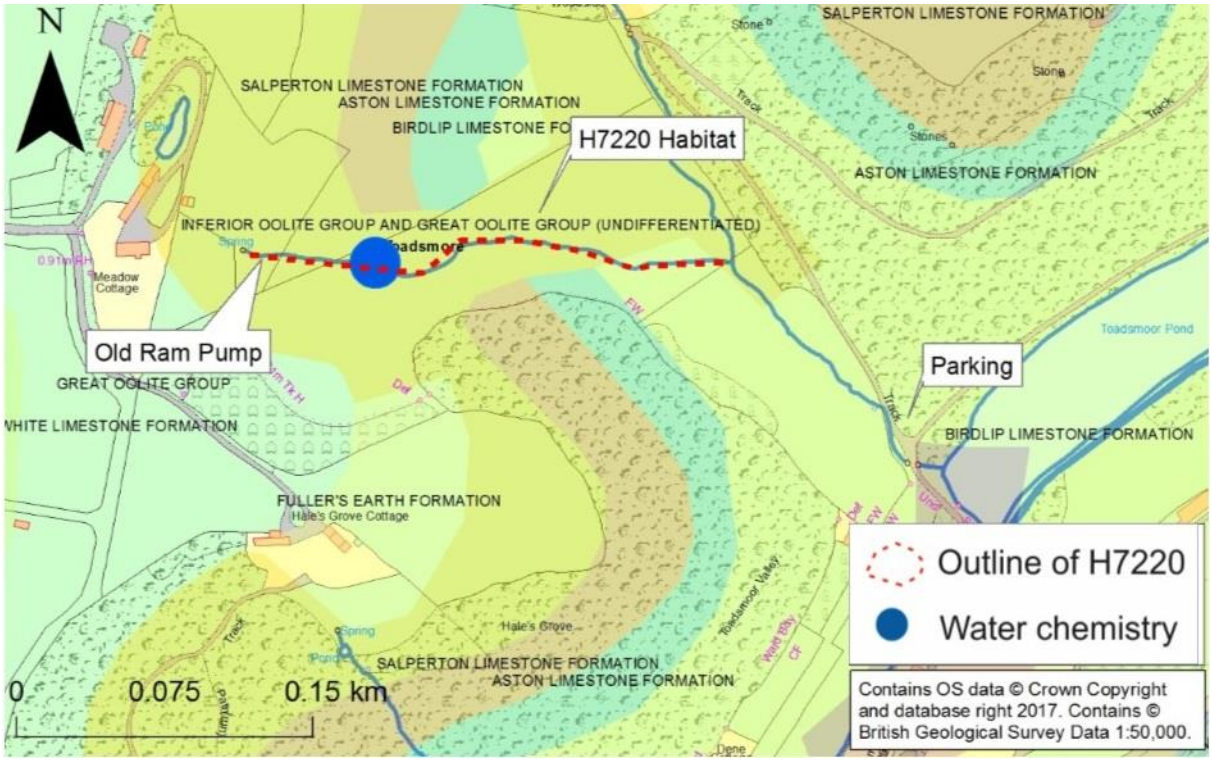



**Figure 3-78 Toadsmoor Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-79 Wide area of wetland adjoining the east bank of the upper stream (just below springhead)**

**Figure 3-80 Muddy area of stream just above stock fence that crosses stream. This area is within scrub and has much fallen dead wood**

**Figure 3-81 Muddy (and eroded) area of stream associated with stock fence and area used as a crossing place for stock. Tufa dams are prominent just below the fence line**

**Figure 3-82 Section of upper stream with frequent tufa dams (associated with *Palustriella commutata*) and patches of Fool's Water-cress within the channel**

**Figure 3-83 Upper part of stream with waterfall associated with tufa and large stands of *Palustriella commutata.***

**Figure 3-84 Lower section of stream with occasional cushion of *Palustriella commutata* (left) and stream below culvert (right)**

## 3.14 WOODCHESTER PARK (SITES 1-3)

Woodchester Park (SO82080133) (Figure 3-85) is an ancient Ash and Beech woodland that is notified as a Site of Special Scientific Interest (SSSI). The site has been extensively modified by the planting of conifers (mainly Larch, Norway Spruce and Douglas Fir). A series of springs arise from the break of slope within the woodland close to the junction of the Great Oolite Group and the Fullers Earth Formation, forming streams that flow west to east draining into the ponds in the base of the valley.

**Site 1** (SO8200500757 to SO82290115) comprises a small stream formed from at least two springheads, within Pontin's plantation, which flow downhill ultimately joining the dammed pond (Middle Pond) in the valley bottom. The stream passes through two culverts associated with tracks.

The main springhead (SO8200500757) (Figure 3-86) appears at the break of slope at the edge of the woodland where there is a disused water feed pipe and collection trough. This shaded and rocky springhead supports just a few marginal stands of Pendulous Sedge *Carex pendula*, Fool's Water-cress *Apium nodiflorum* and the bryophytes *Pellia endiviifolia, Cratoneuron filicinum*. Directly below this main springhead is an open area of wide seepages mixed within scrub woodland comprising Wild Clematis, Goat Willow and Elder. Under this scrub are dominant tall stands of Pendulous Sedge with several other wetland plants including Wild Angelica *Angelica sylvestris*, Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium,* Soft Rush *Juncus effusus*, Water Mint *Mentha aquatica*, Hemp-agrimony *Eupatorium cannabinum,* a willowherb *Epilobium sp*. and the moss *Calliergonella cuspidata*.

Below this wide area of open seepages, a second springhead (SO8202200778: Figure 3-87) forms a muddy channel joining the main stream (SO8205400804: Figure 3-88) which continues down the slope and into a Larch plantation. This area has a dense canopy of Larch with an occasional shrub layer of Birch, Hazel, Holly, Dog Rose and Bramble. The ground flora is sparse, with abundant needle litter from the Larches and washed soil mostly derived from the second spring line and associated channel. However, a broad number of woodland species do occur on the raised banks of the main channel and within the surrounding woodland including, Lesser Celandine *Ficaria verna*, Bugle *Ajuga reptans*, Harts-tongue Fern *Asplenium scolopendrium,* Lords-and-Ladies *Arum maculatum*, Wavy Bitter-cress *Cardamine flexuosa*, Wood Sedge *Carex sylvatica*, Broad Buckler-fern *Dryopteris dilatata*, Male Fern *Dryopteris filix-mas*, Nettle *Urtica dioica*, Rough-leaved Meadow-grass *Poa trivialis*, Cleavers *Galium aparine*, Ground Ivy *Glechoma hederacea*, Ivy *Hedera helix ssp. helix*, Tufted Hair-grass *Deschampsia cespitosa* and the bryophytes *Conocephalum conicum, Brachythecium rivulare, Cirriphyllum piliferum, Fissidens taxifolius, Lophocolea bidentata, Oxyrrhynchium hians, Plagiomnium rostratum, Plagiomnium undulatum* and *Thamnobryum alopecurum*. The ancient woodland indicator Dog's Mercury *Mercurialis perennis* occurs locally.

Further down the stream channel, a few additional plants occur locally including the ancient woodland indicators Wood Sorrel *Oxalis acetosella*, Primrose *Primula vulgaris* and Sweet Woodruff *Galium odoratum*. In addition, the large liverwort *Plagiochila asplenioides* was seen in one place (on a stream bank) and Greater Horse-tail *Equisetum telmateia* occurs at one place (SO82180097) associated with a small side seepage. The small mosses *Eucladium verticillatum* and *Fissidens pusillus* occur locally on shaded stones and tufa-encrusted roots and twigs within the channel. Also, where there is increased water flow (associated with small falls), the robust moss *Platyhypnidium riparioides* occurs locally on stones.

There is a historic linear drain to the east of the main stream (SO82110070 to SO82250102) (Figure 3-89) running down the slope. It is possible that this drain relates to artificial drainage for the Larch plantation (c1960s) but could possibility be 19th Century in origin. The banks of this drain have been reinforced with loose limestone which today support large stands of Hart's-tongue Fern and the moss *Thamnobryum alopecurum*. The channel is filled with muddy sediment and would originally discharged into the main stream.

The high humidity associated with the springs (particularly the wide area of open seepages just below the main springhead) are rich in epiphytic bryophytes. Larger native tree bases have Common Polypody *Polypodium vulgare* as well as the common mosses *Brachythecium rutabulum, Amblystegium serpens var. serpens, Hypnum cupressiforme, Dicranoweissia cirrata, Isothecium myosuroides, Kindbergia praelonga* and large lichens such as *Flavoparmelia caperata*. The upper trunks and twigs of smaller trees (Hazel, Elder and Goat Willow) have *Cryphaea heteromalla, Frullania dilatata, Metzgeria furcata, Metzgeria temporata, Metzgeria violacea, Orthotrichum affine, Orthotrichum lyellii, Orthotrichum*

*pulchellum* as well as the lichen *Hypogymnia tubulosa*. Also the moss *Rhizomnium punctaum* was recorded from rotting logs.

The stream passes through two culverts (associated with tracks) before connecting to the outflow Middle Pond in the valley bottom. At the point of the first culvert there is some evidence of the stream crossing the track (in periods of high flow) with signs of mild erosion.

There is no H7220 feature at this site although there is tufa formation.

**Site 2** (SO81630102 to SO81880133) is similar to site 1 and comprises a small stream (within Pontin's plantation) which arises from a pond (adjoining a springhead marked as a well on most maps) connecting to a dammed pond (Middle Pond) in the valley bottom. The stream passes through a culvert associated with a track.

The springhead (SO81630102) (Figure 3-90) has been dammed to form a gathering pond with stands of Water Forget-me-not *Myosotis scorpioides* and Water Mint *Mentha aquatica*. The outfall from this pond comprises a number of small falls over large limestone blocks (some relating to collapsed water control structures) that form a small stream that continues down the slope into a Douglas Fir plantation. The robust moss *Platyhypnidium ripariodes* occurs on stone and tufa at the outfall of the pond associated with the increased water flow.

The main stream is heavily shaded by the adjoining Douglas Fir plantation although the immediate stream banks locally support naturally regenerating broadleaf species such as Beech and Ash where more light is available. The shaded muddy channel generally supports a small number of shade tolerant bryophytes such as *Pellia endiviifolia* and *Fissidens pusillus*, *Fissidens crassipes* (locally on tufa-encrusted stones) along with small marginal stands of Pendulous Sedge *Carex pendula*. In sections with more light, other species associated with the wet channel margins include Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium,* Hart's-tongue Fern *Asplenium scolopendrium,* Lady Fern *Athyrium filix-femina,* Wild Angelica *Angelica sylvestris*, Wavy Bitter-cress *Cardamine flexuosa,* Remote Sedge *Carex remota,* Tufted Hair-grass *Deschampsia cespitosa*, Male Fern *Dryopteris filix-mas,* Lesser Celandine *Ficaria verna*, Rough-leaved Meadow-grass *Poa trivialis*, Soft Shield-fern *Polystichum setiferum,* Creeping Buttercup *Ranunculus repens*, Greater Horsetail *Equisetum telmateia* (very locally) and bryophytes *Brachythecium rivulare, Conocephalum conicum, Cratoneuron filicinum* and *Plagiomnium rostratum*. The ancient woodland indicator Wild Garlic *Allium ursinum* also occurs locally.

In addition, a broad number of other woodland species occur locally on the raised banks of the main channel or around the raised bases of tree trunks. These include Herb Robert *Geranium robertianum,* Ground Ivy *Glechoma hederacea*, Ivy *Hedera helix ssp. helix*, Wood Sedge *Carex sylvatica,* Red Campion *Silene dioica*, Dog Violet *Viola riviniana* and bryophytes *Eurhynchium striatum, Fissidens taxifolius, Plagiomnium undulatum, Rhytidiadelphus squarrosus, Kindbergia praelonga, Brachythecium rutabulum, Thamnobryum alopecurum* and *Thuidium tamariscinum*. The minute moss *Fissidens gracilifolius* was also found (in one place) on a small block of limestone beside the stream and the ancient woodland indicators Yellow Archangel *Lamiastrum galeobdolon*, Dog's Mercury *Mercurialis perennis* occur very locally.

Towards the centre of the site, there is an interesting tufa dam with associated pool (Figure 3-91) surrounded by stands of Soft shield and Hart's-tongue Fern, probably as a result of the associated high humidity (Figure 3-92). This feature is the largest dam and pool at this site and may have formed from a large old tree stump that has become tufa-encrusted over a long period of time. Below this the channel becomes muddy and intermittent (disappearing completely in several places).

Due to the low humidity resulting from a narrow channel, low extent of seepages and low number of native broadleaved trees within this mainly plantation woodland, few epiphytic bryophytes are recorded. A small number of species present (mainly on Ash) include the bryophytes *Cryphaea heteromalla, Metzgeria furcata, Orthotrichum affine, Radula complanata* with the lichen *Ramalina fasgiata*.

There is no H7220 feature at this site although there is much tufa formation.

**Site 3** (SO82470037 to SO82920081) comprises a small stream (within Collier's plantation) which arises from a springhead in pasture (SO82470037) connecting to a dammed pond (Parkmill Pond) in the valley bottom. The stream passes through a culvert associated with a track.

The springhead arises at the break of slope in rough grass pasture (Figure 3-93) and open seepages below are dominated by Pendulous Sedge *Carex pendula* with Clustered Dock *Rumex conglomeratus* and Water Mint *Mentha aquatica*. The seepages quickly gather into a small muddy runnel which continues below into a Douglas Fir and Norway Spruce plantation.

The developing upper stream is heavily shaded by the adjoining planted conifers (Figure 3-94) and there is much leaf litter (mainly Norway Spruce needles) and fallen dead wood. Consequently the channel supports only a few shade tolerant bryophytes such as *Pellia endiviifolia*, *Fissidens pusillus* (on tufa-encrusted stones), *Eucladium verticillatum* (on tufa-encrusted tree roots) as well as occasional marginal stands of Pendulous Sedge *Carex pendula* and Hart's-tongue Fern *Asplenium scolopendrium.* Further below (just above a culvert and track), the channel begins to deepen, widen and has more seepages (Figure 3-96). In addition, planted conifers (immediately adjoining the channel) have not grown so well allowing development of an understorey of native trees and shrubs including Sycamore, Wild Clematis, Beech, Ash, Holly, Hawthorn and Elder. The open nature of these area has allowed (in places) development of a richer ground flora characteristic of a wet Ash woodland with Wavy Bitter-cress *Cardamine flexuosa*, Remote Sedge *Carex remota*, Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium*, Tufted Hair-grass *Deschampsia cespitosa*, Broad Buckler-fern *Dryopteris dilatata*, Nettle *Urtica dioica* and bryophytes *Plagiomnium undulatum, Brachythecium rivulare, Lophocolea bidentata, Conocephalum conicum, Cratoneuron filicinum.* The ancient woodland indicator Wild Garlic *Allium ursinum* occurs locally.

The stream passes through a culvert associated with a track (SO82740068) below which the gradient increases and the stream descends through a series of small falls and gorges with large stands of the mosses *Thamnobryum alopecurum, Platyhypnidium ripariodes.* In addition, the mosses *Fissidens pusillus* and *Rhynchostegiella teneriffae* are locally abundant on shaded large blocks of limestone with tufa amongst the small gorges and water falls.

Further below this stream section with small gorges, the small stream valley widens as a result of the input of a number of side streams and seepages, most of which have dominant stands of the moss *Palustriella commutata* associated with active tufa formation (Figure 3-95). Cushions of *Palustriella commutata* also frequently occur on tufa-encrusted rocks and tree roots within the main channel. The broad banks of the channel in this area mainly support broadleaved woodland (including larger Ash and Beech) and many additional woodland ground flora species are present including Lords-and-Ladies *Arum maculatum*, Wood Sedge *Carex sylvatica*, Greater Horse-tail *Equisetum telmateia*, Herb Robert *Geranium robertianum*, Ground Ivy *Glechoma hederacea*, Rough-leaved Meadow-grass *Poa trivialis* and bryophytes *Eurhynchium striatum, Fissidens taxifolius, Plagiochila asplenioides, Plagiomnium rostratum, Thuidium tamariscinum, Oxyrrhynchium hians* and *Fissidens viridulus.* The ancient woodland indicators Sweet Woodruff *Galium odoratum*, Wood Sorrel *Oxalis acetosella* and Yellow Archangel *Lamiastrum galeobdolon* also occur locally.

The higher humidity associated with the more deeply cut lower section of the stream valley and higher proportion of native broadleaved trees has resulted in good development of epiphytic bryophytes. Larger tree trunks support colonises of Common Polypody *Polypodium vulgare* as well as the common mosses *Brachythecium rutabulum, Amblystegium serpens var. serpens, Hypnum cupressiforme, Kindbergia praelonga, Homalothecium sericeum, Zygodon viridissimus* while the upper trunks and twigs of smaller trees (mainly on Hazel) have *Cryphaea heteromalla, Frullania dilatata, Metzgeria temporata, Metzgeria violacea, Orthotrichum affine* and *Radula complanata*. The bryophytes *Rhizomnium punctaum, Plagiothecium succulentum, Mnium hornum, Lophocolea heterophylla* were additionally recorded from rotting logs.

Where the stream flows into the Parkmill Pond, a wide gently sloping channel has developed with deep sediment deposited where the stream loses energy. This area supports large stands of Opposite-leaved Golden-saxifrage and ferns (Figure 3-96). A small colony of Hard Fern *Blechnam spicant* is of note on the west bank of the stream channel (SO82930083). This species is often considered to be an ancient woodland indicator within Gloucestershire.

Tufa forms from the spring head to the lake over a length of about 680 m, however the H7220 feature at this site (area of flushing with tufa and frequent patches of *Palustriella commutata*) occurs over a distance of about 210 m (and estimated area of 0.06 ha) from just above the culvert (near the footpath / track) to the outfall into the Parkmill Pond (SO82740068 to SO82920081). The most significant areas of the

H7220 feature are associated with the inflow of small side springs and seepages in the lower part of the valley.

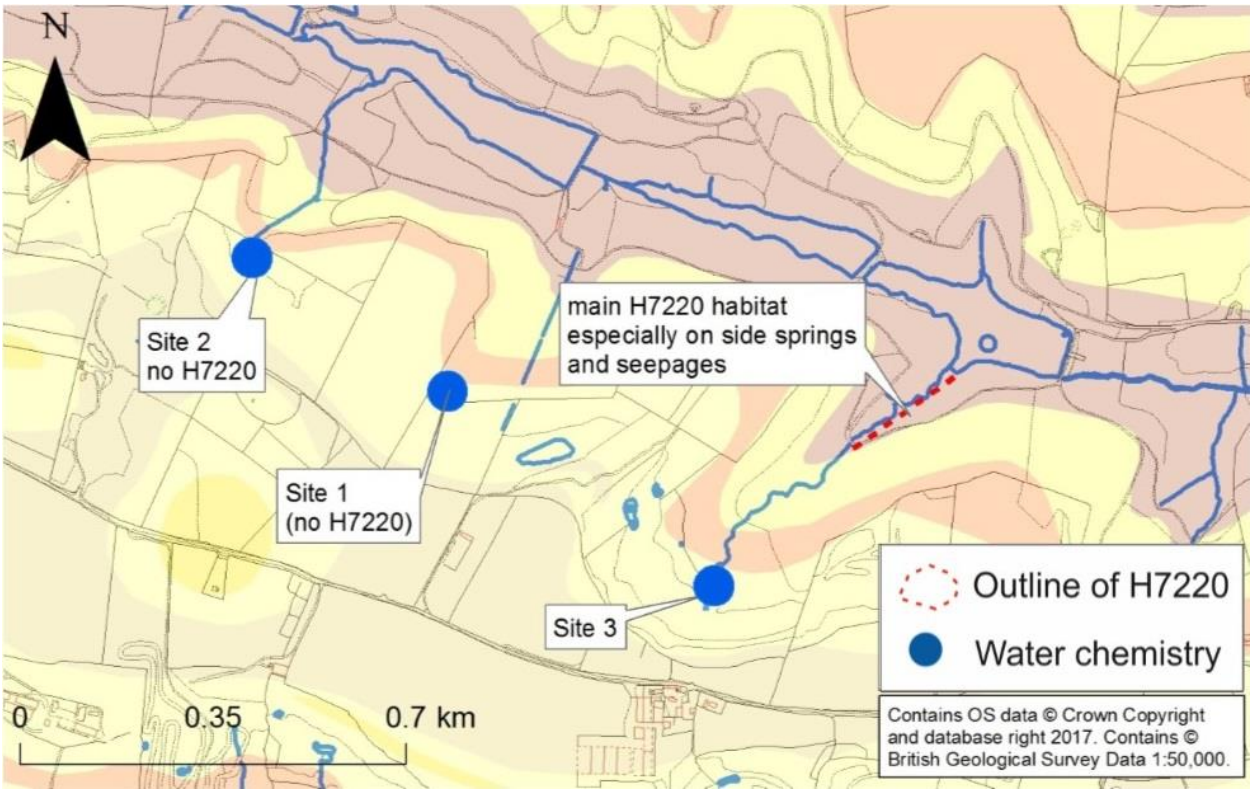



**Figure 3-85 Woodchester Park Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-86 Site 1 Main springhead with marginal stands of pendulous Sedge, old pipe and water collection tank**

**Figure 3-87 Site 1 Second springhead with field pH, EC and Temperature meters**

**Figure 3-88 Site 1 Confluence of two springs showing deposits of muddy sediment and leaf litter**

**Figure 3-89 Site 1 Old linear drain (to east of main spring channel) with frequent Hart's-tongue Fern**

**Figure 3-90 Site 2. Top of channel with small falls below pond and springhead with Pendulous Sedge and Hart's-tongue Fern**

**Figure 3-91 Site 2 – Tufa dam and associated pool surrounded by Hart's-tongue and Soft Shied Fern. This feature may have formed from a large old tree stump that has become tufa-encrusted over a long period of time.**

**Figure 3-92 Site 2 – Lower part of main channel with scattered marginal stands of Pendulous Sedge and Hart's-tongue Fern**

**Figure 3-93 Site 3 – Springhead in pasture (just above plantation woodland) with developing stands of Pendulous Sedge immediately below**

**Figure 3-94 Site 3 – Main channel within plantation (just above culvert and track) with marginal stands of Pendulous Sedge, Hart's-tongue Fern**

**Figure 3-95 Site 3 – one of several side seepages with dominant stands of *Palustriella commutata* (joining main channel in lower plantation below culvert and track)**

**Figure 3-96 Site 3 – Wide channel in lower part of site (closely adjoining outfall into Parkmill Pond) with large stands of Opposite-leaved Golden-saxifrage and ferns growing over deep sediment**

## 3.15 WORKMANS WOOD (SITES 1-3)

Workman's Wood (SO903110) (Figure 3-97) is an ancient Ash and Beech woodland and is part of Cotswold Commons and Beechwoods Site of Special Scientific Interest (SSSI) and National Nature Reserve (NNR).Some areas of the site have been extensively modified by the planting of conifers (mainly Douglas Fir). A series of springs arise from the break of slope, near to the junction of the Jurassic Great Oolite and Inferior Oolite Groups, in the north-east part of the woodland and discharge to a small valley stream (via a small dammed pond) where it continues (beyond the woodland) through the village of Sheepscombe (SO89211023) and ultimately connects to the Painswick Stream (SO87801046).

**Site 1** (SO90661066 to SO90231087) comprises a small stream formed from the gathering of two springheads and seepages within pasture and which run through a Douglas Fir plantation before connecting to the main stream in the valley bottom. The stream passes through a culvert associated with a track lower down.

The main springhead (Figure 3-98) had a strong flow at the time of survey and discharges through a gap in a partly collapsed stone wall. This wall has frequent cushions of the live-loving bryophytes *Anomodon viticulosus* and *Porella platyphylla* and other collapsed stone features may relate to 19th Century water control structures. Below the initial discharge of the springhead, the developing stream has good stands of the mosses *Thamnobryum alopecurum* and *Cratoneuron filicinum* associated with rocks and tree roots. After a short distance, a second muddy spring line joins the main channel (from the west) and from this point onwards the main stream descends into a Douglas Fir plantation (Beech Wood) with occasional Sycamore, Beech, Ash, Holly and planted Hybrid Black Poplar. Throughout the plantation, the channel is heavily shaded with abundant leaf litter and fallen dead wood (Figure 3-99; Figure 3-100). A sparse ground flora has Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium,* Hart's-tongue Fern *Asplenium scolopendrium,* Wavy Bitter-*cress Cardamine flexuosa,* Pendulous Sedge *Carex pendula,* Remote sedge *Carex remota*, Tufted Hair-grass *Deschampsia cespitosa,* Male Fern *Dryopteris filix-mas,* Lesser Celandine *Ficaria verna*, Rough-leaved Meadow-grass *Poa trivialis*, Soft Shield-fern *Polystichum setiferum*, Creeping Buttercup *Ranunculus repens*, Bramble, Nettle *Urtica dioica* and bryophytes *Brachythecium rivulare, Conocephalum conicum, Fissidens taxifolius, Oxyrrhynchium hians* and *Pellia endiviifolia*. Very locally, a number of additional characteristic Ash woodland ground flora species occur on the raised banks of the main channel below including Greater Stitchwort *Stellaria holostea*, Herb Robert *Geranium robertianum*, Wood Sedge *Carex sylvatica* and the moss *Eurhynchium striatum*. The ancient woodland indicators Yellow Archangel *Lamiastrum galeobdolon* and Dog's Mercury *Mercurialis perennis* occur very locally.

Due to the low humidity resulting from a narrow exposed channel, low extent of seepages and low number of native broadleaved trees within a mainly plantation woodland, few epiphytic bryophytes are present. A small number of species occur (mainly on the lower trunks of semi-mature Ash and beech) including *Brachythecium rutabulum, Frullania dilatata, Hypnum cupressiforme, Kindbergia praelonga, Metzgeria furcata, Metzgeria violacea, Neckera complanata, Orthotrichum affine* and *Zygodon viridissimus*.

The upper part of site 1 appears to be suffering from mild erosion (Figure 3-99) with soil washings and exposed tree roots in several places.

There is no H7220 feature at this site although there is tufa formation.

**Site 2** (SO90761108 to SO90641128) comprises a small stream formed from the gathering of two springheads and seepages at the edge of a mixed Beech and Ash woodland.

The springheads gather into a dug pond from which a buried plastic pipe delivers a small flow of water which connects (via a straight and steep channel) to the main stream in the valley bottom. The stream passes through a culvert associated with a track lower down.

The main stream channel is shaded by almost pure stands of Beech and there is abundant leaf litter (Beech) and fallen dead wood (Figure 3-101). Due to the instability of the substrate, shortage of exposed rocks and tree roots, and heavy shading, the associated ground flora of the channel is very sparse. Only a small number of species are present at low cover including Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium,* Hart's-tongue Fern *Asplenium scolopendrium,* Pendulous Sedge *Carex pendula,* Tufted Hair-grass *Deschampsia cespitosa,* Broad Buckler-fern *Dryopteris filix-mas*, Rough-

leaved Meadow-grass *Poa trivialis* and bryophytes *Brachythecium rivulare, Cratoneuron filicinum, Oxyrrhynchium hians* and *Fissidens taxifolius.* The raised banks of the main channel are typically dominated by the shade-tolerant mosses *Kindbergia praelonga, Fissidens bryoides* although very locally below a number of characteristic Ash woodland ground flora species are present including Soft Shield-fern *Polystichum setiferum* and (in one place) the large leafy liverwort *Plagiochila asplenioides*. The ancient woodland indicators Yellow Archangel *Lamiastrum galeobdolon* and Wild Garlic *Allium ursinum* occur very locally.

Due to the low humidity resulting from a narrow exposed channel, low extent of seepages and heavy shading by the Beech canopy, few epiphytic bryophytes are present. A small number of species (mainly on the lower trunks of semi-mature Beech) include *Brachythecium rutabulum, Frullania dilatata, Hypnum cupressiforme, Isothecium myosuroides, Orthotrichum affine, Zygodon viridissimus, Metzgeria furcata*. The bryophytes *Plagiothecium succulentum, Mnium hornum, Orthodontium lineare* and *Lophocolea heterophylla* were additionally recorded from rotting logs and tree stumps.

There is no H7220 feature at this site although there is tufa formation.

**Site 3** (SO90411155 to SO90521127) comprises a small stream and associated seepages running through open mixed Beech and Ash woodland to the main stream in the valley bottom. The stream passes through a culvert associated with a track lower down.

The springhead is contained within a stone building at the top of the site. Water discharges from a spring on the floor of the building and excessive flow means that water is flowing out of the door of the building and into the water control area (pond and dam). Within this building is an electric pump, which looks like it supplies a private water supply, it was not in use at the time of the visit and it is not clear who owns it or if it is still operational (Figure 3-102; Figure 3-103; Figure 3-104). Once the water has left the main pump house some of the water is contained within an old galvanised tank, which is overflowing with tufa and the moss *Palustriella commutata* (Figure 3-104). The water is then contained behind an old dam feature, where there is a redundant ram pump (Figure 3-103). The dam and pond were possibly used to create sufficient head to power the water wheel which is located below it, in another derelict stone building (Figure 3-102).

The springhead is open and rocky with Opposite-leaved Golden-saxifrage *Chrysosplenium oppositifolium,* Hart's-tongue Fern *Asplenium scolopendrium,* Pendulous Sedge *Carex pendula* and bryophytes *Brachythecium rivulare, Conocephalum conicum, Pellia endiviifolia, Cratoneuron filicinum.* Cushions of the moss *Palustriella commutata* appear just below the springhead (on stones and occasional fallen dead wood) and is actively associated with tufa formation.

Below the stone dam of the holding pond, wide seepages have developed in an open area of naturally regenerating wet woodland (with Ash, Hazel and Elder) (Figure 3-105) and continue down the gentle slope. The moss *Palustriella commutata* becomes frequent in this area along with additional species such as Wavy Bitter-cress *Cardamine flexuosa*, Remote Sedge *Carex remota,* Tufted Hair-grass *Deschampsia cespitosa*, Broad Buckler-fern *Dryopteris dilatata*, Male Fern *Dryopteris filix-mas* and bryophytes *Plagiomnium rostratum, Lophocolea bidentata*. An open area (near SO90511149) (Figure 3-106) supports a number of additional wetland species including Greater Horse-tail *Equisetum telmateia*, Hemp-agrimony *Eupatorium cannabinum* and Hard Rush *Juncus inflexus.*

The raised banks of the main channel (lower section) locally support a number of characteristic Ash woodland ground flora species including: Wood Sedge *Carex sylvatica*, Lords-and-Ladies *Arum maculatum*, Herb Robert *Geranium robertianum*, Herb Bennet *Geum urbanum*, Ground Ivy *Glechoma hederacea*, seedling Holly, Bramble and the bryophytes *Ctenidium molluscum, Eurhynchium striatum, Fissidens taxifolius, Plagiomnium undulatum, Thamnobryum alopecurum, Thuidium tamariscinum, Oxyrrhynchium hians, Kindbergia praelonga.* The ancient woodland indicators Yellow Archangel *Lamiastrum galeobdolon*, Wild Garlic *Allium ursinum*, Dog's Mercury *Mercurialis perennis* also occur locally.

Where naturally regenerating scrub woodland occurs around seepages, the high humidity has resulted in good growth of epiphytic bryophytes including *Hypnum cupressiforme, Isothecium myosuroides, Frullania dilatata, Orthotrichum lyellii* (on larger Ash trunks) and *Brachythecium rutabulum* (on elder trunks above the level of flushing). Smaller twigs and branches (mainly Elder) have *Zygodon viridissimus, Orthotrichum affine, Cryphaea heteromalla, Metzgeria violacea, Ulota bruchii*. In addition, rotting logs had the moss *Rhizomnium punctaum* and a species of Dog Lichen *Peltigera sp*.

The lower part of the site (just above a culvert and associated track) (Figure 3-107) has a steeper gradient and a number of small falls. The moss *Palustriella commutata* is less frequent in this section but does occur as large cushions on occasional stones in the channel and the robust moss *Platyhypnidium ripariodes* occurs locally associated with the increased water flow. Several artificial log dams also occur in this area as part of enhancement works.

The H7220 feature at this site (area of flushing with tufa and frequent patches of *Palustriella commutata*) occurs across a large part of site, over a length of about 210 m and estimated area of 0.06 ha, from just below the springhead (SO90531141) to just above the culvert and associated track (SO90531141).

An outcrop of limestone at SO90321088 (beside a track) exposes the local bedrock as well as having large stands of the mosses *Ctenidium molluscum, Rhytidiadelphus triquetrus, Anomodon viticulosus, Encalytpta streptocarpa, Eurhynchium striatum, Tortella tortuosa* and on vertical dripping faces fruiting colonies of the tiny moss *Seligeria pusilla*.

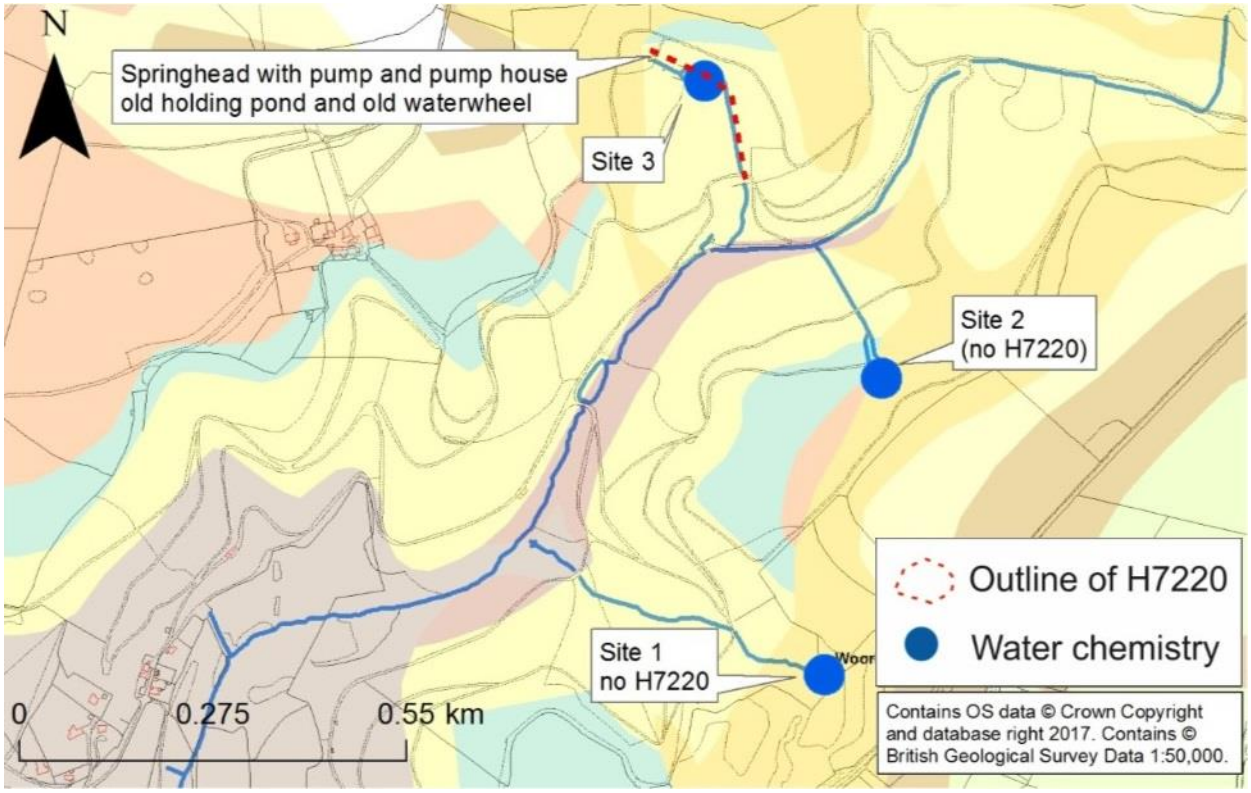



**Figure 3-97 Workmans Wood Location Map.** ***Includes mapping data licensed from Ordnance Survey. © Crown Copyright and/or database right 2017. Licence number 100021290 EUL.***

**Figure 3-98 Site 1 Main springhead and catch pit with tufa and Opposite-leaved Golden-saxifrage. The vertical sides of the wall have large cushions of the bryophytes *Anomodon viticulosus, Porella platyphylla***

**Figure 3-99 Site 1 Upper muddy stream channel showing signs or erosion with exposed tree roots**

**Figure 3-100 Site 1 Lower muddy channel with abundant leaf litter and fallen twigs**

**Figure 3-101 Site 2 Main channel, above culvert and track, with tufa-covered stones, abundant Beech leaf litter and fallen dead wood**

**Figure 3-102 Site 3 Stone building (left) with water wheel (right) which would have been powered by water stored in the holding pond immediately up gradient. Water still discharges from below building**

**Figure 3-103 Site 3 – Ram pump within small purpose built stone building, adjoining springhead**

**Figure 3-104 Site 3 Galvanised steel holding tank with large tufa block covered with *Palustriella commutata*. The main springhead with associated pump are in the building behind.**

**Figure 3-105 Site 3 Seepages within regenerating broadleaved woodland (upper part of site) with scattered cushions of *Palustriella commutata*, marginal stands of Hart's-tongue Fern, Pendulous Sedge**

**Figure 3-106 Site 3 Open area with wetland plants upper part of site**

**Figure 3-107 Site 3 Lower part of site (just above culvert and track) with frequent leaf litter, marginal Hart's-tongue Fern, large cushions of *Palustriella commutata* (on stones in channel). The log dam is part of enhancement works**

# 4. Results

## 4.1 ELEVATION AND ORIENTATION

The study sites (Figure 1-3) occur across a range of elevations from coastal cliff faces on the Severn Estuary at 11 maOD up to 252 maoD at Workmans Wood (Table 3).

| Site | Easting | Northing | Orientation | Elevation maOD |
|---|---|---|---|---|
| Alder_Carr | 385297 | 207895 | SE | 77 |
| Aust_Cliff | 356427 | 189190 | NW | 12 |
| Bathurst_Estate | 395150 | 204409 | SE | 137 |
| Cranham_Woods | 390447 | 212803 | NE | 236 |
| Dodeswell | 399177 | 220573 | SE | 175 |
| Fishponds_Wood | 382938 | 197047 | SE | 168 |
| Horsley_Wood | 383514 | 197603 | SE | 130 |
| Kingscote_Wood | 382753 | 197126 | NE | 148 |
| Kingscote_Wood_Main | 382634 | 197202 | NE | 139 |
| Midger Wood (Fissidens) | 380033 | 189530 | NW | 128 |
| Midger_Woods_(Main) | 380054 | 189602 | SE | 150 |
| Minchiampton_Stream | 386997 | 200066 | NW | 130 |
| Sedbury_Cliff | 355645 | 193093 | SE | 11 |
| Slade_Brook | 356774 | 205546 | SW | 70 |
| Strawberry_Banks | 390892 | 203500 | SW | 117 |
| Toadsmore | 387783 | 204209 | SE | 155 |
| Woodchester_Park 1 | 382005 | 200757 | NE | 162 |
| Woodchester_Park 2 | 381790 | 201226 | NE | 164 |
| Woodchester_Park 3 | 382448 | 200505 | NE | 133 |
| Woorkmans_Wood_WW1 | 390664 | 210676 | NW | 216 |
| Woorkmans_Wood_WW2 | 390868 | 211171 | NW | 252 |
| Woorkmans_Wood_WW3 | 390500 | 211532 | SE | 211 |

**Table 3 Elevation from 10m DTM and general orientation**

## 4.2 WETLANDS FUNCTIONAL MECHANISMS (WETMECS)

Wetlands Functional Mechanisms or 'WETMECS' as they are more commonly known were defined for the Environment Agency and describe the main (but not all) of the most common ecohydrological units that occur within lowland wetlands in England and Wales. They offer a simple way to classify water supply mechanisms to wetlands. The most appropriate for the majority of the sites within this study are 'WETMEC 10a Permanent Seepage Slopes' (Figure 4-1) and 'WETMEC 17 (Figure 4-2) Groundwater flushed slopes', which often occur together on following onto the other. They are often found in valley heads and slopes, typical of the Cotswold's landscape where permanent groundwater discharge from semi-confined or unconfined bedrock or drift aquifers, issues from springs and seepages.

Most of the sites in this study are flushed with water that has emerged from a spring or seepage nearby. As tufa forms rapidly as groundwater reacts with the atmosphere, all of the tufa forming sites start almost immediately nearby the groundwater source that supplies them. The geology of Gloucestershire is varied and tufa is associated with a range of geologies and aquifers. The Great Oolite and Inferior Oolite Group of the Jurassic along with adjacent formations such as the Fullers Earth and Salperton Limestone were commonly associated with tufa forming springs in this study, although this may simply reflect our choice of study sites. The calcareous geology and the steep topography of the Cotswold's valleys make this an ideal setting for springs and streams with active tufa formation. It is likely that there are many more tufa forming streams and springs associated with the Jurassic strata in the Stroud area. Tufa and H7220 habitat

was also associated with Jurassic Whitby Mudstone Formation (Alder Carr); the Jurassic Blue Lias, and Triassic Penarth Group at cliff face seepages at Sedbury and the Carboniferous Limestone and Devonian Tintern Sandstone formation at Slade Brook.

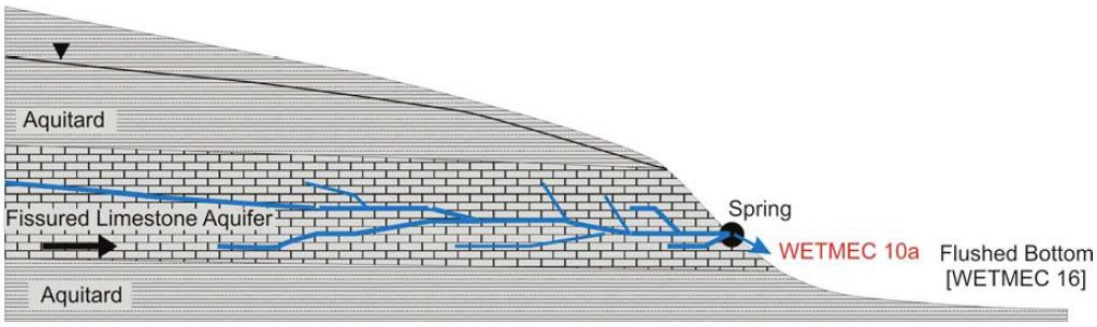



**Figure 4-1 WETMEC 10a Permanet seepage slopes (Environment Agency, 2009)**

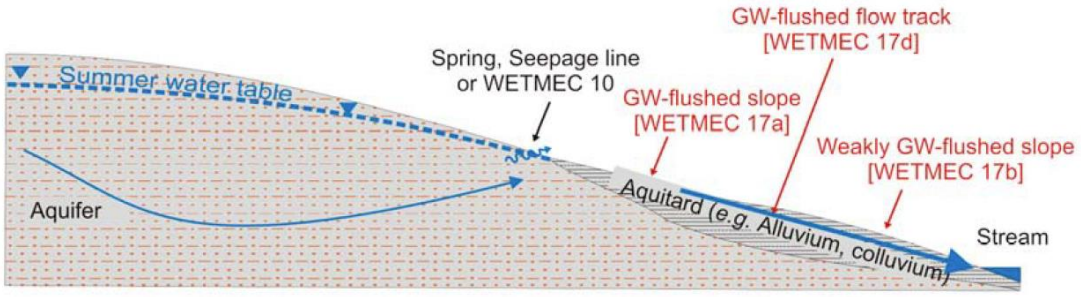



**Figure 4-2 WETMEC 17 Groundwater flushed slopes (Environment Agency, 2009)**

## 4.3 WATER CHEMSITRY

### 4.3.1 Field parameters

Field measurements were made for pH, temperature and electrical conductivity at the same time as collecting the water sample. Field readings for temperature ranged between 6.6 °C to 10.7 °C with a mean of 8.8 °C, and field pH between 8.65 to 7.28 with a mean of pH 7.93. Field electrical conductivity ranged from 446 µscm to 1075 µscm with a mean of 598 µscm. Direct and careful on site measurements are water from tufa forming springs will change chemistry as it precipitates tufa. This is nicely illustrated by a comparison of field and lab electrical conductivity measurements taken on the same samples (Figure 4-4) where the lab electrical conductivities are all lower than the field data, this is possibly due to major ionic components (calcium, sulphate and bicarbonate) dropping out of solution. This confirms the need for onsite electrical conductivity and temperature readings when sampling at tufa forming springs. In addition, due to the rapidly changing chemical nature of the waters, alkalinity should be performed in the field and not in the laboratory (pers. com. Thomas Barlow).

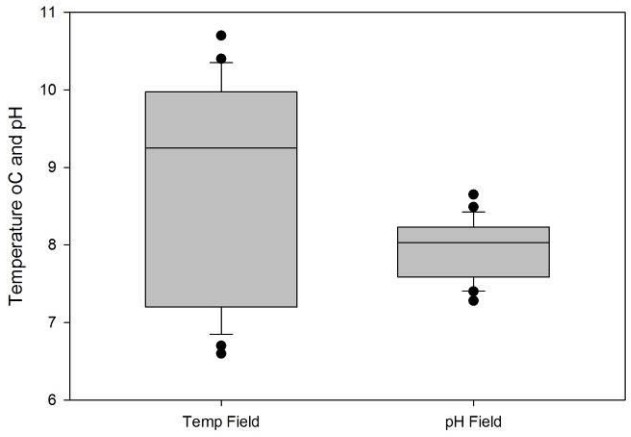



**Figure 4-3 Field temperature and pH (n= 24)**

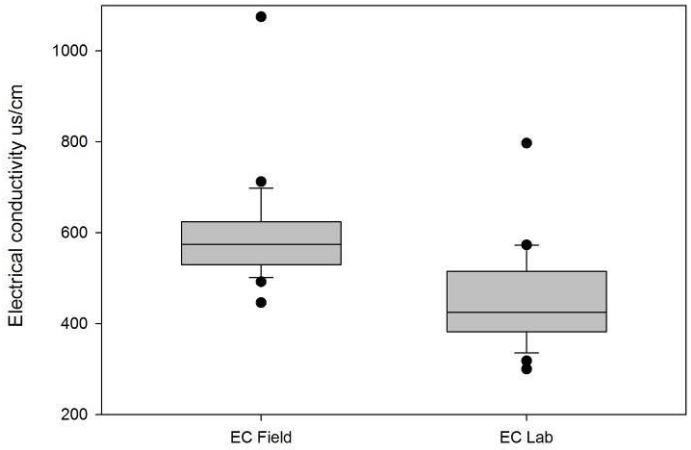



**Figure 4-4 Electrical conductivity field versus laboratory (n= 24)**

### 4.3.2 Major Ions

The major ion chemistry allows us to look at the relative proportions of ions and to define baseline water types or facies. Firstly the table and box and whisker plot illustrate the samples collected from the site in this study (Table 4; Figure 4-5). The samples are mostly dominated by $Ca^{2+}$ and $HCO_3^-$ (calcium-bicarbonate type waters) however some samples do show relatively high proportions of $Cl^-$and $SO_4^{2-}$, namely samples from Woodchester Park, Midger Woods and also the coastal sites Aust and Sedbury Cliffs. The coastal sites may have some influence from sea spray or coastal rainfall. The major ions are also plotted on a Piper Diagram (Figure 4-6). Piper plots ae sometimes called ternary diagrams and are made up of two lower triangles, where the cations are plotted on the bottom left and the anions on the bottom right. The 'results' of these two plots are then projected up onto the upper diamond where it is possible to look at the ionic composition of the water samples in comparison to one another. It is clear that most of the water samples are gathered on the left hand side of the upper triangle, this is the calcium bicarbonate type area, suggesting that they are mostly of similar composition, this is expected as the majority of samples have been from the Jurassic Great Oolite and Inferior Oolite aquifers. The samples with more $Cl^-$and $SO_4^{2-}$ are also clearly visible in the upper part of the diamond.

| LIMS Code | Site | Date | No | Field Temp | Field pH | Field EC | EC | Ca | Mg | Na | K | $CO_3^{2-}$ | $HCO_3^-$ | $Cl^-$ | $SO_4^{2-}$ | $NO_3^-$ | N | Ionic Balance | $Br^-$ | $NO_2^-$ | Total P | Total S | Si | $SiO_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | °C | | µS cm$^{-1}$ | µS cm$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg/l | % | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ | mg l$^{-1}$ |
| ICP-MS DL | | | | | | | | 0.3 | 0.01 | 0.2 | 0.02 | | | | | | | | | | 0.01 | 1 | 0.05 | |
| 13959-0015 | Alder Carr | 22.1.2017 | 13 | 10.3 | 7.28 | 712 | 573 | 106 | 8.38 | 21.1 | 1.86 | n/a | 236 | 41.7 | 26.1 | 7.89 | 1.79 | 9.92 | <0.1 | <0.05 | <0.01 | 11 | 3.75 | 8.02 |
| 13959-0023 | Aust Clif | 29.1.2017 | 20 | 9.5 | 8.03 | 621 | 512 | 86.8 | 14.7 | 13.7 | 4.69 | n/a | 209 | 17.1 | 63.0 | 0.292 | 0.066 | 9.10 | 0.079 | <0.025 | 0.01 | 23 | 4.03 | 8.62 |
| 13959-0019 | Bathurst Estate | 27.1.2017 | 17 | 10.1 | 7.77 | 492 | 370 | 91.1 | 2.18 | 5.1 | 0.63 | n/a | 162 | 9.11 | 13.1 | 19.4 | 4.39 | 17.47 | <0.05 | <0.025 | <0.01 | 5 | 2.29 | 4.90 |
| 13959-0004 | Cranham Woods (top) | 19.1.2017 | 3.1 | 9.9 | 7.45 | 625 | 382 | 99.3 | 2.12 | 8.4 | 0.53 | 45 | 96 | 15.1 | 9.00 | 6.86 | 1.55 | 18.09 | <0.05 | <0.025 | <0.01 | 5 | 3.40 | 7.27 |
| 13959-0005 | Cranham Woods (bottom) | 19.1.2017 | 3.2 | 6.7 | 8.03 | 523 | 318 | 91.4 | 2.20 | 8.0 | 0.80 | 63 | 19 | 14.3 | 9.07 | 7.43 | 1.68 | 24.40 | <0.05 | <0.025 | <0.01 | 4 | 3.38 | 7.23 |
| 13959-0024 | Dowdeswell | 29.1.2017 | 21 | 10.7 | 7.81 | 446 | 383 | 84.7 | 2.05 | 6.1 | 0.58 | n/a | 183 | 7.87 | 8.25 | 11.7 | 2.65 | 13.30 | <0.05 | <0.025 | <0.01 | 4 | 2.16 | 4.62 |
| 13959-0012 | Fishponds Wood | 21.1.2017 | 10 | 9.1 | 7.40 | 550 | 466 | 109 | 2.62 | 7.3 | 0.50 | n/a | 204 | 14.3 | 20.5 | 33.2 | 7.52 | 11.81 | <0.05 | <0.025 | <0.01 | 9 | 2.28 | 4.88 |
| 13959-0011 | Horsley Wood | 21.1.2017 | 9 | 7.0 | 8.21 | 611 | 427 | 114 | 4.10 | 6.3 | 1.92 | n/a | 207 | 9.35 | 29.8 | 9.24 | 2.09 | 18.03 | <0.05 | <0.025 | <0.01 | 12 | 3.47 | 7.42 |
| 13959-0013 | Kingscote Wood | 21.1.2017 | 11 | 9.4 | 7.58 | 533 | 425 | 89.8 | 2.76 | 6.0 | 0.56 | n/a | 174 | 13.3 | 19.8 | 31.0 | 7.01 | 9.30 | <0.05 | <0.025 | <0.01 | 8 | 2.29 | 4.90 |
| 13959-0014 | Kingscote Wood | 21.1.2017 | 12 | 9.0 | 8.11 | 563 | 424 | 106 | 2.89 | 7.0 | 1.33 | n/a | 174 | 13.2 | 20.1 | 30.3 | 6.86 | 17.13 | <0.05 | <0.025 | <0.01 | 9 | 2.48 | 5.31 |
| 13959-0018 | Lydney Cliff | 26.1.2017 | 16 | 7.2 | 8.29 | 628 | 567 | 74.1 | 12.8 | 14.6 | 13.4 | n/a | 164 | 31.1 | 98.2 | 3.96 | 0.896 | 0.41 | 0.056 | <0.025 | <0.01 | 34 | 4.01 | 8.58 |
| 13959-0021 | Midger Woods (main) | 28.1.2017 | 19.1 | 10.1 | 7.43 | 583 | 520 | 106 | 4.94 | 8.7 | 2.97 | n/a | 202 | 13.2 | 30.5 | 49.5 | 11.2 | 9.30 | <0.05 | <0.025 | 0.03 | 13 | 2.41 | 5.16 |
| 13959-0022 | Midger Woods (fissidens) | 28.1.2017 | 19.2 | 7.2 | 8.31 | 609 | 493 | 91.3 | 9.31 | 11.0 | 4.10 | n/a | 164 | 18.5 | 76.1 | 7.17 | 1.62 | 9.24 | <0.05 | <0.025 | <0.01 | 29 | 3.13 | 6.70 |
| 13959-0020 | Minchiampton | 27.1.2017 | 18 | 9.6 | 8.37 | 511 | 420 | 91.0 | 3.01 | 12.3 | 1.20 | n/a | 176 | 18.3 | 23.5 | 11.0 | 2.50 | 13.66 | <0.05 | <0.025 | 0.04 | 10 | 2.35 | 5.03 |
| 13959-0017 | Slade Brook | 26.1.2017 | 15 | 10.0 | 7.41 | 684 | 572 | 93.5 | 23.3 | 5.5 | 1.22 | n/a | 276 | 10.5 | 34.4 | 31.7 | 7.17 | 6.26 | <0.05 | <0.025 | <0.01 | 14 | 2.20 | 4.71 |
| 13959-0009 | Strawberry Bank | 21.1.2017 | 7 | 10.4 | 7.61 | 529 | 411 | 89.2 | 2.71 | 8.7 | 2.36 | n/a | 163 | 12.1 | 16.4 | 33.8 | 7.65 | 13.49 | <0.05 | <0.025 | <0.01 | 7 | 2.30 | 4.92 |
| 13959-0010 | Toadsmoor | 20.1.2017 | 8 | 8.9 | 8.17 | 606 | 468 | 101 | 4.06 | 7.1 | 1.58 | 80 | 40 | 13.1 | 29.4 | 28.2 | 6.38 | 9.32 | <0.05 | <0.025 | 0.01 | 12 | 3.09 | 6.61 |
| 13959-0001 | Woodchester Park | 18.1.2017 | 1 | 9.6 | 8.09 | 550 | 360 | 102 | 2.67 | 6.6 | 1.63 | 74 | 15 | 11.6 | 18.6 | 7.90 | 1.79 | 22.57 | <0.05 | <0.025 | <0.01 | 8 | 2.76 | 5.90 |
| 13959-0016 | Woodchester Park | 22.1.2017 | 14 | 9.1 | 8.03 | 1075 | 797 | 190 | 5.95 | 23.6 | 7.80 | n/a | 199 | 50.2 | 157 | 24.3 | 5.51 | 14.54 | <0.2 | <0.1 | <0.01 | 64 | 3.41 | 7.30 |
| 13959-0002 | Woodchester Park | 18.1.2017 | 2.1 | 6.6 | 8.65 | 680 | 516 | 126 | 2.77 | 9.4 | 0.92 | n/a | 153 | 13.8 | 116 | 12.7 | 2.87 | 11.56 | <0.05 | <0.025 | <0.01 | 43 | 2.15 | 4.60 |
| 13959-0003 | Woodchester Park | 18.1.2017 | 2.2 | 7.1 | 8.49 | 510 | 300 | 89.5 | 2.45 | 8.0 | 0.79 | n/a | 122 | 14.9 | 15.5 | 8.37 | 1.89 | 27.29 | <0.05 | <0.025 | <0.01 | 7 | 2.52 | 5.39 |
| 13959-0006 | Workmans Wood (WW1) | 20.1.2017 | 4 | 9.9 | 7.69 | 573 | 353 | 91.8 | 2.33 | 10.0 | 4.09 | 42 | 39 | 19.0 | 15.1 | 23.3 | 5.26 | 23.72 | <0.05 | <0.025 | 0.12 | 7 | 3.90 | 8.34 |
| 13959-0007 | Workmans Wood (WW2) | 20.1.2017 | 5 | 7.1 | 8.24 | 575 | 390 | 98.0 | 2.35 | 7.5 | 0.47 | 51 | 61 | 16.7 | 21.9 | 9.31 | 2.11 | 17.91 | <0.05 | <0.025 | <0.01 | 9 | 4.92 | 10.5 |
| 13959-0008 | Workmans Wood (WW3) | 20.1.2017 | 6 | 7.5 | 7.74 | 569 | 385 | 106 | 4.00 | 6.1 | 0.95 | 55 | 63 | 10.8 | 18.8 | 13.5 | 3.05 | 22.27 | <0.05 | <0.025 | <0.01 | 8 | 3.76 | 8.04 |

**Table 4 Major ion water chemistry**

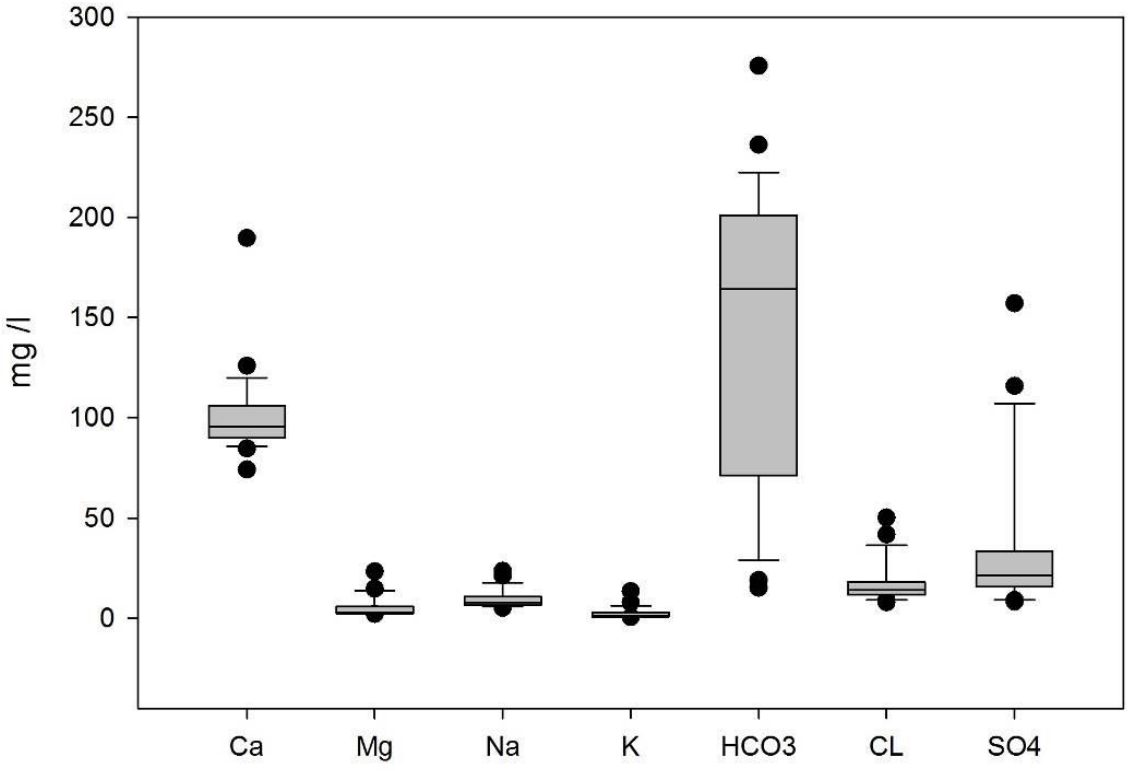



**Figure 4-5 Major ions Box plot (n=24)**

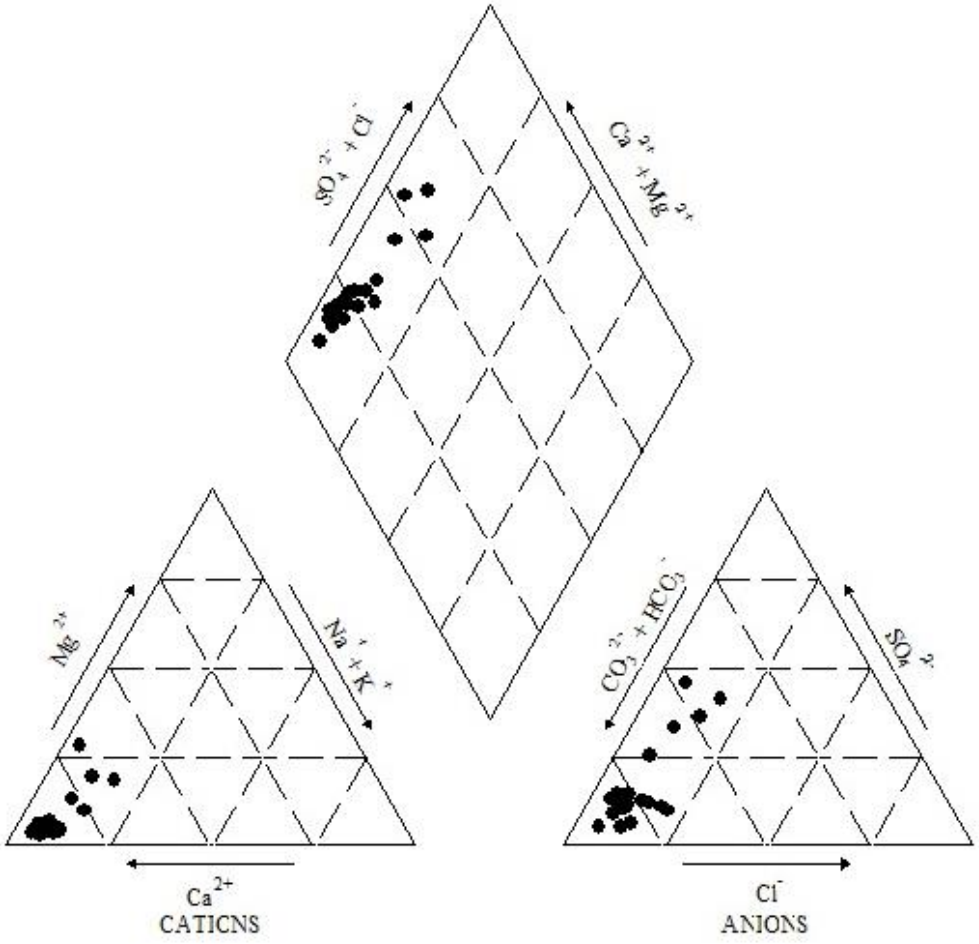



**Figure 4-6 Piper plot showing the relative proportions of cations and anions (n=24). The bottom left hand triangle represents the cations and the bottom right hand triangle the anions, they are both projected into the upper diamond.**

### 4.3.3 Nitrate & Phosphate

Recent work in the Netherlands (Royal Haskoning, 2016) has, for the first time, tried to assign threshold values for nitrate and phosphate to the H7220 habitat. The work which also incorporates data collected from previous studies in Wales by the authors (see Farr et al., 2014) suggests threshold values of 28 mg/l $NO_3^-$ or 6.35 mg/l N and 0.05 mg/l P. The nitrate threshold value is higher than the UKTAG Threshold Values of 1 mg/l for medium altitude (>175 maOD) and 4.5 mg/l N for low altitude (<175 maOD) fens that include tufa forming springs (UKTAG, 2012a). For comparison the often quoted drinking water standard for nitrate is 50 mg/l as $NO_3^-$ or 11.3 mg/l as N.

The data for each of the sites in this study is reported in descending order, for nitrate (as $NO_3^-$ and N) (Figure 4-7), nitrite and total phosphate (Table 5). Nitrate ranges from 0.29 to 49.5 mg/l with a mean of 17.58 mg/l reported as $NO_3^-$ or 0.06 to 11.12 with a mean of 3.98 mg/l reported as N (Figure 4-7).Nitrate levels in the Gloucestershire H7220 sites are higher than those reported from Welsh sites (Farr et al., 2014), however this is to be expected as the land use for the majority of the Welsh sites was very low intensity. The sites with the highest nitrate are Midger Woods 1, Strawberry Bank, Fishponds Wood, Slade Brook, Kingscote Woods and Toadsmoor all of which have some form of agricultural activity within their potential catchments. We have compared the data collected for this study against the threshold values produced by Royal Haskoning (2016) and using their threshold values for the H7220 habitat only Midger Woods, Kingscote and Horsley Woods, Strawberry Bank, Slade Brook and Toadsmoor 'fail' when compared to these nitrate threshold values (Figure 4-7). None of the sites exceed the phosphate threshold value of 0.05 mg/l (Figure 4-8). Although the nitrate threshold value was exceeded at several sites, it was not considered that vegetation was in unfavourable condition at any of

the sites. This suggests that perhaps other factors such as flow, slope, shade, etc. also need to be considered in more detail.

| LIMS Code | Site | Date | No | $NO_3^-$ | N | $NO_2^-$ | Total P |
|---|---|---|---|---|---|---|---|
| | | | | mg $l^{-1}$ | mg/l | mg $l^{-1}$ | mg $l^{-1}$ |
| ICP-MS DL | | | | | | | 0.01 |
| 13959-0021 | Midger Woods 1 | 28.1.2017 | 19 | 49.5 | 11.2 | <0.025 | 0.03 |
| 13959-0009 | Strawberry Bank | 21.1.2017 | 7 | 33.8 | 7.65 | <0.025 | <0.01 |
| 13959-0012 | Fishponds Wood | 21.1.2017 | 10 | 33.2 | 7.52 | <0.025 | <0.01 |
| 13959-0017 | Slade Brook | 26.1.2017 | 15 | 31.7 | 7.17 | <0.025 | <0.01 |
| 13959-0013 | Kingscote Wood | 21.1.2017 | 11 | 31.0 | 7.01 | <0.025 | <0.01 |
| 13959-0014 | Kingscote Wood | 21.1.2017 | 12 | 30.3 | 6.86 | <0.025 | <0.01 |
| 13959-0010 | Toadsmoor | 20.1.2017 | 8 | 28.2 | 6.38 | <0.025 | 0.01 |
| 13959-0016 | Woodchester Park | 22.1.2017 | 14 | 24.3 | 5.51 | <0.1 | <0.01 |
| 13959-0006 | Workmans Wood 1 | 20.1.2017 | 4 | 23.3 | 5.26 | <0.025 | 0.12 |
| 13959-0019 | Bathurst Estate | 27.1.2017 | 17 | 19.4 | 4.39 | <0.025 | <0.01 |
| 13959-0008 | Workmans Wood 3 | 20.1.2017 | 6 | 13.5 | 3.05 | <0.025 | <0.01 |
| 13959-0002 | Woodchester Park | 18.1.2017 | 2.1 | 12.7 | 2.87 | <0.025 | <0.01 |
| 13959-0024 | Dowdeswell | 29.1.2017 | 21 | 11.7 | 2.65 | <0.025 | <0.01 |
| 13959-0020 | Minchiampton | 27.1.2017 | 18 | 11.0 | 2.50 | <0.025 | 0.04 |
| 13959-0007 | Workmans Wood 2 | 20.1.2017 | 5 | 9.31 | 2.11 | <0.025 | <0.01 |
| 13959-0011 | Horsley Wood | 21.1.2017 | 9 | 9.24 | 2.09 | <0.025 | <0.01 |
| 13959-0003 | Woodchester Park | 18.1.2017 | 2.2 | 8.37 | 1.89 | <0.025 | <0.01 |
| 13959-0001 | Woodchester Park | 18.1.2017 | 1 | 7.90 | 1.79 | <0.025 | <0.01 |
| 13959-0015 | Alder Carr | 22.1.2017 | 13 | 7.89 | 1.79 | <0.05 | <0.01 |
| 13959-0005 | Cranham Woods (top of site) | 19.1.2017 | 3.2 | 7.43 | 1.68 | <0.025 | <0.01 |
| 13959-0022 | Midger Woods 2 | 28.1.2017 | 19 | 7.17 | 1.62 | <0.025 | <0.01 |
| 13959-0004 | Cranham Woods (base fo site) | 19.1.2017 | 3.1 | 6.86 | 1.55 | <0.025 | <0.01 |
| 13959-0018 | Lydney Cliff | 26.1.2017 | 16 | 3.96 | 0.896 | <0.025 | <0.01 |
| 13959-0023 | Aust Clif | 29.1.2017 | 20 | 0.292 | 0.066 | <0.025 | 0.01 |

**Table 5 Nitrate and phosphate with the Royal Haskoning (2016) threshold value in red.**

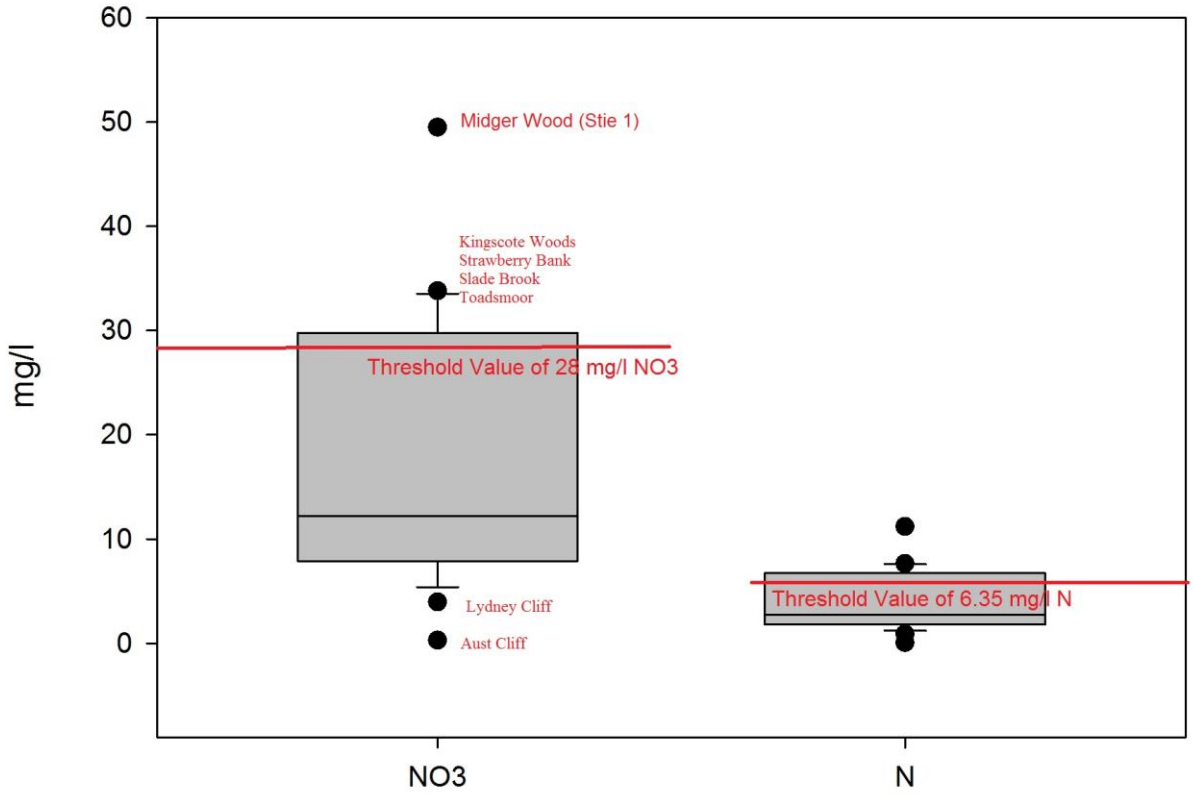



**Figure 4-7 Nitrate $NO_3$ mg/l compared to the Royal Haskoning (2016) threshold value of 28mg/l $NO_3$ (n=24). Sites that exceed the threshold value are indicated on the graph (threshold value is 6.35mg/l when nitrate is reported as N).**

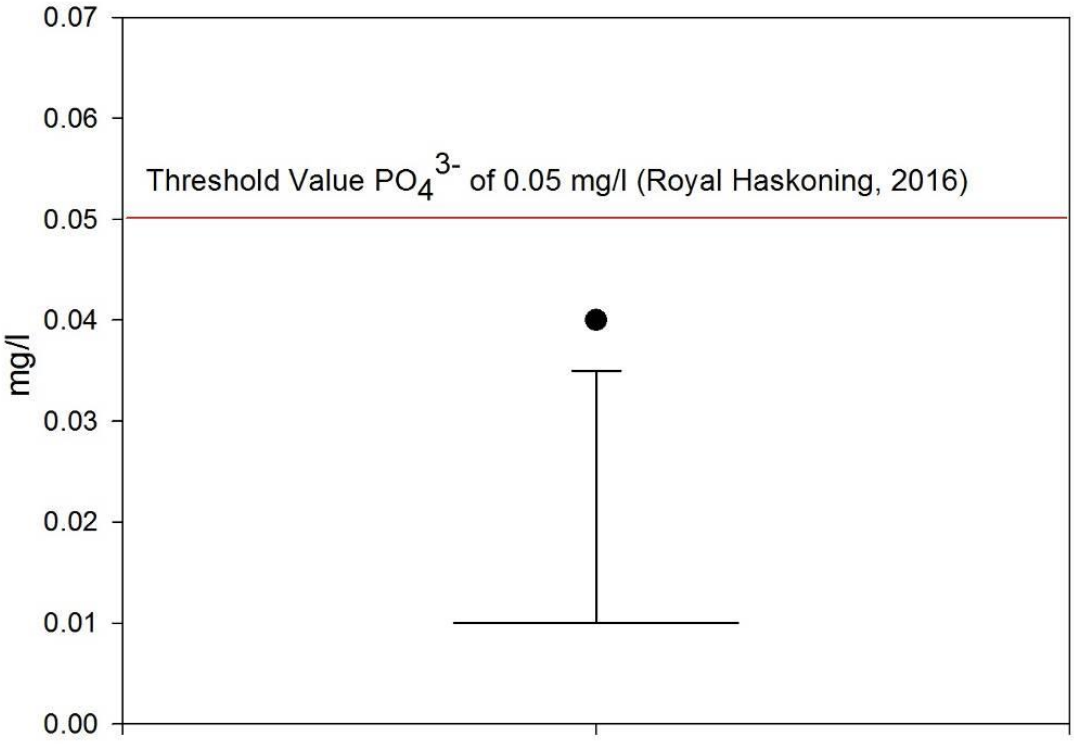



**Figure 4-8 Total Phosphate as P mg/l (with LOD of 0.01mg/l) compared to the Royal Haskoning (2016) threshold value of 0.05mg/l $PO_4^{3-}$ (n=24)**

## 4.4 TRACE ELEMENTS

| LIMS Code | Site | Date | No | Ba | Sr | Mn | Total Fe | Li | Be | B | Al | Ti | V | Cr | Co | Ni | Cu | Zn | Ga | As | Se | Rb | Y | Zr | Nb | Mo | Ag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 |
| ICP-MS DL | | | | 0.1 | 0.1 | 0.2 | 1 | 1 | 0.01 | 10 | 1 | 0.05 | 0.1 | 0.05 | 0.01 | 0.1 | 0.4 | 0.5 | 0.03 | 0.02 | 0.1 | 0.01 | 0.005 | 0.05 | 0.02 | 0.03 | 0.05 |
| 13959-0015 | Alder Carr | 22.1.2017 | 13 | 4.8 | 536 | 4.5 | 250 | 13 | <0.01 | 65 | 5 | 0.09 | 0.4 | 0.18 | 0.12 | 0.3 | <0.4 | 0.5 | <0.03 | 0.23 | 0.2 | 0.50 | 0.042 | <0.05 | <0.02 | 0.07 | <0.05 |
| 13959-0023 | Aust Clif | 29.1.2017 | 20 | 57.4 | 414 | 3.9 | 17 | 16 | <0.01 | 55 | 11 | 0.09 | <0.1 | 0.12 | 0.06 | 2.5 | 3.2 | 11.3 | <0.03 | 0.17 | 0.4 | 1.50 | 0.039 | <0.05 | <0.02 | 0.88 | <0.05 |
| 13959-0019 | Bathurst Estate | 27.1.2017 | 17 | 7.1 | 113 | 0.3 | 1 | <1 | <0.01 | 14 | 1 | <0.05 | 0.1 | 0.06 | 0.02 | 0.2 | <0.4 | 0.9 | <0.03 | 0.11 | 0.1 | 0.27 | <0.005 | <0.05 | <0.02 | 0.05 | <0.05 |
| 13959-0004 | Cranham Woods (top) | 19.1.2017 | 3.1 | 22.0 | 158 | 0.6 | <1 | 1 | <0.01 | 17 | <1 | <0.05 | <0.1 | <0.05 | 0.02 | 0.1 | <0.4 | 7.6 | <0.03 | 0.08 | 0.1 | 0.21 | 0.007 | <0.05 | <0.02 | 0.05 | <0.05 |
| 13959-0005 | Cranham Woods (bottom) | 19.1.2017 | 3.2 | 9.8 | 159 | <0.2 | <1 | 1 | <0.01 | <10 | <1 | <0.05 | <0.1 | <0.05 | 0.02 | <0.1 | <0.4 | 4.8 | <0.03 | 0.11 | 0.1 | 0.39 | <0.005 | <0.05 | <0.02 | 0.07 | <0.05 |
| 13959-0024 | Dowdeswell | 29.1.2017 | 21 | 274 | 136 | <0.2 | <1 | 2 | <0.01 | 32 | <1 | <0.05 | 0.2 | 0.19 | 0.06 | 0.1 | <0.4 | 77.1 | <0.03 | 0.34 | 0.2 | 0.14 | 0.008 | <0.05 | <0.02 | 0.03 | <0.05 |
| 13959-0012 | Fishponds Wood | 21.1.2017 | 10 | 27.9 | 162 | <0.2 | <1 | 1 | <0.01 | 19 | <1 | <0.05 | 0.2 | 0.13 | 0.03 | 0.1 | <0.4 | 11.9 | <0.03 | 0.08 | 0.2 | 0.13 | 0.016 | <0.05 | <0.02 | 0.09 | <0.05 |
| 13959-0011 | Horsley Wood | 21.1.2017 | 9 | 7.1 | 242 | 2.9 | 6 | 3 | <0.01 | 21 | 3 | 0.06 | 0.2 | <0.05 | 0.04 | 0.3 | <0.4 | <0.5 | <0.03 | 0.14 | 0.3 | 1.04 | 0.012 | <0.05 | <0.02 | 0.10 | <0.05 |
| 13959-0013 | Kingscote Wood | 21.1.2017 | 11 | 25.0 | 174 | 0.2 | <1 | 2 | <0.01 | 33 | <1 | <0.05 | <0.1 | 0.07 | 0.03 | 0.1 | <0.4 | 17.8 | <0.03 | 0.09 | 0.2 | 0.19 | 0.013 | <0.05 | <0.02 | 0.09 | <0.05 |
| 13959-0014 | Kingscote Wood | 21.1.2017 | 12 | 6.7 | 166 | <0.2 | <1 | 1 | <0.01 | 18 | <1 | <0.05 | <0.1 | 0.07 | 0.03 | 0.2 | <0.4 | <0.5 | <0.03 | 0.12 | 0.2 | 0.56 | <0.005 | <0.05 | <0.02 | 0.14 | <0.05 |
| 13959-0018 | Lydney Cliff | 26.1.2017 | 16 | 45.2 | 225 | 0.4 | <1 | 14 | <0.01 | 65 | <1 | <0.05 | <0.1 | <0.05 | 0.04 | 1.6 | 1.5 | 0.8 | <0.03 | 0.11 | 1.1 | 2.24 | <0.005 | <0.05 | <0.02 | 1.66 | <0.05 |
| 13959-0021 | Midger Woods (main) | 28.1.2017 | 19.1 | 12.5 | 310 | 1.9 | 16 | 3 | <0.01 | 41 | 11 | 0.11 | 0.1 | 0.09 | 0.07 | 1.1 | 1.5 | 16.7 | <0.03 | 0.17 | 0.1 | 0.99 | 0.039 | <0.05 | <0.02 | 0.18 | <0.05 |
| 13959-0022 | Midger Woods (fissidens) | 28.1.2017 | 19.2 | 14.1 | 403 | 1.1 | 2 | 11 | <0.01 | 50 | <1 | <0.05 | <0.1 | <0.05 | 0.04 | 0.4 | 1.2 | 3.3 | <0.03 | 0.13 | 0.1 | 1.34 | 0.007 | <0.05 | <0.02 | 0.16 | <0.05 |
| 13959-0020 | Minchiampton | 27.1.2017 | 18 | 353 | 155 | 0.7 | 5 | 3 | <0.01 | 136 | 4 | 0.12 | 0.2 | 0.16 | 0.04 | 0.2 | <0.4 | 40.0 | <0.03 | 0.31 | 0.3 | 0.44 | 0.024 | <0.05 | <0.02 | 0.15 | <0.05 |
| 13959-0017 | Slade Brook | 26.1.2017 | 15 | 52.7 | 103 | <0.2 | <1 | 1 | <0.01 | 26 | <1 | <0.05 | 0.2 | 0.36 | 0.03 | <0.1 | <0.4 | 11.1 | <0.03 | 0.09 | 0.3 | 0.30 | 0.036 | <0.05 | <0.02 | <0.03 | <0.05 |
| 13959-0009 | Strawberry Bank | 21.1.2017 | 7 | 318 | 115 | <0.2 | <1 | <1 | <0.01 | 43 | <1 | <0.05 | 0.1 | 0.18 | 0.05 | 0.1 | <0.4 | 66.7 | <0.03 | 0.18 | 0.1 | 0.45 | 0.011 | <0.05 | <0.02 | 0.10 | <0.05 |
| 13959-0010 | Toadsmoor | 20.1.2017 | 8 | 64.4 | 175 | <0.2 | <1 | 2 | <0.01 | 22 | <1 | <0.05 | 0.1 | 0.13 | 0.03 | 0.2 | <0.4 | 10.8 | <0.03 | 0.17 | 0.1 | 0.61 | 0.006 | <0.05 | <0.02 | 0.13 | <0.05 |
| 13959-0001 | Woodchester Park | 18.1.2017 | 1 | 34.5 | 154 | 0.6 | 2 | 2 | <0.01 | 21 | <1 | <0.05 | <0.1 | 0.06 | 0.03 | 0.9 | 0.4 | 9.7 | <0.03 | 0.10 | 0.2 | 0.42 | 0.014 | <0.05 | <0.02 | 0.13 | <0.05 |
| 13959-0016 | Woodchester Park | 22.1.2017 | 14 | 16.1 | 318 | 0.5 | 5 | 3 | <0.01 | 38 | <1 | <0.05 | <0.1 | <0.05 | 0.09 | 0.9 | 0.8 | <0.5 | <0.03 | 0.16 | 0.2 | 1.52 | 0.009 | <0.05 | <0.02 | 0.11 | <0.05 |
| 13959-0002 | Woodchester Park | 18.1.2017 | 2.1 | 6.5 | 162 | 0.7 | 2 | <1 | <0.01 | 19 | <1 | <0.05 | <0.1 | <0.05 | 0.05 | 0.3 | 0.5 | <0.5 | <0.03 | 0.13 | 0.1 | 0.27 | 0.022 | <0.05 | <0.02 | 0.10 | <0.05 |
| 13959-0003 | Woodchester Park | 18.1.2017 | 2.2 | 4.4 | 143 | 0.2 | 2 | 1 | <0.01 | 12 | <1 | <0.05 | <0.1 | 0.10 | 0.03 | 0.4 | 1.0 | <0.5 | <0.03 | 0.13 | 0.2 | 0.19 | 0.010 | <0.05 | <0.02 | 0.10 | <0.05 |
| 13959-0006 | Workmans Wood (WW1) | 20.1.2017 | 4 | 399 | 144 | <0.2 | <1 | 1 | <0.01 | 38 | <1 | <0.05 | 0.4 | 0.34 | 0.03 | 0.2 | <0.4 | 96.9 | <0.03 | 0.92 | 0.2 | 1.31 | 0.010 | <0.05 | <0.02 | 0.35 | <0.05 |
| 13959-0007 | Workmans Wood (WW2) | 20.1.2017 | 5 | 229 | 164 | 0.2 | 2 | 2 | <0.01 | 20 | <1 | <0.05 | 0.1 | 0.13 | 0.03 | 0.2 | <0.4 | 46.3 | <0.03 | 0.14 | 0.1 | 0.16 | 0.021 | <0.05 | <0.02 | 0.10 | <0.05 |
| 13959-0008 | Workmans Wood (WW3) | 20.1.2017 | 6 | 6.8 | 198 | <0.2 | 2 | 2 | <0.01 | 15 | <1 | <0.05 | <0.1 | <0.05 | 0.03 | 0.1 | <0.4 | <0.5 | <0.03 | 0.15 | 0.2 | 0.39 | 0.008 | <0.05 | <0.02 | 0.10 | <0.05 |

| LIMS Code | Site | Date | No | Cd | Sn | Sb | Cs | Pr | Nd | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu | Hf | Ta | W | Tl | Pb | Th | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 | µg l-1 |
| ICP-MS DL | | | | 0.01 | 0.02 | 0.005 | 0.005 | 0.003 | 0.01 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.01 | 0.02 | 0.05 | 0.01 | 0.02 | 0.04 | 0.002 |
| 13959-0015 | Alder Carr | 22.1.2017 | 13 | <0.01 | <0.02 | 0.023 | <0.005 | 0.012 | 0.05 | 0.009 | <0.002 | 0.010 | <0.002 | 0.006 | <0.002 | 0.004 | <0.002 | 0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.16 | <0.04 | 0.482 |
| 13959-0023 | Aust Clif | 29.1.2017 | 20 | 0.02 | 0.04 | 0.144 | 0.024 | 0.012 | 0.05 | 0.010 | <0.002 | 0.009 | <0.002 | 0.007 | <0.002 | 0.004 | <0.002 | 0.004 | <0.002 | <0.01 | <0.02 | <0.05 | 0.13 | 0.91 | <0.04 | 2.43 |
| 13959-0019 | Bathurst Estate | 27.1.2017 | 17 | <0.01 | <0.02 | 0.015 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.22 | <0.04 | 0.294 |
| 13959-0004 | Cranham Woods (top) | 19.1.2017 | 3.1 | <0.01 | <0.02 | 0.049 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.04 | <0.04 | 0.206 |
| 13959-0005 | Cranham Woods (bottom) | 19.1.2017 | 3.2 | <0.01 | <0.02 | 0.041 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | <0.02 | <0.04 | 0.273 |
| 13959-0024 | Dowdeswell | 29.1.2017 | 21 | <0.01 | <0.02 | 0.107 | <0.005 | <0.003 | <0.01 | 0.003 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | 0.003 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.05 | <0.04 | 0.169 |
| 13959-0012 | Fishponds Wood | 21.1.2017 | 10 | <0.01 | <0.02 | 0.051 | <0.005 | <0.003 | 0.01 | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.003 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.05 | <0.04 | 0.253 |
| 13959-0011 | Horsley Wood | 21.1.2017 | 9 | <0.01 | <0.02 | 0.013 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.19 | <0.04 | 0.355 |
| 13959-0013 | Kingscote Wood | 21.1.2017 | 11 | <0.01 | <0.02 | 0.050 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | <0.02 | <0.04 | 0.245 |
| 13959-0014 | Kingscote Wood | 21.1.2017 | 12 | <0.01 | <0.02 | 0.019 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.14 | <0.04 | 0.267 |
| 13959-0018 | Lydney Cliff | 26.1.2017 | 16 | <0.01 | <0.02 | 0.228 | 0.024 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | 0.11 | <0.02 | <0.04 | 0.987 |
| 13959-0021 | Midger Woods (main) | 28.1.2017 | 19.1 | 0.02 | 0.03 | 0.043 | 0.005 | 0.010 | 0.04 | 0.009 | 0.003 | 0.009 | <0.002 | 0.007 | <0.002 | 0.004 | <0.002 | 0.004 | <0.002 | <0.01 | <0.02 | <0.05 | 0.02 | 0.67 | <0.04 | 0.266 |
| 13959-0022 | Midger Woods (fissidens) | 28.1.2017 | 19.2 | <0.01 | <0.02 | 0.064 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | 0.02 | 0.06 | <0.04 | 0.392 |
| 13959-0020 | Minchiampton | 27.1.2017 | 18 | 0.01 | <0.02 | 0.218 | <0.005 | 0.004 | 0.02 | 0.006 | <0.002 | 0.004 | <0.002 | 0.004 | <0.002 | 0.002 | <0.002 | 0.004 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.07 | <0.04 | 0.185 |
| 13959-0017 | Slade Brook | 26.1.2017 | 15 | <0.01 | <0.02 | 0.045 | <0.005 | 0.003 | 0.02 | 0.003 | <0.002 | 0.003 | <0.002 | 0.004 | <0.002 | 0.003 | <0.002 | 0.003 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.35 | <0.04 | 0.163 |
| 13959-0009 | Strawberry Bank | 21.1.2017 | 7 | <0.01 | <0.02 | 0.145 | <0.005 | <0.003 | <0.01 | 0.004 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | 0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.11 | <0.04 | 0.305 |
| 13959-0010 | Toadsmoor | 20.1.2017 | 8 | <0.01 | <0.02 | 0.064 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.12 | <0.04 | 0.261 |
| 13959-0001 | Woodchester Park | 18.1.2017 | 1 | 0.01 | <0.02 | 0.079 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.06 | <0.04 | 0.320 |
| 13959-0016 | Woodchester Park | 22.1.2017 | 14 | <0.01 | <0.02 | 0.051 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 1.95 | 0.06 | 0.505 |
| 13959-0002 | Woodchester Park | 18.1.2017 | 2.1 | <0.01 | <0.02 | 0.034 | <0.005 | 0.003 | <0.01 | 0.003 | <0.002 | 0.003 | <0.002 | 0.003 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | <0.02 | <0.04 | 0.321 |
| 13959-0003 | Woodchester Park | 18.1.2017 | 2.2 | <0.01 | <0.02 | 0.025 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.03 | <0.04 | 0.255 |
| 13959-0006 | Workmans Wood (WW1) | 20.1.2017 | 4 | <0.01 | <0.02 | 0.200 | <0.005 | <0.003 | <0.01 | 0.003 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | 0.003 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.10 | <0.04 | 0.209 |
| 13959-0007 | Workmans Wood (WW2) | 20.1.2017 | 5 | <0.01 | <0.02 | 0.099 | <0.005 | <0.003 | <0.01 | 0.003 | <0.002 | 0.004 | <0.002 | 0.003 | <0.002 | <0.002 | <0.002 | 0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | 0.07 | <0.04 | 0.219 |
| 13959-0008 | Workmans Wood (WW3) | 20.1.2017 | 6 | <0.01 | <0.02 | 0.024 | <0.005 | <0.003 | <0.01 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.01 | <0.02 | <0.05 | <0.01 | <0.02 | <0.04 | 0.230 |

**Table 6 Trace elements (ug/l)**

## 4.5 ATMOSPHERIC DEPOSITION AND SITE RELEVANT CRITICAL LOAD

Excessive atmospheric deposition of nitrogen can be detrimental to most habitats, and in some cases could result in unfavourable status for Habitats Directive assessment. PlantLife (2016) estimate that 63% of the UKs most sensitive habitats are exposed to excessive nitrogen deposition. Although we could not find any information on the H7220 habitat, recent work has highlighted the risk to epiphytic bryophytes and lichens (Wolseley, et al., 2006; Mitchell et al., 2005; Steven et al, 2012).

A recent analysis of groundwater dependent terrestrial ecosystems (GWDTEs) in England and Wales (Farr and Hall, 2014), which includes the Petrifying Springs Habitat H7220, found that nitrogen deposition exceeded the critical loads for a least one habitat features in 64% of GWDTEs (which also includes the H7220 habitat). However, the multiple potential sources of nitrogen (source), its fate within wetlands (pathway) and the impact on habitats (receptor) is not simple to unravel. Coupled with the need to consider the combined effects of multiple sources of nitrogen (atmospheric, surface water, groundwater) that may result in detrimental pressures to a habitat we also need to consider the potential effect of poor site management, under - over grazing and succession may have on habitat condition.

Critical Loads for the petrifying springs habitat have not been defined specifically in the UK, however a recommended critical load is available and this is based upon based upon the corresponding EUNIS class (Hall et al., 2015). In England and Wales, or the current Annex 1 assessments, the EUNIS class D4.2

critical loads are applied. The current critical load range for this habitat is 15-25 kg N/ha/yr, with a recommended critical load of 15 kg N/ha/year which we have applied to the petrifying springs habitats in this study. The results (Table 7) show that all but three of the sites have modelled total nitrogen deposition that exceeds the recommended critical load. Only the coastal sites, Aust and Lydney are significantly below the critical load, and one island site Strawberry Banks has an average annual deposition just less than 15 kg N/ha/year.

| | Easting | Northing | Ammonia | | | Nitrogen oxides | | | Total nitrogen | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | NHx_av | NHx_m | NHx-w | Nox_av | Nox_m | Nox_w | TOTN_av | TOTN_m | TOTN_w | Exceed Critical |
| | | | kg/N/ha/year | | | kg/N/ha/year | | | kg/N/ha/year | | | Loading Value ? |
| Alder Carr | 385297 | 207895 | 9.38 | 13.72 | 21.84 | 7.7 | 6.02 | 13.16 | 17.08 | 19.74 | 35 | Yes |
| Aust Clif | 356427 | 189190 | 4.48 | 14.7 | 26.04 | 5.04 | 4.62 | 9.52 | 9.52 | 19.32 | 35.56 | No |
| Bathurst Estate | 395150 | 204409 | 9.38 | 11.48 | 18.2 | 8.54 | 5.88 | 12.88 | 19.92 | 17.36 | 31.08 | Yes |
| Cranham Woods | 390447 | 212803 | 9.38 | 12.88 | 21.14 | 8.4 | 6.16 | 14.7 | 17.78 | 19.04 | 35.84 | Yes |
| Dowdeswell | 399177 | 220573 | 7 | 14 | 22.82 | 8.54 | 6.02 | 13.16 | 15.54 | 20.02 | 35.98 | Yes |
| Kingscote & Horsley Woods (1-4) | 382634 | 197202 | 9.24 | 14.98 | 23.94 | 7.42 | 6.02 | 13.16 | 16.66 | 21 | 37.1 | Yes |
| Midger Woods (1-2) | 382634 | 197202 | 8.4 | 15.26 | 24.64 | 6.86 | 5.74 | 12.18 | 15.26 | 21 | 36.82 | Yes |
| Minchiampton | 386997 | 200066 | 9.24 | 14.42 | 22.96 | 7.84 | 6.16 | 13.16 | 17.08 | 20.58 | 36.12 | Yes |
| Sedbury Cliff | 355645 | 193093 | 7.14 | 9.52 | 15.96 | 4.48 | 4.43 | 8.96 | 11.62 | 13.86 | 24.92 | No |
| Slade Brook | 356774 | 205546 | 11.06 | 14.14 | 22.68 | 7.28 | 5.46 | 11.48 | 18.34 | 19.6 | 34.16 | Yes |
| Strawberry Bank | 390892 | 203500 | 7.28 | 12.74 | 20.3 | 7 | 5.88 | 13.16 | 14.28 | 18.62 | 33.46 | No |
| Toadsmoor | 387783 | 204209 | 9.24 | 14.42 | 22.96 | 7.84 | 6.16 | 13.16 | 17.08 | 20.58 | 36.12 | Yes |
| Woodchester Park (1-3) | 382005 | 200757 | 10.22 | 15.26 | 25.2 | 7.42 | 5.6 | 11.9 | 17.64 | 20.86 | 37.1 | Yes |
| Workmans Wood (1-3) | 390664 | 210676 | 9.38 | 12.88 | 21.14 | 8.4 | 6.16 | 14.7 | 17.78 | 19.04 | 35.84 | Yes |

av= average weighting for the 5 x 5 km square

m = moorland (non forest)

w = woodland

recommended ciritcal load of 15 kg N/ha/yr

**Table 7 Atmospheric deposition for $NH_3$, NOx and Total Nitrogen compared to a recommended critical load value of 15 kg N/ha/year.**

## 4.6 TUFA MORPHOLOGY AND ASSOCIATION WITH BRYOPHYTES

The definition of H7220 is 'petrifying springs with tufa formation (*Cratoneurion*)' and is somewhat suggestive that it is only *Palustriella commutata* that is associated with, or important for tufa formation. This is far from the truth, and the following discusses our general observations on the occurrence of tufa and association with other bryophytes during this study, illustrated in Figure 4-9. The various types of tufa structures are illustrated in Figure 4-10.

- The occurrence of tufa is by no means a proxy for the likely extent of H7220 habitat. Slade Brook is an excellent example of how several hundred meters of impressive tufa dams can be formed but with relatively little H7220.
- Tufa was deposited upon all sorts of substrates however it generally preferred to form on harder material (e.g. stones or living roots) rather than on soft organic material such as rotting twigs (Beech leaves perhaps being an exception).
- More often, *Palustriella commutata* was observed to grow upon tufa-encrusted stones rather than tufa-encrusted living tree roots or deadwood, and this has implications for potential restoration of tufa dams, with use of imported stone more likely to be successful when considering restoration of tufa dams and pools.
- *Eucladium verticillatum* is well known for its association with tufa, and forms spectacular cushions on some of the cliff sites, but where *Palustriella commutata* was not present (e.g. Aust Cliffs Figure 3-10)
- Perhaps the most interesting observation was the formation of large pools, retained behind tufa dams formed mainly of *Pellia endiviifolia* and *Conocephalum conicum* (e.g. Dowdeswell Figure 3-26).

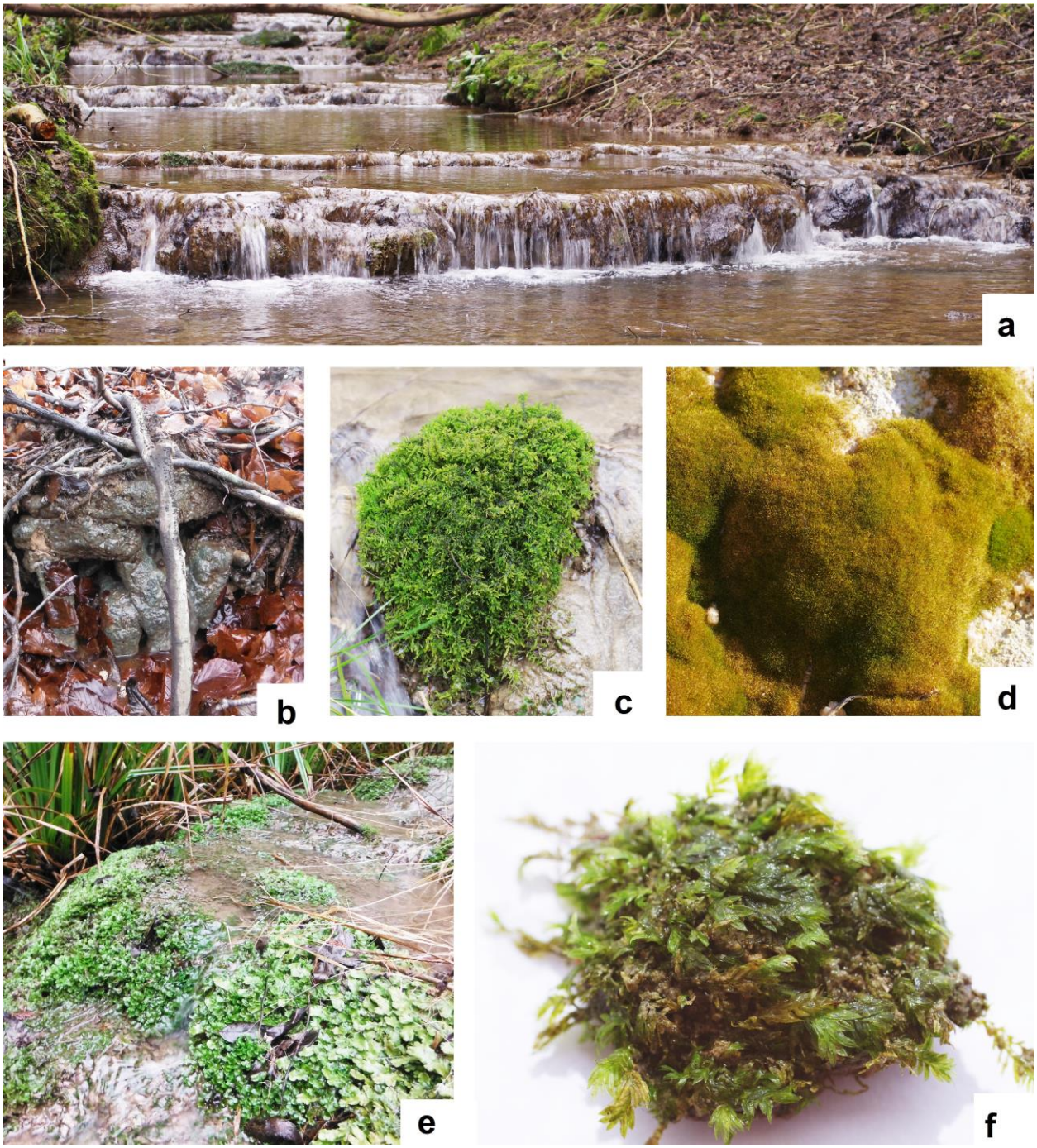



**Figure 4-9 Types of moss -tufa structures**

(a)Tufa dams formed in association with algae and very few bryophytes (Slade Brook); (b) blue/grey-coloured tufa formed in association with algae and no bryophytes (Workmans Wood site 2); (c) developing single patch of *Palustriella commutata* on tufa dam (Dowdeswell); (d) Large cushions of *Eucladium verticillatum* on tufa (Aust Cliff) (e) large tufa dam associated with *Pellia endiviifolia* and *Conocephalum conicum* (Dowdeswell); (f) the small aquatic moss *Fissidens crassipes* on tufa-encrusted stone (Minchinhampton Brook).

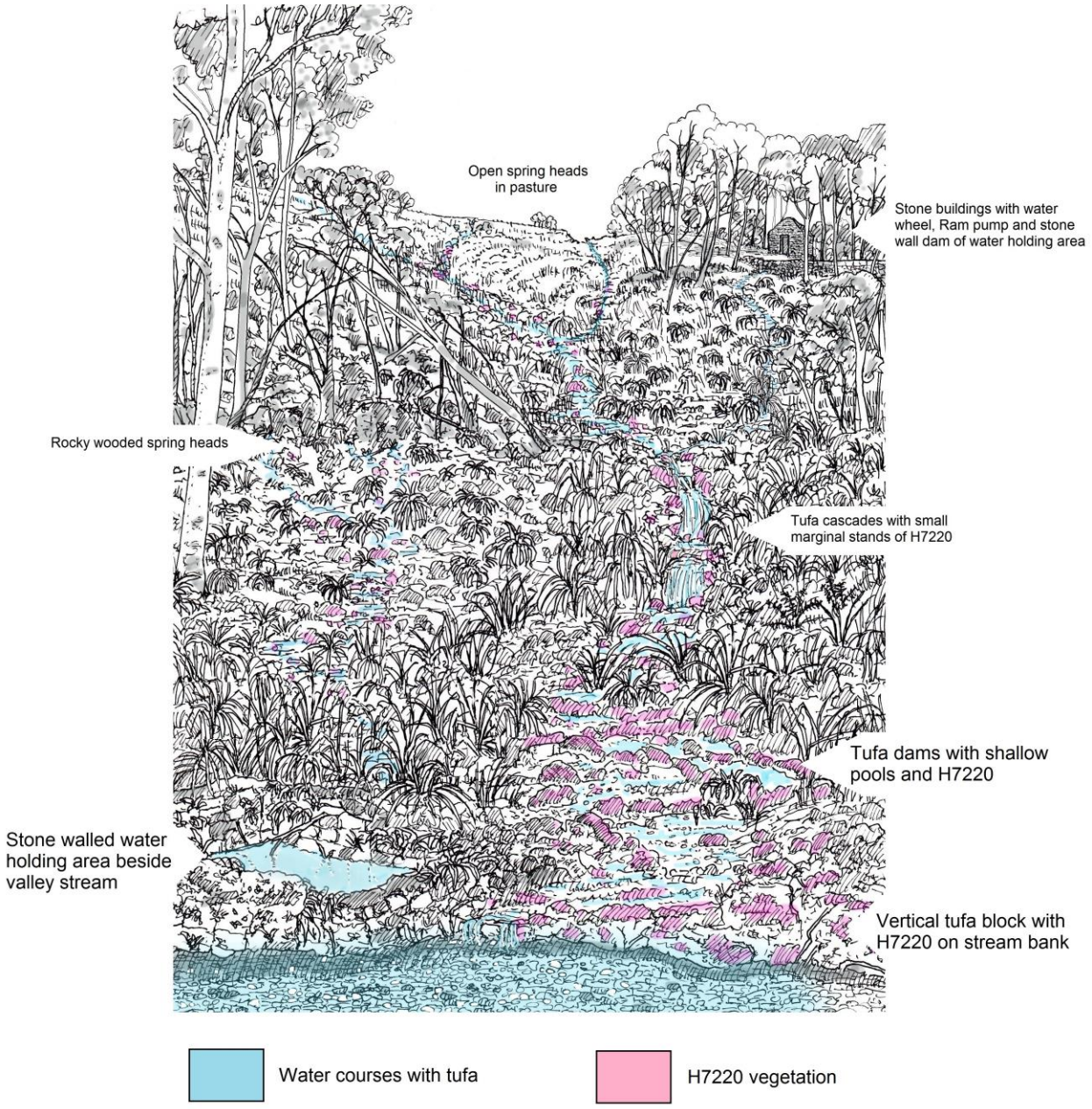



**Figure 4-10 Illustration of the principal H7220 habiats in Gloucstershire**

## 4.7 PRESSURES AND CONDITION ASSESSMENT

Table 8 lists the extent of the H7720 feature for each site and potential associated pressures, including hydrological, grazing, management, soil erosion and nutrient water chemistry. Many of these pressures have the potential to affect the H7220 feature positively or negatively so can be regarded as risks to the favourable conservation status of sites.

The following pressures have been highlighted:

**Statutory Protection:** a high proportion of sites with the H7220 feature (60%) lie within Sites of Special Scientific Interest (SSSI) and are therefore afforded a degree of protection. In addition, Cranham Wood and Workmans Wood site 3 lie within the Cotswold Beechwoods Special Area of Conservation (SAC) and are afforded a higher level of protection from wider land use pressures such as changes to hydrology and housing development. However, the H7220 feature is listed only in one SSSI citation for the sites surveyed (Cotswold Commons and Beechwoods SSSI) and 40% of sites surveys have no statutory protection or are afforded only mild protection in statutory planning law as County Wildlife sites.

**Woodland Management:** the majority of sites surveyed occurred in open (often rocky) woodland on valley sides. Woodland management has the potential to impact (both positively or negatively) on H7220 vegetation associated with flushes by affecting locally both levels of light and humidity. Such management could include tree planting (notably conifers), felling and thinning of woodland stands. In addition, brash (following various types of woodland management) can block seepage channels, shade or smother flush vegetation. Two sites (Dowdeswell and Woodchester Park site 3) have been highlighted where some sections of H7220 vegetation are negatively affected by shading from adjoining conifer plantations. Studies in Germany (Jokić, 2007) show that removal of conifers and replacement with an appropriate native woodland type promotes the regeneration of tufa-forming mosses.

**Grazing:** Two sites surveyed (Strawberry Bank and Toadsmoor) have open areas of H7220 vegetation that are lightly and traditionally grazed by cattle or ponies. In these situations, traditional light grazing is essential for maintaining the open mix of *Palustriella commutata* cushions with various wetland species. In the case of Toadsmoor, H7720 vegetation was grazed in conjunction with a small adjoining area of different "marshy" vegetation. Changes to the grazing regime at these sites (either an increase or abolition of grazing) has the potential to impact both positively or negatively on H7220 vegetation. Over grazing has been observed to negatively affect H7720 sites in Germany by physically damaging tufa formations (some forms of which can be fragile) causing soil erosion and increasing nutrients through dung (Jokic, 2007).

**Soil Erosion:** Several sites surveyed showed general signs of soil erosion (Workmans Wood sites 1 and 2) and in some cases this erosion may relate to the erection of stock fences (Toadsmoor, Kingscote and Horsley Woods site 4). In addition, several sites showed signs of soil erosion that may relate to the temporary increases in channel flow associated with installation of culverts and a single site (Toadsmoor) had soil erosion near to the springhead associated with the inappropriate location of a pig field.

**Hydrological (abstractions):** There are plenty of defunct piston pumps which are of no concern. We only identified one potentially active abstraction at the main spring head at Workmans Wood 3, however the plentiful outflow from the spring did not suggest that the water supply to the site was being degraded.

**Hydrological (drainage):** we identified several historic and modern drainage features, including culverts and drains. The effect, weather positive or negative, of these features is unclear. We propose, based on visual observations only, that some drainage features such as culverts may alter the velocity of the water within proximity to the culvert and thus minimising the ability of tufa and tufa forming mosses to develop.

**Water quality**: Using the recently defined threshold values for N and P only four sites exceeded the nitrate threshold and no sites exceeded the phosphate threshold value.

**Atmospheric deposition:** although there is no specific critical load value for the H7220 habitat, the best estimate of 15 N kg/ Ha/ year is exceeded at all but three sites.

**Condition assessment:** The H7720 feature has been assessed as being in favourable condition for all of the 15 sites where it has been shown to occur. This is based on sites having the greater majority of the H7220 feature in good general condition (in terms of both tufa formations and *Palustriella commutata*-dominated vegetation) and land management being favourable. However, a number of concerns are highlighted for some sites including a number of sites failing for nitrate threshold values (Midger Wood site 1, Toadsmoor, Strawberry Bank, Slade Brook, Kingscote and Horsley Woods sites 1 and 3) and shading associated with conifer plantations (Dowdeswell, Woodchester Park site 3).

| Site | SSSI | H7220 channel length (m) (estimated from aerial maps) | H7220 extent (ha) (estimated from aerial maps) | Currently grazed | Nitrate Threshold Values (28 mg/l NO3 or 6.35mg/l as N) | Phoipshate Threshold Value (0.05mg/l) | Soil erosion | Old water control features present | Other pressures |
|---|---|---|---|---|---|---|---|---|---|
| Alder Carr | No | 80 | 0.76 | No | No | No | No | No | n/a |
| Bathurst Estate | No | 100 | 0.3 | No | No | No | No | Holding pond | n/a |
| Cranham Wood | Yes | 70 | 0.3 | No | No | No | No | No | n/a |
| Dowdeswell | No | 600 | 0.3 | No | No | No | No | No | shading from conifer plantation |
| Kingscote & Horsley Wood (Site 4) | No | 130 | 0.1 | No | No | No | Yes | No | n/a |
| Midger Wood (Site 1) | Yes | 60 | 0.08 | No | YES | No | No | No | n/a |
| Toadsmoor | No | 230 | 0.07 | Yes | YES | No | Yes | Old Ram Pump | n/a |
| Workmans Wood (Site 3) | Yes | 210 | 0.06 | No | No | No | No | Old Ram Pump | Small abstraction at springhead |
| Woodchester Park (Site 3) | Yes | 210 | 0.06 | No | No | No | No | No | shading from conifer plantation |
| Strawberry Bank | Yes (part) | 180 | 0.05 | Yes | YES | No | No | Yes | n/a |
| Midger Wood (Site 2) | Yes | 50 | 0.02 | No | No | No | No | No | n/a |
| Slade Brook | No | 30 | 0.01 | No | YES | No | No | Possible Ram pump | Quarry |
| Kingscote & Horsley Wood (Site 1) | Yes | 40 | 0.008 | No | YES | No | No | No | n/a |
| Kingscote & Horsley Wood (Site 3) | Yes | 4 | 0.0004 | No | YES | No | No | No | n/a |
| Sedbury Cliff | No | 1 | 0.0001 | No | No | No | No | No | Natural cliff falls |
| Aust Cliff | No | 0 | 0 | No | No | No | No | No | Natural cliff falls |
| Kingscote & Horsley Wood (Site 2) | Yes | 0 | 0 | No | No | No | No | Possibly | n/a |
| Minchinhampton Stream | No | 0 | 0 | Yes | No | No | No | No | n/a |
| Woodchester Park (Site 1) | Yes | 0 | 0 | No | No | No | No | Old water catch pit | n/a |
| Woodchester Park (Site 2) | Yes | 0 | 0 | No | No | No | No | Pond | n/a |
| Workmans Wood (Site 1) | Yes | 0 | 0 | No | No | No | Yes | Culvert | n/a |
| Workmans Wood (Site 2) | Yes | 0 | 0 | No | No | No | Yes | Culvert | n/a |
| Total (estimate) | | | 2 ha | | | | | | |

*n.b all areas have been calaculted using GIS and site specific survey is needed for definative measurments*

**Table 8 Estimated extent of H7220 habitat, pressures and chemical threshold values**

# 5. Discussion

The geology, topography, hydrology and land use (e.g. high proportion of open woodland) within Gloucestershire is favourable for the formation of H7720 habitat, and this is reflected in the frequency in which this feature was found at sites. Bryophytes (particularly *Palustriella commutata, Pellia endiviifolia* and *Conocephalum conicum*) are associated with active tufa formation. These 3 relatively robust species were observed to be active in the formation of complex and prominent tufa dams with pools. These features tend to form where there is generally a slow "trickling" water flow.

Tufa dams at Slade Brook are orange/brown in colour, possibly reflecting the influence of sediment from the Old Red Sandstone. Occasionally the tufa dams at Slade Brook are formed in association with the liverwort *Pellia endiviifolia* but generally they occur in the absence of bryophytes or associated just with algae. Unusually, the rare aquatic moss *Fissidens rivularis* was recorded from tufa-encrusted stones within the channel at Slade Brook. The pH recorded for Slade Brook (pH 7.4) was one of the lowest recorded during the survey and contrasted with the majority of sites on the Oolite that had a pH >8.

Open rocky woodland sites on the Oolite (the majority of sites surveyed) are dominated by *Palustriella commutata*. This moss is almost always actively associated with tufa formation and is responsible for the formation of complex tufa dam and associated pools which can greatly enhance the structure of these sites and their biodiversity (invertebrates and flowering plants).

At many sites, complexes of tufa dams and pools appeared to form in the absence of *Palustriella commutata*. In such cases the principle bryophytes involved are *Pellia endiviifolia* and *Conocephalum conicum*. However, these types of dams always occurred within close proximity to stands of *Palustriella commutata* and are considered to be part of the H7220 feature. Vertical dripping faces (stream banks or coastal cliffs) were often dominated by *Eucladium verticillatum* which can sometimes form large cushions with thick associated deposits of tufa.

Slope and water flow appear to be key factors which affect formation of and types of tufa structures. Steeper slopes or streams with faster flowing and deeper water appear to favour more simply structured tufa dams formed without the association of bryophytes (such as at Slade Brook) or merely tufa-encrusted stones with aquatic mosses such as *Fissidens pusillus, F. crassipes* and *Platyhypnidium riparioides*.

Gently sloping sites with lower flow velocities tend to favour more complex development of H7220 habitat dominated by *Palustriella commutata* with *Pellia endiviifolia* and *Conocephalum conicum*. In addition, the water channels of gently sloping sites tend to naturally divide, resulting in further complexity of the tufa dams and pools created. Field observations suggest that *Palustriella commutata* typically starts growth on tufa-encrusted stones within a water channel and is therefore critically important to the formation of tufa dams in low flow sites.

H7720 does occur in open pasture below springheads, typically on tufa-encrusted stones, but the majority of sites occur in open broadleaved woodland. The largest and most structurally diverse H7220 sites were associated with rocky open woodland, and there is good evidence that shading by planted conifers has a negative effect on the vegetation.

Two sites, in particular (Woodchester Park and Workmans Wood), stand out as having great potential for restoration. Both sites have one spring line with good H7220 habitat along with several other spring lines without H7220. Consequently, tufa-encrusted stones with *Palustriella commutata* are locally available for creation of dams to aid restoration.

Field experiments (Gradsinski, 2010; Arenas et al, 2010) record the growth rate of tufa in active streams, by installing small limestone 'tablets' into the flowing water. Sedimentation rates (tufa formation) were variable with a maximum of 13.1mm/year (Arenas et al, 2010) however Gradzinski (2010) note there was no common seasonal trend in tufa growth rates. Although growth rates were variable, both studies suggest that tufa formation will occur within relatively short time frames on suitable material introduced into the water courses. This has promising implications for restoration and suggests that if the correct materials are used (possibly local stones) that tufa formation and the establishment of an associated bryophyte flora will follow.

Several EU LIFE projects have focused on the restoration of petrifying springs, including: LIFE03 'Kalktuffquellen Frankenalb'; LIFE12 'Springday' and LIFE14 'RigKilde' (Full details of these restoration projects can be found on the EU LIFE website http://ec.europa.eu/environment/life/project/Projects/). Removal of spruce, the shade from which caused tufa mosses to die off, and replacement with deciduous woodland has proved successful in (LIFE03), as has the removal of organic material, which has negative effects on tufa springs (LIFE03). LIFE12 project is investigating the design of rapids by using local stone in the watercourses. We contacted the project team but the project is not due to be completed until next year (2018) so they did not have any publications that illustrated their in stream engineering. LIFE14 is still in progress and is focusing on restoring the hydrology and increasing the area of favourable H7220 habitat.

# 6. Recommendations

- This study has highlighted the abundance of H7220 habitat in Gloucestershire, and it is likely (due to high levels of saturated calcium carbonate in spring waters generally and topography) that there is much more of this feature to locate. Identification of the true abundance of this habitat in Gloucestershire could be undertaken by comparing detailed stream and spring maps with geological formations that are known to produce tufa forming springs. This could greatly improve the known coverage for this Annex 1 habitat in England and make it easier to secure this Annex 1 habitat.
- Consider adding H7720 as a notified feature for existing SSSIs where it is not listed and notifying H7220 sites (currently without statutory protection) as County Wildlife sites.
- Several sites have the potential to be considered for restoration of the H7220 habitat including Woodchester Park and Workmans Wood.
- Consider selective removal of conifers from H77720 sites within conifer plantations where shading is highlighted as a problem (i.e. Dowdeswell and Woodchester Park site 3).
- Invertebrate specialists both national and local (Gloucestershire Invertebrate Group GIG) should be encouraged to look specifically at the H7220 habitat.

# 7. Conclusions

- Gloucestershire, due to its geology and often steep topography, has a large potential for the H7220 petrifying spring habitat.
- The total estimated area for 'new' H7220 habitat in Gloucestershire is 2 ha
- During this study we identified 15 sites that fit the European Annex 1 habitat H7220, Petrifying springs with tufa formation (*Cratoneurion*)
- Seven sites had tufa formation but did not have *Palustriella commutata.*
- H7220 sites can vary greatly in area, the smallest was just 0.0001 ha (Sedbury Cliff) and the largest was 0.76 ha (Alder Carr).
- H7220 sites can also vary greatly in length, with the longest tufa stream section identified as H7220 being some 600 m in length (Dowdeswell).
- The following bryophytes are recorded as directly associated with tufa (*Palustriella commutata, Cratoneuron filicinum, Pellia endiviifolia, Fissidens pusillus, Fissidens crassipes, Fissidens rivularis, Fissidens adianthoides, Conocephalum conicum, Chiloscyphus polyanthos, Eucladium verticillatum, Didymodon tophaceus* and *Platyhypnidium riparioides*).

- Nitrate and phosphate values were applied and although several sites exceeded the nitrate threshold value, we could not see any evidence for unfavourable condition at these sites.

- The H7720 feature has been assessed as being in favourable condition for all of the 15 sites where it has been shown to occur although shading (planted conifers) and water quality (nitrogen) have been highlighted as having potential for negative impact.

- Observations include the preference of *Palustriella commutata* to grow in areas of slowly flowing water, this may be one reason for the relatively small H7220 habitat at Slade Brook when compared to slower flowing sites.

- Observations include the preference of *Palustriella commutata* to grow on firm substrates, mainly stones or living roots, as opposed to deadwood or rotting organic matter. We think that stones rather than organic matter (e.g. logs) may provide a better foundation for the restoration of *Palustriella commutata* dams and pools.

- No plants of conservation concern were recorded as directly associated with H7220 vegetation although the following were recorded more generally from sites: the aquatic moss *Fissidens rivularis* (Slade Brook), 6 Red data Book England (Near Threatened) flowering plants; 8 flowering plants generally considered to be ancient woodland indicators.

- Spring and seepages (particularly when calcareous and/or wooded) are of great importance for invertebrates (crane flies, soldier flies and some specialized snails and water beetles. These habitats are widespread in the UK (and include the H7720 habitat) but their associated invertebrate fauna is poorly known.

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# Appendices

# APPENDIX 1. PLANT SPECIES LISTS & STATUS

| SPECIES | English Name | Status |
|---|---|---|
| *Bryophytes* | Mosses & Liverworts | **Gloucestershire status** |
| *Amblystegium serpens var.* | Creeping Feather-moss | Least Concern |
| *Aneura pinguis* | Greasewort | Least Concern |
| *Anomodon viticulosus* | Rambling Tail-moss | Least Concern |
| *Atrichum undulatum* | Common Smoothcap | Least Concern |
| *Barbula convoluta* | Lesser Bird's-claw Beard-moss | Least Concern |
| *Barbula unguiculata* | Bird's-claw Beard-moss | Least Concern |
| *Brachythecium rivulare* | River Feather-moss | Least Concern |
| *Brachythecium rutabulum* | Rough-stalked Feather-moss | Least Concern |
| *Bryum capillare* | Capillary Thread-moss | Least Concern |
| *Calliergonella cuspidata* | Pointed Spear-moss | Least Concern |
| *Calypogeia arguta* | Notched Pouchwort | Least Concern |
| *Calypogeia fissa* | Common Pouchwort | Least Concern |
| *Chiloscyphus polyanthus* | St Winfrid's Moss | Least Concern |
| *Cirriphyllum crassinervium* | Beech Feather-moss | Least Concern |
| *Cirriphyllum piliferum* | Hair pointed Feather-moss | Least Concern |
| *Conocephalum conicum* | Great Scented Liverwort | Least Concern |
| *Conocephalum salebrosum* | Snakewort | Least Concern |
| *Cratoneuron filicinum* | Fern-leaved Hook-moss | Least Concern |
| *Cryphaea heteromalla* | Lateral Cryphaea | Least Concern |
| *Ctenidium molluscum* | Comb-moss | Least Concern |
| *Dichodontium cf flavescens* | Yellowish Fork-moss | Least Concern |
| *Dicranella varia* | Variable Forklet-moss | Least Concern |
| *Dicranoweissia cirrata* | Common Pincushion | Least Concern |
| *Dicranum scoparium* | Broom Fork-moss | Least Concern |
| *Didymodon fallax* | False Beard-moss | Least Concern |
| *Didymodon insulanus* | Cylindric Beard-moss | Least Concern |
| *Didymodon sinuosus* | Wavy Beard-moss | Least Concern |
| *Didymodon tophaceus* | Olive Beard-moss | Least Concern |
| *Encalytpta streptocarpa* | Spiral Extinguisher-moss | Least Concern |
| *Eucladium verticillatum* | Whorled Tufa-moss | Least Concern |
| *Eurhynchium striatum* | Common Striated Feather- | Least Concern |
| *Fissidens adianthoides* | Maidenhair Pocket-moss | Least Concern |
| *Fissidens bryoides* | Lesser Pocket-moss | Least Concern |
| *Fissidens crassipes* | Fatfoot Pocket-moss | Least Concern |
| *Fissidens dubius* | Rock Pocket-moss | Least Concern |
| *Fissidens gracilifolius* | Narrow-leaved Pocket-moss | Least Concern |
| *Fissidens pusillus* | Petty Pocket-moss | Least Concern |
| *Fissidens rivularis* | River Pocket-moss | Least Concern (National Responsibility) |
| *Fissidens rufulus* | Beck Pocket-moss | Least Concern |
| *Fissidens taxifolius* | Common Pocket-moss | Least Concern |
| *Fissidens viridulus* | Green Pocket-moss | Least Concern |
| *Frullania dilatata* | Dilated Scalewort | Least Concern |
| *Frullania tamarisci* | Tamarisk Scalewort | Least Concern |
| *Homalia trichomanoides* | Blunt Feather-moss | Least Concern |
| *Homalothecium sericeum* | Silky wall Feather-moss | Least Concern |
| *Hypnum cupressiforme* | Cypress-leaved Plait-moss | Least Concern |
| *Isothecium alopecuroides* | Larger Mouse-tail Moss | Least Concern |
| *Isothecium myosuroides* | Mouse-tail Moss | Least Concern |
| *Jungermannia atrovirens* | Dark-green Flapwort | Least Concern |
| *Kindbergia praelonga* | Common Feather-moss | Least Concern |
| *Leicolea turbinata* | Top Notchwort | Least Concern |
| *Lejeunea carvifolia* | Michelli's Least Poncewort | Least Concern |
| *Lepidozia reptans* | Creeping Fingerwort | Least Concern |
| *Lophocolea bidentata* | Bifid Crestwort | Least Concern |
| *Lophocolea heterophylla* | Variable-leaved Crestwort | Least Concern |
| *Lunularia cruciata* | Crescent-cup Liverwort | Least Concern |
| *Metzgeria furcata* | Forked Veilwort | Least Concern |
| *Metzgeria temporata* | Whiskered Veilwort | Least Concern |
| *Metzgeria violacea* | Bluish Veilwort | Least Concern |
| *Microlejeunea ulicina* | Fairy Beads | Least Concern |
| *Mnium hornum* | Swan's-neck Thyme-moss | Least Concern |
| *Mnium marginatum* | Bordered Thyme-moss | Least Concern |
| *Neckera complanata* | Flat Neckera | Least Concern |
| *Neckera crispa* | Crisped Neckera | Least Concern |
| *Nowellia curvifolia* | Rustwort | Least Concern |
| *Orthodontium lineare* | Cape Thread-moss | Least Concern |
| *Orthotrichum affine* | Wood Bristle-moss | Least Concern |
| *Orthotrichum lyellii* | Lyell's Bristle-moss | Least Concern |
| *Orthotrichum pulchellum* | Elegant Bristle-moss | Least Concern |
| *Oxyrrhynchium hians* | Swartz's feather-moss | Least Concern |
| *Palustriella commutata* | Curled Hook-moss | Least Concern |
| *Pellia endiviifolia* | Endive Pellia | Least Concern |
| *Phascum cuspidatum* | Cuspidate Earth-wort | Least Concern |
| *Plagiochila asplenioides* | Greater Featherwort | Least Concern |
| *Plagiochila porelloides* | Lesser Featherwort | Least Concern |
| *Plagiomnium ellipticum* | Marsh Thyme-moss | Least Concern |
| *Plagiomnium rostratum* | Long-beaked Thyme-moss | Least Concern |
| *Plagiomnium undulatum* | Hart's-tongue Thyme-moss | Least Concern |
| *Plagiothecium succulentum* | Juicy Silk-moss | Least Concern |
| *Platyhypnidium riparioides* | Long-beaked Water feather- | Least Concern |
| *Pohlia melanodon* | Pink-fruited Thyme-moss | Least Concern |
| *Polytrichastrum formosum* | Bank Haircap | Least Concern |
| *Porella platyphylla* | Wall Scalewort | Least Concern |
| *Pseudoscleropodium purum* | Neat Feather-moss | Least Concern |
| *Radula complanata* | Even Scalewort | Least Concern |
| *Rhizomnium punctaum* | Dotted Thyme-moss | Least Concern |
| *Rhynchostegiella pumila* | Dwarf Feather-moss | Least Concern |
| *Rhynchostegiella teneriffae* | Teesdale Feather-moss | Least Concern |
| *Rhynchostegium confertum* | Clustered Feather-moss | Least Concern |
| *Rhytidiadelphus squarrosus* | Springy Turf-moss | Least Concern |
| *Rhytidiadelphus triquetrus* | Big Shaggy-moss | Least Concern |
| *Riccardia chamedryfolia* | Jagged Germanderwort | Least Concern |
| *Schistidium crassipilum* | Thickpoint Grimmia | Least Concern |
| *Seligeria pusilla* | Dwarf Rock-bristle | Least Concern (National responsibility) |
| *Syntrichia montana* | Intermediate Screw-moss | Least Concern |
| *Thamnobryum alopecurum* | Fox-tail Feather-moss | Least Concern |
| *Thuidium tamariscinum* | Common Tamarisk-moss | Least Concern |
| *Tortella tortuosa* | Frizzled Crisp-moss | Least Concern |
| *Ulota bruchii* | Bruch's Pincushion | Least Concern |
| *Zygodon viridissimus* | Green Yoke-moss | Least Concern |

| SPECIES | English Name | Status |
|---|---|---|
| Angioserms | Flowering plants | **English Red list status** |
| *Acer campestre* | Field Maple | Least Concern |
| *Acer pseudoplatanus* | Sycamore | Least Concern |
| *Ajuga reptans* | Bugle | Least Concern |
| *Allium ursinum* | Wild Garlic | Least Concern |
| *Alnus glutinosa* | Alder | Least Concern |
| *Angelica sylvestris* | Wild Angelica | Least Concern |
| *Anthriscus sylvestris* | Cow parsley | Least Concern |
| *Apium nodiflorum* | Fool's water-cress | Least Concern |
| *Arum maculatum* | Lords-and-Ladies | Least Concern |
| *Asplenium scolopendrium* | Hart's-tongue Fern | Least Concern |
| *Athyrium filix-femina* | Lady-fern | Least Concern |
| *Betula pendula* | Silver Birch | Least Concern |
| *Blechnam spicant* | Hard Fern | Least Concern |
| *Brachypodium sylvaticum* | False-brome | Least Concern |
| *Buddleja davidii* | Buddleia | Least Concern |
| *Caltha palustris* | Marsh Marigold | Least Concern |
| *Cardamine flexuosa* | Wavy Bitter-cress | Least Concern |
| *Cardamine pratense* | Cuckoo Flower | Least Concern |
| *Carex acutiformis* | Lesser Pond-sedge | Least Concern |
| *Carex flacca* | Glaucous Sedge | Least Concern |
| *Carex pendula* | Pendulous Sedge | Least Concern |
| *Carex remota* | Remote Sedge | Least Concern |
| *Carex sylvatica* | Wood Sedge | Least Concern |
| *Centaurea nigra* | Knapweed | Least Concern |
| *Chrysosplenium oppositifolium* | Opposite-leaved Golden- | Least Concern |
| *Cirsium palustre* | Marsh Thistle | Least Concern |
| *Clematis vitalba* | Wild Clematis | Least Concern |
| *Corylus avellana* | Hazel | Least Concern |
| *Crataegus monogyna* | Hawthorn | Least Concern |
| *Dactylis glomerata* | Cock's-foot | Least Concern |
| *Deschampsia cespitosa* | Tufted Hair-grass | Least Concern |
| *Dipsacus fullonum* | Teasel | Least Concern |
| *Dipsacus pilosus* | Small Teasel | Least Concern |
| *Dryopteris dilatata* | Common Buckler-fern | Least Concern |
| *Dryopteris filix-mas* | Male Fern | Least Concern |
| *Epilobium hirsutum* | Greater Willowherb | Least Concern |
| *Epilobium parviflorum* | Hoary Willowherb | Least Concern |
| *Epilobium sp.* | Willowherb sp. | Least Concern |
| *Equisetum telmateia* | Greater Horse-tail | Least Concern |
| *Eupatorium cannabinum* | Hemp-agrimony | Least Concern |
| *Fagus sylvatica* | Beech | Least Concern |
| *Festuca rubra* | Red Fescue | Least Concern |
| *Ficaria verna* | Lesser Celandine | Least Concern |
| *Filipendula ulmaria* | Meadowsweet | Least Concern |
| *Fragaria vesca* | Wild Strawberry | Near Threatened |
| *Fraxinus excelsior* | Ash | Least Concern |
| *Galium aparine* | Cleavers | Least Concern |
| *Galium odoratum* | Sweet Woodruff | Least Concern |
| *Geranium robertianum* | Herb Robert | Least Concern |
| *Geum urbanum* | Herb Bennet | Least Concern |
| *Glechoma hederacea* | Ground Ivy | Least Concern |
| *Glyceria fluitans* | Floating Sweet-grass | Least Concern |
| *Hedera helix ssp. helix* | Ivy | Least Concern |
| *Holcus lanatus* | Yorkshire Fog | Least Concern |
| *Hyacinthoides non-scripta* | Bluebell | Least Concern |
| *Hypericum tetrapterum* | Square-stemmed St John's-wort | Least Concern |
| *Ilex aquifolium* | Holly | Least Concern |
| *Iris pseudacorus* | Yellow Iris | Least Concern |
| *Juncus effusus* | Soft Rush | Least Concern |
| *Juncus inflexus* | Hard Rush | Least Concern |
| *Lamiastrum galeobdolon* | Yellow Archangel | Least Concern |
| *Lapsana communis* | Nipplewort | Least Concern |
| *Larix decidua* | European Larch | Planted non-native |
| *Ligustrum vulgare* | Wild Privet | Least Concern |
| *Lonicera nitida* | Wilson's Honeysuckle | Planted non-native |
| *Lonicera periclymenum* | Honeysuckle | Least Concern |
| *Lysimachia nemorum* | Yellow Pimpernel | Least Concern |
| *Malus sylvestris* | Crab Apple | Least Concern |
| *Mentha aquatica* | Water Mint | Least Concern |
| *Mercurialis perennis* | Dog's Mercury | Least Concern |
| *Myosotis scorpioides* | Water Forget-me-not | Least Concern |
| *Nasturtium officinale sensu. lato.* | Water-cress | Least Concern |
| *Oxalis acetosella* | Wood Sorrell | Near Threatened |
| *Phalaris arundinacea* | Reed Canary-grass | Least Concern |
| *Phragmites australis* | Reed | Least Concern |
| *Picea abies* | Norway Spruce | Planted non-native |
| *Plantago lanceolata* | Ribwort Plantain | Least Concern |
| *Poa trivialis* | Rough-leaved Meadow-grass | Least Concern |
| *Polypodium vulgare* | Common Polypoid | Least Concern |
| *Polystichum aculeatum* | Hard-fern | Least Concern |
| *Polystichum setiferum* | Soft-fern | Least Concern |
| *Populus x canadensis* | Hybrid Black Poplar | Planted non-native |
| *Poterium sanguisorba* | Salad Burnet | Least Concern |
| *Primula veris* | Cowslip | Least Concern |
| *Primula vulgaris* | Primrose | Least Concern |
| *Prunella vulgaris* | Self-heal | Least Concern |
| *Pseudotsuga menziesii* | Douglas Fir | Planted non-native |
| *Pteridium aquilinum* | Bracken | Least Concern |
| *Pulicaris dysenterica* | Fleabane | Least Concern |
| *Quercus robur* | Pedunculate Oak | Least Concern |
| *Ranunculus repens* | Creeping Buttercup | Least Concern |
| *Rosa canina agg.* | Dog Rose | Least Concern |
| *Rubia peregrina* | Wild Madder | Least Concern |
| *Rubus fruticosus agg.* | Bramble | Least Concern |
| *Rumex conglomeratus* | Clustered Dock | Least Concern |
| *Salix caprea* | Goat Willow | Least Concern |
| *Salix cinerea* | Grey Willow | Least Concern |
| *Salix x fragilis* | Crack Willow | Least Concern |
| *Sambucus nigra* | Elder | Least Concern |
| *Sanicula europaea* | Wood Sanicle | Near Threatened |
| *Scrophularia auriculata* | Water Betony | Least Concern |
| *Senecio aquaticus* | Marsh Ragwort | Near Threatened |
| *Silene dioica* | Red Campion | Least Concern |
| *Stachys sylvatica* | Hedge Woundwort | Least Concern |
| *Stellaria holostea* | Greater Stitchwort | Least Concern |
| *Taraxacum sp.* | Dandelion | Least Concern |
| *Taxus baccata* | Yew | Least Concern |
| *Thuja plicata* | Western Red Cedar | Planted non-native |
| *Trifolium repens* | White Clover | Least Concern |
| *Ulmus glabra* | Wych Elm | Least Concern |
| *Ulmus sp.* | Elm sp. | Least Concern |
| *Urtica dioica* | Nettle | Least Concern |
| *Valeriana dioica* | Marsh Valerian | Near Threatened |
| *Valeriana officinalis* | Valerian | Near Threatened |
| *Veronica beccabunga* | Brooklime | Least Concern |
| *Veronica chamaedrys* | Germander Speedwell | Least Concern |
| *Viola odorata* | Sweet Violet | Least Concern |
| *Viola riviniana* | Dog Violet | Least Concern |

| SPECIES | English Name | Status |
|---|---|---|
| Lichens | Lichens | **Gloucestershire status** |
| *Evernia prunastri* | Oak Moss | N/a |
| *Flavoparmelia caperata* | Common Greenshield Lichen | N/a |
| *Hypogymnia tubulosa* | Tubular Lichen | N/a |
| *Peltigera cf horizontalis* | Brown horizontal Lichen | N/a |
| *Pertusaria multipuncta* | Many-dotted Lichen | N/a |
| *Ramalina fasgiata* | - | N/a |
| Fungi | Fungi | |
| *Auricularia auricula-judae* | Jelly Ear | N/a |

# APPENDIX 2. PLANT RECORDS

## Alder Carr Wet woodland (Wades Mill), S of Pitchcombe SO85290789, 22/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Allium ursinum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Alnus glutinosa | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Angelica sylvestris | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Apium nodiflorum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | open seepages close to river |
| Asplenium scolopendrium | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Brachypodium sylvaticum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Brachythecium rivulare | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | frequent at spring head, occasional below |
| Brachythecium rutabulum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | occasional on old stumps and tree bases (above the flood water level) |
| Bryum capillare | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | epiphyte on old hazel, fruiting |
| Caltha palustris | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Cardamine flexuosa | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Cardamine pratense | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Carex pendula | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | dominating much of the swampy ground layer |
| Carex remota | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Carex sylvatica | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Chrysosplenium oppositifolium | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | mainly in open seepages close to river |
| Conocephalum conicum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | occasional |
| Corylus avellana | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Cratoneuron filicinum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | frequent at spring head on stones and tree roots (associated with tufa), occasional below |
| Cryphaea heteromalla | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | epiphyte on old hazel, fruiting |
| Didymodon sinuosus | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | shaded rocks beside lower part of stream (confluence with main river) |
| Dryopteris dilatata | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Dryopteris filix-mas | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Equisetum telmateia | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | single plant in flushed area |
| Fagus sylvatica | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Ficaria verna ssp. verna | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Fissidens taxifolius | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | frequent (and associated with tufa) |
| Fraxinus excelsior | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Frullania dilatata | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | epiphyte on hazel, with perianths |
| Geum urbanum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Glechoma hederacea | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Hedera helix ssp. helix | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Hypnum cupressiforme | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | epiphyte on trunks of larger trees |
| Ilex aquifolium | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Iris pseudacorus | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Isothecium myosuroides | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | epiphyte on trunks of larger trees |
| Kindbergia praelonga | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | occasional on old stumps and tree bases (above the flood water level) |
| Lamiastrum galeobdolon | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Lonicera periclymenum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Lophocolea bidentata | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | tree bases |
| Mercurialis perennis | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Metzgeria furcata | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | epiphyte on hazel |
| Mnium hornum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | log (local) |
| Orthotrichum affine | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | epiphyte on hazel, fruiting |
| Oxyrrhynchium hians | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | frequent |
| Palustriella commutata | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | locally dominant stands below spring head on stones and forming low tufa terraces |
| Pellia endiviifolia | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | frequent at spring head on stones and tree roots (associated with tufa), occasional below |
| Plagiomnium rostratum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | logs and flushed areas |
| Plagiomnium undulatum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Plagiothecium succulentum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | oak stump, fruiting [lf cells 16-20 x 100-120um] |
| Platyhypnidium riparioides | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | rocks in main river (confluence of spring) |
| Poa trivialis | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Quercus robur | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Radula complanata | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | epiphyte on old hazel, with perianths |
| Ranunculus repens | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | open seepages close to river |
| Rhizomnium punctaum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | log (local) |
| Rhynchostegium confertum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | epiphyte on old hazel, fruiting |
| Rumex conglomeratus | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | open seepages close to river (with old seed heads) |
| Sanicula europaea | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Silene dioica | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Thamnobryum alopecurum | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |
| Ulmus glabra | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | local |
| Ulota bruchii | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | epiphyte on old hazel, fruiting |
| Urtica dioica | 'spring head in swampy alder woodland bordering stream (with Palustriella and tufa) | |

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Aneura pinguis | ,Open area of shallow Cliff with seepage and tufa | occasional creeping over other bryophytes that are forming tufa [checked microscopically] |
| Calliergonella cuspidata | ,Open area of shallow Cliff with seepage and tufa | occasional dominant stands in seepages at base of and below limestone rock face |
| Carex acutiformis | ,Open area of shallow Cliff with seepage and tufa | seepages below limestone rock face |
| Carex flacca | ,Open area of shallow Cliff with seepage and tufa | seepages below limestone rock face |
| Crataegus monogyna | ,Open area of shallow Cliff with seepage and tufa | limestone rock face |
| Cratoneuron filicinum | ,Open area of shallow Cliff with seepage and tufa | frequent on dripping rocks, associated with tufa formation |
| Dactylis glomerata | ,Open area of shallow Cliff with seepage and tufa | limestone rock face |
| Didymodon tophaceus | ,Open area of shallow Cliff with seepage and tufa | frequent stands forming tufa, fruiting |
| Equisetum telmateia | ,Open area of shallow Cliff with seepage and tufa | seepages below limestone rock face |
| Eucladium verticillatum | ,Open area of shallow Cliff with seepage and tufa | dominant stands forming tufa [checked microscopically] |
| Eupatorium cannabinum | ,Open area of shallow Cliff with seepage and tufa | seepages below limestone rock face |
| Filipendula ulmaria | ,Open area of shallow Cliff with seepage and tufa | seepages below limestone rock face |
| Hedera helix ssp. helix | ,Open area of shallow Cliff with seepage and tufa | limestone rock face |
| Ligustrum vulgare | ,Open area of shallow Cliff with seepage and tufa | limestone rock face |
| Pellia endiviifolia | ,Open area of shallow Cliff with seepage and tufa | locally dominant patches on dripping soil covered rocks, associated with tufa formation |
| Phalaris arundinacea | ,Open area of shallow Cliff with seepage and tufa | seepages below limestone rock face |
| Phragmites australis | ,Open area of shallow Cliff with seepage and tufa | seepages below limestone rock face |
| Plantago lanceolata | ,Open area of shallow Cliff with seepage and tufa | limestone rock face |
| Riccardia chamedryfolia | ,Open area of shallow Cliff with seepage and tufa | rare (one place only) creeping over other bryophytes that are forming tufa in shade [checked microscopically] |
| Rosa canina agg. | ,Open area of shallow Cliff with seepage and tufa | limestone rock face |
| Rubus fruticosus agg. | ,Open area of shallow Cliff with seepage and tufa | limestone rock face |

# Bathurst Estate (Hen Wood Sapperton) SO9502, 27/02/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Acer campestre | Ancient woodland with springs and tufa terraces | |
| Allium ursinum | Ancient woodland with springs and tufa terraces | |
| Anomodon viticulosus | Ancient woodland with springs and tufa terraces | large shaded limestone blocks/ crags above main spring head |
| Asplenium scolopendrium | Ancient woodland with springs and tufa terraces | |
| Brachypodium sylvaticum | Ancient woodland with springs and tufa terraces | |
| Brachythecium rivulare | Ancient woodland with springs and tufa terraces | |
| Brachythecium rutabulum | Ancient woodland with springs and tufa terraces | mainly as an epiphyte on the lower trunks of trees |
| Calliergonella cuspidata | Ancient woodland with springs and tufa terraces | locally dominant at main spring head |
| Carex pendula | Ancient woodland with springs and tufa terraces | |
| Carex remota | Ancient woodland with springs and tufa terraces | |
| Carex sylvatica | Ancient woodland with springs and tufa terraces | |
| Chrysosplenium oppositifolium | Ancient woodland with springs and tufa terraces | |
| Cirriphyllum crassinervium | Ancient woodland with springs and tufa terraces | occasional on boulders beside stream |
| Conocephalum salebrosum | Ancient woodland with springs and tufa terraces | occasional (mainly on limestone boulders) |
| Corylus avellana | Ancient woodland with springs and tufa terraces | |
| Cratoneuron filicinum | Ancient woodland with springs and tufa terraces | on limestone, roots beside stream, associated with tufa |
| Ctenidium molluscum | Ancient woodland with springs and tufa terraces | tops of limestone boulders |
| Deschampsia cespitosa | Ancient woodland with springs and tufa terraces | |
| Dicranum scoparium | Ancient woodland with springs and tufa terraces | local epiphyte on ash |
| Didymodon fallax | Ancient woodland with springs and tufa terraces | tops of limestone boulders, fruiting |
| Dryopteris dilatata | Ancient woodland with springs and tufa terraces | |
| Dryopteris filix-mas | Ancient woodland with springs and tufa terraces | |
| Eucladium verticillatum | Ancient woodland with springs and tufa terraces | on shaded limestone blocks/ crags with tufa (main spring head) and on tufa terraces below [checked microscopically] |
| Eurhynchium striatum | Ancient woodland with springs and tufa terraces | |
| Fagus sylvatica | Ancient woodland with springs and tufa terraces | |
| Fissidens dubius | Ancient woodland with springs and tufa terraces | tops of limestone boulders, fruiting (lf cells 10-12um, pale lf margin weak) |
| Fissidens taxifolius | Ancient woodland with springs and tufa terraces | frequent |
| Fraxinus excelsior | Ancient woodland with springs and tufa terraces | |
| Frullania dilatata | Ancient woodland with springs and tufa terraces | epiphyte on hazel (with perianths) |
| Frullania tamarisci | Ancient woodland with springs and tufa terraces | local on tops of limestone boulders and epiphyte on ash |
| Geranium robertianum | Ancient woodland with springs and tufa terraces | |
| Glechoma hederacea | Ancient woodland with springs and tufa terraces | |
| Hedera helix ssp. helix | Ancient woodland with springs and tufa terraces | |
| Homalothecium sericeum | Ancient woodland with springs and tufa terraces | epiphyte on ash |
| Hyacinthoides non-scripta | Ancient woodland with springs and tufa terraces | |
| Hypnum cupressiforme | Ancient woodland with springs and tufa terraces | epiphyte on ash and field maple, fruiting |
| Isothecium alopecuroides | Ancient woodland with springs and tufa terraces | local epiphyte on ash |
| Isothecium myosuroides | Ancient woodland with springs and tufa terraces | epiphyte on lower trunks of larger trees |
| Jungermannia atrovirens | Ancient woodland with springs and tufa terraces | occasional creeping through other bryophyte (limestone boulders by stream), on tufa and pure stands on stones at edge of stream (lowing lower part of stream close to confluence with River Frome)[non fertile plants] |
| Kindbergia praelonga | Ancient woodland with springs and tufa terraces | mainly as an epiphyte on the lower trunks of trees |
| Lamiastrum galeobdolon | Ancient woodland with springs and tufa terraces | |
| Lepidozia reptans | Ancient woodland with springs and tufa terraces | local on logs |
| Lophocolea bidentata | Ancient woodland with springs and tufa terraces | logs |
| Lunularia cruciata | Ancient woodland with springs and tufa terraces | local on soil beside stream (lowing lower part of stream close to confluence with River Frome) |
| Metzgeria furcata | Ancient woodland with springs and tufa terraces | epiphyte on ash, hazel and field maple |
| Metzgeria violacea | Ancient woodland with springs and tufa terraces | epiphyte on hazel |
| Mnium hornum | Ancient woodland with springs and tufa terraces | logs |
| Nasturtium officinale s.l. | Ancient woodland with springs and tufa terraces | dominating small pool beneath main spring head |
| Neckera complanata | Ancient woodland with springs and tufa terraces | epiphyte on ash |
| Neckera crispa | Ancient woodland with springs and tufa terraces | large shaded limestone blocks/ crags above main spring head |
| Nowellia curvifolia | Ancient woodland with springs and tufa terraces | local on logs |
| Orthotrichum affine | Ancient woodland with springs and tufa terraces | epiphyte on ash, hazel and field maple, fruiting |
| Palustriella commutata | Ancient woodland with springs and tufa terraces | dominating much of site forming extensive tufa terraces |
| Pellia endiviifolia | Ancient woodland with springs and tufa terraces | frequent, often associated with tufa |
| Plagiochila asplenioides | Ancient woodland with springs and tufa terraces | occasional on soil and tops of limestone boulders |
| Plagiochila porelloides | Ancient woodland with springs and tufa terraces | local on tops of limestone boulders and epiphyte on lower trunks of larger trees |
| Plagiomnium rostratum | Ancient woodland with springs and tufa terraces | |
| Plagiomnium undulatum | Ancient woodland with springs and tufa terraces | |
| Platyhypnidium riparioides | Ancient woodland with springs and tufa terraces | on limestone, faster flowing lower part of stream (close to confluence with River Frome) |
| Polystichum setiferum | Ancient woodland with springs and tufa terraces | |
| Primula vulgaris | Ancient woodland with springs and tufa terraces | |
| Radula complanata | Ancient woodland with springs and tufa terraces | epiphyte on hazel (with perianths) |
| Ranunculus repens | Ancient woodland with springs and tufa terraces | beside stream (lowing lower part of stream close to confluence with River Frome) |
| Rhizomnium punctaum | Ancient woodland with springs and tufa terraces | logs |
| Rhytidiadelphus triquetrus | Ancient woodland with springs and tufa terraces | local |
| Salix caprea | Ancient woodland with springs and tufa terraces | |
| Thamnobryum alopecurum | Ancient woodland with springs and tufa terraces | |
| Thuidium tamariscinum | Ancient woodland with springs and tufa terraces | local |
| Tortella tortuosa | Ancient woodland with springs and tufa terraces | tops of limestone boulders |
| Ulota bruchii | Ancient woodland with springs and tufa terraces | epiphyte on hazel and field maple, fruiting |
| Viola odorata | Ancient woodland with springs and tufa terraces | |
| Zygodon viridissimus | Ancient woodland with springs and tufa terraces | epiphyte on ash and field maple, fruiting |

# Craham Woods SO9012, 18/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Ulota bruchii | woodland spring head and stream with Palustriella tufa terraces | |
| Ulota bruchii | woodland spring head and stream with Palustriella tufa terraces | |
| Asplenium scolopendrium | woodland spring head and stream with Palustriella tufa terraces | |
| Barbula unguiculata | woodland spring head and stream with Palustriella tufa terraces | tufa and soil spoil (old badger hole) |
| Brachythecium rivulare | woodland spring head and stream with Palustriella tufa terraces | abundant around spring head and below (beside tufa terraces) |
| Brachythecium rutabulum | woodland spring head and stream with Palustriella tufa terraces | mostly as an epiphyte on tree bases |
| Calliergonella cuspidata | woodland spring head and stream with Palustriella tufa terraces | local patches below spring head |
| Cardamine flexuosa | woodland spring head and stream with Palustriella tufa terraces | |
| Carex pendula | woodland spring head and stream with Palustriella tufa terraces | |
| Carex remota | woodland spring head and stream with Palustriella tufa terraces | |
| Carex sylvatica | woodland spring head and stream with Palustriella tufa terraces | local |
| Chrysosplenium oppositifolium | woodland spring head and stream with Palustriella tufa terraces | |
| Conocephalum conicum | woodland spring head and stream with Palustriella tufa terraces | occasional |
| Cratoneuron filicinum | woodland spring head and stream with Palustriella tufa terraces | frequent around spring head and below on tufa terraces |
| Ctenidium molluscum | woodland spring head and stream with Palustriella tufa terraces | on vertical limestone beside spring head (this one place only) |
| Deschampsia cespitosa | woodland spring head and stream with Palustriella tufa terraces | |
| Didymodon insulanus | woodland spring head and stream with Palustriella tufa terraces | on flat topped old tufa with Eucladium |
| Dryopteris filix-mas | woodland spring head and stream with Palustriella tufa terraces | |
| Eucladium verticillatum | woodland spring head and stream with Palustriella tufa terraces | on tufa terraces below spring head |
| Eurhynchium striatum | woodland spring head and stream with Palustriella tufa terraces | |
| Fagus sylvatica | woodland spring head and stream with Palustriella tufa terraces | |
| Fissidens bryoides | woodland spring head and stream with Palustriella tufa terraces | on clay back beside spring head (away from water), fruiting (lf margin reaching nerve) |
| Fissidens pusillus | woodland spring head and stream with Palustriella tufa terraces | on limestone beside spring head, fruiting (lf cells 8-10um, spores 8-12um, lf apex acute) |
| Fissidens taxifolius | woodland spring head and stream with Palustriella tufa terraces | frequent, fruiting (often on tufa) |
| Fraxinus excelsior | woodland spring head and stream with Palustriella tufa terraces | |
| Galium odoratum | woodland spring head and stream with Palustriella tufa terraces | local |
| Geranium robertianum | woodland spring head and stream with Palustriella tufa terraces | |
| Geum urbanum | woodland spring head and stream with Palustriella tufa terraces | |
| Hedera helix ssp. helix | woodland spring head and stream with Palustriella tufa terraces | |
| Hypnum cupressiforme | woodland spring head and stream with Palustriella tufa terraces | epiphyte on tree bases |
| Ilex aquifolium | woodland spring head and stream with Palustriella tufa terraces | |
| Lamiastrum galeobdolon | woodland spring head and stream with Palustriella tufa terraces | local |
| Lophocolea bidentata | woodland spring head and stream with Palustriella tufa terraces | tree bases and logs |
| Mentha aquatica | woodland spring head and stream with Palustriella tufa terraces | local (under spring head) |
| Metzgeria furcata | woodland spring head and stream with Palustriella tufa terraces | epiphyte on ash |
| Orthotrichum affine | woodland spring head and stream with Palustriella tufa terraces | epiphyte on ash, fruiting |
| Oxyrrhynchium hians | woodland spring head and stream with Palustriella tufa terraces | |
| Palustriella commutata | woodland spring head and stream with Palustriella tufa terraces | abundant forming tufa terraces below spring head |
| Pellia endiviifolia | woodland spring head and stream with Palustriella tufa terraces | abundant |
| Plagiomnium rostratum | woodland spring head and stream with Palustriella tufa terraces | local on limestone beside stream |
| Plagiomnium undulatum | woodland spring head and stream with Palustriella tufa terraces | |
| Poa trivialis | woodland spring head and stream with Palustriella tufa terraces | |
| Polystichum setiferum | woodland spring head and stream with Palustriella tufa terraces | |
| Ranunculus repens | woodland spring head and stream with Palustriella tufa terraces | |
| Rhynchostegium confertum | woodland spring head and stream with Palustriella tufa terraces | on shaded limestone near spring head |
| Taxus baccata | woodland spring head and stream with Palustriella tufa terraces | |
| Thamnobryum alopecurum | woodland spring head and stream with Palustriella tufa terraces | frequent |
| Ulota bruchii | woodland spring head and stream with Palustriella tufa terraces | epiphyte on ash, fruiting |
| Viola riviniana | woodland spring head and stream with Palustriella tufa terraces | |
| Zygodon viridissimus | woodland spring head and stream with Palustriella tufa terraces | epiphyte on ash |

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Acer campestre | wooded stream connecting to River Chelt (Scobb Grove) | |
| Ajuga reptans | wooded stream connecting to River Chelt (Scobb Grove) | occasional below (close to confluence with River Chelt) |
| Allium ursinum | wooded stream connecting to River Chelt (Scobb Grove) | |
| Amblystegium serpens var. | wooded stream connecting to River Chelt (Scobb Grove) | on small stones (limestone) |
| Angelica sylvestris | wooded stream connecting to River Chelt (Scobb Grove) | wider and open area with seepages and marshy vegetation |
| Arum maculatum | wooded stream connecting to River Chelt (Scobb Grove) | |
| Asplenium scolopendrium | wooded stream connecting to River Chelt (Scobb Grove) | |
| Atrichum undulatum | wooded stream connecting to River Chelt (Scobb Grove) | very local on clay banks beside stream (close to confluence with River Chelt) |
| Brachypodium sylvaticum | wooded stream connecting to River Chelt (Scobb Grove) | |
| Brachythecium rivulare | wooded stream connecting to River Chelt (Scobb Grove) | more frequent in upper section of stream nearer spring head |
| Brachythecium rutabulum | wooded stream connecting to River Chelt (Scobb Grove) | |
| Calliergonella cuspidata | wooded stream connecting to River Chelt (Scobb Grove) | occasional<br>local on steep clay banks beside stream (close to confluence with River Chelt) |
| Calypogeia fissa | wooded stream connecting to River Chelt (Scobb Grove) | [checked microscopically] |
| Cardamine pratense | wooded stream connecting to River Chelt (Scobb Grove) | mainly in open areas adjoining stream |
| Carex pendula | wooded stream connecting to River Chelt (Scobb Grove) | locally dominant in open areas adjoining stream |
| Carex remota | wooded stream connecting to River Chelt (Scobb Grove) | local |
| Carex sylvatica | wooded stream connecting to River Chelt (Scobb Grove) | local |
| Chrysosplenium oppositifolium | wooded stream connecting to River Chelt (Scobb Grove) | |
| Cirriphyllum piliferum | wooded stream connecting to River Chelt (Scobb Grove) | occasional |
| Clematis vitalba | wooded stream connecting to River Chelt (Scobb Grove) | |
| Conocephalum conicum | wooded stream connecting to River Chelt (Scobb Grove) | locally frequent (occasional associated with tufa but usually a secondary colonist of Pellia tufa dams) |
| Corylus avellana | wooded stream connecting to River Chelt (Scobb Grove) | |
| Crataegus monogyna | wooded stream connecting to River Chelt (Scobb Grove) | |
| Cratoneuron filicinum | wooded stream connecting to River Chelt (Scobb Grove) | more frequent in upper section of stream nearer spring head |
| Cryphaea heteromalla | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte, fruiting (Goat Willow) |
| Deschampsia cespitosa | wooded stream connecting to River Chelt (Scobb Grove) | |
| Dipsacus pilosus | wooded stream connecting to River Chelt (Scobb Grove) | occasional below (close to confluence with River Chelt) |
| Dryopteris dilatata | wooded stream connecting to River Chelt (Scobb Grove) | |
| Dryopteris filix-mas | wooded stream connecting to River Chelt (Scobb Grove) | |
| Equisetum telmateia | wooded stream connecting to River Chelt (Scobb Grove) | wider and open area with seepages and marshy vegetation |
| Eupatorium cannabinum | wooded stream connecting to River Chelt (Scobb Grove) | wider and open area with seepages and marshy vegetation |
| Eurhynchium striatum | wooded stream connecting to River Chelt (Scobb Grove) | |
| Evernia prunastri | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte (Ash) |
| Fagus sylvatica | wooded stream connecting to River Chelt (Scobb Grove) | |
| Ficaria verna ssp. verna | wooded stream connecting to River Chelt (Scobb Grove) | occasional below (close to confluence with River Chelt) |
| Fissidens bryoides | wooded stream connecting to River Chelt (Scobb Grove) | clay banks beside stream, fruiting (spores 10-14um), most pants with gemmiferous male buds, lvs acute |
| Fissidens pusillus | wooded stream connecting to River Chelt (Scobb Grove) | Tiny plants (cells 8-10um) growing directly on limestone within stream channel, fruiting (spores 12-14um), lf border ceasing below apex, perichaetial lvs to x6 longer than wide |
| Fissidens taxifolius | wooded stream connecting to River Chelt (Scobb Grove) | frequent, fruiting |
| Fraxinus excelsior | wooded stream connecting to River Chelt (Scobb Grove) | |
| Frullania dilatata | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte (Ash) |
| Galium odoratum | wooded stream connecting to River Chelt (Scobb Grove) | occasional below (close to confluence with River Chelt) |
| Geranium robertianum | wooded stream connecting to River Chelt (Scobb Grove) | occasional |
| Geum urbanum | wooded stream connecting to River Chelt (Scobb Grove) | occasional below (close to confluence with River Chelt) |
| Glechoma hederacea | wooded stream connecting to River Chelt (Scobb Grove) | |
| Hedera helix ssp. helix | wooded stream connecting to River Chelt (Scobb Grove) | |
| Hypnum cupressiforme | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte (Goat Willow) |
| Ilex aquifolium | wooded stream connecting to River Chelt (Scobb Grove) | |
| Kindbergia praelonga | wooded stream connecting to River Chelt (Scobb Grove) | |
| Lamiastrum galeobdolon | wooded stream connecting to River Chelt (Scobb Grove) | occasional below (close to confluence with River Chelt) |
| Lophocolea bidentata | wooded stream connecting to River Chelt (Scobb Grove) | mostly on logs |
| Mercurialis perennis | wooded stream connecting to River Chelt (Scobb Grove) | |
| Metzgeria furcata | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte (Ash) |
| Metzgeria violacea | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte (Ash) |
| Mnium hornum | wooded stream connecting to River Chelt (Scobb Grove) | occasional on logs |
| Neckera complanata | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte (Ash trunk) |
| Orthotrichum affine | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte, fruiting (Goat Willow) |
| Orthotrichum lyellii | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte (Ash) |
| Orthotrichum pulchellum | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte, fruiting (Ash & Elder) |
| Oxalis acetosella | wooded stream connecting to River Chelt (Scobb Grove) | occasional below (close to confluence with River Chelt) |
| Oxyrrhynchium hians | wooded stream connecting to River Chelt (Scobb Grove) | |
| Palustriella commutata | wooded stream connecting to River Chelt (Scobb Grove) | actively forming tufa dams in central section of stream, absent from spring |
| Pellia endiviifolia | wooded stream connecting to River Chelt (Scobb Grove) | locally frequent and actively forming tufa |
| Picea abies | wooded stream connecting to River Chelt (Scobb Grove) | |
| Plagiochila asplenioides | wooded stream connecting to River Chelt (Scobb Grove) | local on clay banks<br>very local below (close to confluence with River Chelt) on steep clay banks |
| Plagiochila porelloides | wooded stream connecting to River Chelt (Scobb Grove) | and tree bases within deeper humid cut of stream [checked microscopically] |
| Plagiomnium rostratum | wooded stream connecting to River Chelt (Scobb Grove) | locally frequent, some stands fruiting |
| Plagiomnium undulatum | wooded stream connecting to River Chelt (Scobb Grove) | frequent |
| Plagiothecium succulentum | wooded stream connecting to River Chelt (Scobb Grove) | local on logs, fruiting (lf cells 16 x 120um, x7 long as wide) |
| Platyhypnidium riparioides | wooded stream connecting to River Chelt (Scobb Grove) | local on limestone in faster flowing sections of stream and associated with |
| Poa trivialis | wooded stream connecting to River Chelt (Scobb Grove) | |
| Polystichum setiferum | wooded stream connecting to River Chelt (Scobb Grove) | |
| Pseudotsuga menziesii | wooded stream connecting to River Chelt (Scobb Grove) | |
| Quercus robur | wooded stream connecting to River Chelt (Scobb Grove) | |
| Radula complanata | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte, with perianths (Ash) |
| Rhizomnium punctatum | wooded stream connecting to River Chelt (Scobb Grove) | occasional on logs |
| Rhynchostegium confertum | wooded stream connecting to River Chelt (Scobb Grove) | occasional on stone (limestone) and tree bases, fruiting |
| Rubus fruticosus agg. | wooded stream connecting to River Chelt (Scobb Grove) | |
| Salix caprea | wooded stream connecting to River Chelt (Scobb Grove) | |
| Sambucus nigra | wooded stream connecting to River Chelt (Scobb Grove) | |
| Scrophularia auriculata | wooded stream connecting to River Chelt (Scobb Grove) | |
| Silene dioica | wooded stream connecting to River Chelt (Scobb Grove) | occasional below (close to confluence with River Chelt) |
| Stellaria holostea | wooded stream connecting to River Chelt (Scobb Grove) | occasional below (close to confluence with River Chelt) |
| Thamnobryum alopecurum | wooded stream connecting to River Chelt (Scobb Grove) | |
| Thuidium tamariscinum | wooded stream connecting to River Chelt (Scobb Grove) | local |
| Thuja plicata | wooded stream connecting to River Chelt (Scobb Grove) | |
| Ulota bruchii | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte, fruiting (Goat Willow) |
| Urtica dioica | wooded stream connecting to River Chelt (Scobb Grove) | |
| Zygodon viridissimus | wooded stream connecting to River Chelt (Scobb Grove) | Epiphyte (Goat Willow) |

# Kingsocte Wood (Horsely), ST8397, 20/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Acer pseudoplatanus | open spring head and wooded stream below (some Palustriella with tufa) | |
| Amblystegium serpens var. serpens | open spring head and wooded stream below (some Palustriella with tufa) | epiphyte on trunks of beech and sycamore |
| Anomodon viticulosus | open spring head and wooded stream below (some Palustriella with tufa) | epiphyte on base of ash trunk |
| Apium nodiflorum | open spring head and wooded stream below (some Palustriella with tufa) | open cattle-grazed spring head |
| Asplenium scolopendrium | open spring head and wooded stream below (some Palustriella with tufa) | |
| Brachypodium sylvaticum | open spring head and wooded stream below (some Palustriella with tufa) | |
| Brachythecium rivulare | open spring head and wooded stream below (some Palustriella with tufa) | frequent at spring head, occasional below in woodland |
| Brachythecium rutabulum | open spring head and wooded stream below (some Palustriella with tufa) | mainly as an occasional epiphyte on trunks of larger trees |
| Calliergonella cuspidata | open spring head and wooded stream below (some Palustriella with tufa) | open cattle-grazed spring head |
| Cardamine flexuosa | open spring head and wooded stream below (some Palustriella with tufa) | |
| Carex pendula | open spring head and wooded stream below (some Palustriella with tufa) | |
| Cirsium palustre | open spring head and wooded stream below (some Palustriella with tufa) | open cattle-grazed spring head |
| Crataegus monogyna | open spring head and wooded stream below (some Palustriella with tufa) | |
| Cratoneuron filicinum | open spring head and wooded stream below (some Palustriella with tufa) | frequent at spring head, on stones and tree roots below in woodland (associated with tufa) |
| Ctenidium molluscum | open spring head and wooded stream below (some Palustriella with tufa) | local on limestone beside stream |
| Deschampsia cespitosa | open spring head and wooded stream below (some Palustriella with tufa) | |
| Dryopteris filix-mas | open spring head and wooded stream below (some Palustriella with tufa) | |
| Epilobium sp. | open spring head and wooded stream below (some Palustriella with tufa) | local beside stream in woodland |
| Eucladium verticillatum | open spring head and wooded stream below (some Palustriella with tufa) | locally dominant at edge of woodland on tufa block (below spring head) and occasional on tufa-encrusted tree roots in stream below [checked microscopically] |
| Fagus sylvatica | open spring head and wooded stream below (some Palustriella with tufa) | |
| Fissidens pusillus | open spring head and wooded stream below (some Palustriella with tufa) | tufa-encrusted ash root beside stream, fruiting (spores 10-14um, lf cells 8-10um, perichaetial lvs to x6 longer than wide, acute) |
| Fissidens taxifolius | open spring head and wooded stream below (some Palustriella with tufa) | frequent, occasionally on tufa |
| Fraxinus excelsior | open spring head and wooded stream below (some Palustriella with tufa) | |
| Geranium robertianum | open spring head and wooded stream below (some Palustriella with tufa) | |
| Geum urbanum | open spring head and wooded stream below (some Palustriella with tufa) | |
| Glyceria fluitans | open spring head and wooded stream below (some Palustriella with tufa) | open cattle-grazed spring head |
| Hedera helix ssp. helix | open spring head and wooded stream below (some Palustriella with tufa) | |
| Hypnum cupressiforme | open spring head and wooded stream below (some Palustriella with tufa) | epiphyte on trunks of beech and sycamore |
| Ilex aquifolium | open spring head and wooded stream below (some Palustriella with tufa) | |
| Juncus inflexus | open spring head and wooded stream below (some Palustriella with tufa) | open cattle-grazed spring head |
| Kindbergia praelonga | open spring head and wooded stream below (some Palustriella with tufa) | soil and as an epiphyte on trunks of larger trees |
| Lophocolea heterophylla | open spring head and wooded stream below (some Palustriella with tufa) | epiphyte on ash trunk |
| Neckera complanata | open spring head and wooded stream below (some Palustriella with tufa) | epiphyte on base of ash trunk |
| Orthotrichum affine | open spring head and wooded stream below (some Palustriella with tufa) | epiphyte on ash, fruiting |
| Palustriella commutata | open spring head and wooded stream below (some Palustriella with tufa) | locally dominant at edge of woodland on tufa block (below spring head) and occasional in stream below |
| Pellia endiviifolia | open spring head and wooded stream below (some Palustriella with tufa) | frequent at spring head on limestone, occasional below in woodland (associated with tufa) |
| Plagiomnium undulatum | open spring head and wooded stream below (some Palustriella with tufa) | |
| Poa trivialis | open spring head and wooded stream below (some Palustriella with tufa) | |
| Prunella vulgaris | open spring head and wooded stream below (some Palustriella with tufa) | margins of open cattle-grazed spring head |
| Pseudoscleropodium purum | open spring head and wooded stream below (some Palustriella with tufa) | open cattle-grazed spring head |
| Ranunculus repens | open spring head and wooded stream below (some Palustriella with tufa) | open cattle-grazed spring head |
| Rhynchostegium confertum | open spring head and wooded stream below (some Palustriella with tufa) | epiphyte on trunks of beech and sycamore |
| Rubus fruticosus agg. | open spring head and wooded stream below (some Palustriella with tufa) | |
| Rumex conglomeratus | open spring head and wooded stream below (some Palustriella with tufa) | margins of open cattle-grazed spring head |
| Senecio aquaticus | open spring head and wooded stream below (some Palustriella with tufa) | open cattle-grazed spring head |
| Stachys sylvatica | open spring head and wooded stream below (some Palustriella with tufa) | local in woodland |
| Thamnobryum alopecurum | open spring head and wooded stream below (some Palustriella with tufa) | on limestone and as epiphyte on bases of ash and beech |
| Veronica beccabunga | open spring head and wooded stream below (some Palustriella with tufa) | open cattle-grazed spring head |
| Veronica chamaedrys | open spring head and wooded stream below (some Palustriella with tufa) | margins of open cattle-grazed spring head |
| Viola odorata | open spring head and wooded stream below (some Palustriella with tufa) | |
| Amblystegium serpens var. serpens | spring head at edge of woodland (tufa present but no Palustriella) | mainly on bases of beech trees |

# Kingscoste Wood (SW of Nailsworth) ST8297, 20/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Anthriscus sylvestris | spring head at edge of woodland (tufa present but no Palustriella) | |
| Asplenium scolopendrium | spring head at edge of woodland (tufa present but no Palustriella) | |
| Apium nodiflorum | spring head at edge of woodland (tufa present but no Palustriella) | spring head |
| Brachythecium rivulare | spring head at edge of woodland (tufa present but no Palustriella) | frequent on rocks and tree roots at spring head, occasional below |
| Brachythecium rutabulum | spring head at edge of woodland (tufa present but no Palustriella) | mainly as an occasional epiphyte on trunks of larger trees |
| Carex pendula | spring head at edge of woodland (tufa present but no Palustriella) | |
| Chrysosplenium oppositifolium | spring head at edge of woodland (tufa present but no Palustriella) | mainly at spring head, occasional below |
| Corylus avellana | spring head at edge of woodland (tufa present but no Palustriella) | |
| Dryopteris dilatata | spring head at edge of woodland (tufa present but no Palustriella) | |
| Dryopteris filix-mas | spring head at edge of woodland (tufa present but no Palustriella) | |
| Eurhynchium striatum | spring head at edge of woodland (tufa present but no Palustriella) | local |
| Fagus sylvatica | spring head at edge of woodland (tufa present but no Palustriella) | |
| Frullania dilatata | spring head at edge of woodland (tufa present but no Palustriella) | epiphyte on hazel |
| Geranium robertianum | spring head at edge of woodland (tufa present but no Palustriella) | |
| Geum urbanum | spring head at edge of woodland (tufa present but no Palustriella) | |
| Hedera helix ssp. helix | spring head at edge of woodland (tufa present but no Palustriella) | |
| Hypnum cupressiforme | spring head at edge of woodland (tufa present but no Palustriella) | mainly on bases of beech trees |
| Lamiastrum galeobdolon | spring head at edge of woodland (tufa present but no Palustriella) | local |
| Orthotrichum affine | spring head at edge of woodland (tufa present but no Palustriella) | epiphyte on hazel, fruiting |
| Oxyrrhynchium hians | spring head at edge of woodland (tufa present but no Palustriella) | |
| Pellia endiviifolia | spring head at edge of woodland (tufa present but no Palustriella) | frequent on rocks at spring head, occasional below (associated with tufa) |
| Plagiomnium undulatum | spring head at edge of woodland (tufa present but no Palustriella) | |
| Poa trivialis | spring head at edge of woodland (tufa present but no Palustriella) | |
| Quercus robur | spring head at edge of woodland (tufa present but no Palustriella) | |
| Rhynchostegium confertum | spring head at edge of woodland (tufa present but no Palustriella) | mainly on roots of beech trees |
| Rubus fruticosus agg. | spring head at edge of woodland (tufa present but no Palustriella) | |
| Salix x fragilis | spring head at edge of woodland (tufa present but no Palustriella) | |
| Ulota bruchii | spring head at edge of woodland (tufa present but no Palustriella) | epiphyte on hazel, fruiting |
| Zygodon viridissimus | spring head at edge of woodland (tufa present but no Palustriella) | epiphyte on hazel |
| | | |
| Amblystegium serpens var. serpens | small spring head (partly capped) in woodland (short series of Palustriella terraces v | old mortar (remains of caped spring head) |
| Asplenium scolopendrium | small spring head (partly capped) in woodland (short series of Palustriella terraces | with tufa below) |
| Brachythecium rivulare | small spring head (partly capped) in woodland (short series of Palustriella terraces v | occasional below spring head |
| Brachythecium rutabulum | small spring head (partly capped) in woodland (short series of Palustriella terraces v | on soil covered rocks beside seepages |
| Conocephalum conicum | small spring head (partly capped) in woodland (short series of Palustriella terraces v | local on tufa terraces |
| Cratoneuron filicinum | small spring head (partly capped) in woodland (short series of Palustriella terraces v | frequent on tufa terraces below spring head |
| | | old mortar (remains of caped spring head) and extending onto tufa within |
| Didymodon sinuosus | small spring head (partly capped) in woodland (short series of Palustriella terraces v | flushes |
| | | |
| Eucladium verticillatum | small spring head (partly capped) in woodland (short series of Palustriella terraces v | locally frequent on tufa terraces below spring head [checked microscopically] |
| Fagus sylvatica | small spring head (partly capped) in woodland (short series of Palustriella terraces | with tufa below) |
| Fissidens taxifolius | small spring head (partly capped) in woodland (short series of Palustriella terraces v | occasional on rocks and loosely associated with tufa |
| Homalothecium sericeum | small spring head (partly capped) in woodland (short series of Palustriella terraces v | old mortar (remains of caped spring head) |
| Ilex aquifolium | small spring head (partly capped) in woodland (short series of Palustriella terraces | with tufa below) |
| Kindbergia praelonga | small spring head (partly capped) in woodland (short series of Palustriella terraces v | on soil covered rocks beside seepages |
| Lophocolea bidentata | small spring head (partly capped) in woodland (short series of Palustriella terraces | with tufa below) |
| Palustriella commutata | small spring head (partly capped) in woodland (short series of Palustriella terraces v | frequent forming tufa terraces below spring head |
| Pellia endiviifolia | small spring head (partly capped) in woodland (short series of Palustriella terraces v | frequent forming tufa terraces below spring head |
| Plagiochila asplenioides | small spring head (partly capped) in woodland (short series of Palustriella terraces v | single patch on soil covered limestone beside seepages |
| Polystichum setiferum | small spring head (partly capped) in woodland (short series of Palustriella terraces | with tufa below) |
| Thamnobryum alopecurum | small spring head (partly capped) in woodland (short series of Palustriella terraces | with tufa below) |
| Acer pseudoplatanus | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Allium ursinum | strong open spring head and extensive series of Palustriella terraces with tufa below | local |
| | | |
| Amblystegium serpens var. serpens | strong open spring head and extensive series of Palustriella terraces with tufa below | epiphyte on elder |
| Angelica sylvestris | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Apium nodiflorum | strong open spring head and extensive series of Palustriella terraces with tufa below | spring head |
| Arum maculatum | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Asplenium scolopendrium | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Auricularia auricula-judae | strong open spring head and extensive series of Palustriella terraces with tufa below | epiphyte on elder |
| Brachypodium sylvaticum | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Brachythecium rivulare | strong open spring head and extensive series of Palustriella terraces with tufa below | frequent below spring head |
| Brachythecium rutabulum | strong open spring head and extensive series of Palustriella terraces with tufa below | epiphyte on elder |
| Cardamine flexuosa | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Carex pendula | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Carex remota | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Chrysosplenium oppositifolium | strong open spring head and extensive series of Palustriella terraces with tufa below | mostly lower down in woodland (below woodland track) |
| Clematis vitalba | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| | | frequent just below spring head on tufa terraces, tufa-encrusted rocks below |
| Conocephalum conicum | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Corylus avellana | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| | | frequent just below spring head and on tufa terraces, tufa-encrusted rocks and |
| Cratoneuron filicinum | strong open spring head and extensive series of Palustriella terraces with tufa below | twigs below in woodland |
| Cryphaea heteromalla | strong open spring head and extensive series of Palustriella terraces with tufa below | epiphyte on elder and ash, fruiting |
| Ctenidium molluscum | strong open spring head and extensive series of Palustriella terraces with tufa below | local on limestone |
| Deschampsia cespitosa | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Dipsacus pilosus | strong open spring head and extensive series of Palustriella terraces with tufa below | occasional lower down in woodland |
| Dryopteris filix-mas | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Equisetum telmateia | strong open spring head and extensive series of Palustriella terraces with tufa below | rare |
| | | on shaded tufa-encrusted limestone beside cascade (culvert under woodland |
| Eucladium verticillatum | strong open spring head and extensive series of Palustriella terraces with tufa below | track) [checked microscopically] |
| Fagus sylvatica | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| | | local on limestone and tufa within flushes, fruiting (spores 10-14um, lf cells 8- |
| Fissidens pusillus | strong open spring head and extensive series of Palustriella terraces with tufa below | 10um, perichaetial lvs to x6 longer than wide, acute) |
| Fraxinus excelsior | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Frullania dilatata | strong open spring head and extensive series of Palustriella terraces with tufa below | epiphyte on elder and hazel, with perianths |
| Geum urbanum | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Glechoma hederacea | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Hedera helix ssp. helix | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Homalothecium sericeum | strong open spring head and extensive series of Palustriella terraces with tufa below | epiphyte on elder |
| Hypnum cupressiforme | strong open spring head and extensive series of Palustriella terraces with tufa below | epiphyte on elder |
| Juncus inflexus | strong open spring head and extensive series of Palustriella terraces with tufa below | spring head |
| Kindbergia praelonga | strong open spring head and extensive series of Palustriella terraces with tufa below | occasional on rocks and tree bases |
| Lamiastrum galeobdolon | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Mercurialis perennis | strong open spring head and extensive series of Palustriella terraces with tufa below | local lower down in woodland (tree bases) |
| Orthotrichum affine | strong open spring head and extensive series of Palustriella terraces with tufa below | epiphyte on elder, fruiting |
| Oxyrrhynchium hians | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Palustriella commutata | strong open spring head and extensive series of Palustriella terraces with tufa below | forming extensive tufa terraces below spring head in woodland |
| | | frequent just below spring head on tufa terraces, tufa-encrusted rocks below |
| Pellia endiviifolia | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Plagiomnium undulatum | strong open spring head and extensive series of Palustriella terraces with tufa below | occasional lower down in woodland |
| Platyhypnidium riparioides | strong open spring head and extensive series of Palustriella terraces with tufa below | stones in faster flowing main river (at confluence of spring line) |
| Radula complanata | strong open spring head and extensive series of Palustriella terraces with tufa below | epiphyte on hazel, with perianths |
| Ranunculus repens | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Rubus fruticosus agg. | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Rumex conglomeratus | strong open spring head and extensive series of Palustriella terraces with tufa below | open areas beside flushes (with old seed heads) |
| Sambucus nigra | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Silene dioica | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Thamnobryum alopecurum | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Urtica dioica | strong open spring head and extensive series of Palustriella terraces with tufa below | in woodland |
| Zygodon viridissimus | strong open spring head and extensive series of Palustriella terraces with tufa below | epiphyte on elder |

# Midger Brook (Site 1) ST8005, 28/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Allium ursinum | woodland with stream, side springs and tufa formations | |
| Asplenium scolopendrium | woodland with stream, side springs and tufa formations | |
| Brachypodium sylvaticum | woodland with stream, side springs and tufa formations | |
| Brachythecium rivulare | woodland with stream, side springs and tufa formations | mainly at spring head |
| Brachythecium rutabulum | woodland with stream, side springs and tufa formations | mostly as an epiphyte on bases of larger trees |
| Cardamine flexuosa | woodland with stream, side springs and tufa formations | |
| Carex pendula | woodland with stream, side springs and tufa formations | |
| Chrysosplenium oppositifolium | woodland with stream, side springs and tufa formations | |
| Conocephalum conicum | woodland with stream, side springs and tufa formations | occasional (mainly at spring head) |
| Corylus avellana | woodland with stream, side springs and tufa formations | |
| Crataegus monogyna | woodland with stream, side springs and tufa formations | |
| Cratoneuron filicinum | woodland with stream, side springs and tufa formations | stone and roots (mainly at spring head) |
| Cryphaea heteromalla | woodland with stream, side springs and tufa formations | epiphyte on hazel, fruiting |
| Deschampsia cespitosa | woodland with stream, side springs and tufa formations | |
| Didymodon tophaceus | woodland with stream, side springs and tufa formations | top of rock beside stream (one place only) |
| Dryopteris dilatata | woodland with stream, side springs and tufa formations | |
| Dryopteris filix-mas | woodland with stream, side springs and tufa formations | felled tree trunk by stream |
| Eucladium verticillatum | woodland with stream, side springs and tufa formations | top of rock beside stream (one place only) with Didymodon tophaceus [checked microscopically] |
| Eurhynchium striatum | woodland with stream, side springs and tufa formations | |
| Fagus sylvatica | woodland with stream, side springs and tufa formations | |
| Ficaria verna ssp. verna | woodland with stream, side springs and tufa formations | |
| Fissidens taxifolius | woodland with stream, side springs and tufa formations | on stone and clay banks of stream, fruiting |
| Fraxinus excelsior | woodland with stream, side springs and tufa formations | |
| Frullania dilatata | woodland with stream, side springs and tufa formations | epiphyte on hazel |
| Frullania tamarisci | woodland with stream, side springs and tufa formations | epiphyte on ash |
| Geranium robertianum | woodland with stream, side springs and tufa formations | |
| Hedera helix ssp. helix | woodland with stream, side springs and tufa formations | |
| Homalothecium sericeum | woodland with stream, side springs and tufa formations | epiphyte on ash |
| Hyacinthoides non-scripta | woodland with stream, side springs and tufa formations | |
| Hypnum cupressiforme | woodland with stream, side springs and tufa formations | epiphyte on ash |
| Ilex aquifolium | woodland with stream, side springs and tufa formations | |
| Isothecium myosuroides | woodland with stream, side springs and tufa formations | epiphyte on bases of larger trees |
| Kindbergia praelonga | woodland with stream, side springs and tufa formations | |
| Lamiastrum galeobdolon | woodland with stream, side springs and tufa formations | |
| Lejeunea carvifolia | woodland with stream, side springs and tufa formations | epiphyte on lower trunk of hazel (one place only) [checked microscopically] |
| Lophocolea bidentata | woodland with stream, side springs and tufa formations | logs and bases of trees |
| Lophocolea heterophylla | woodland with stream, side springs and tufa formations | logs (local) |
| Malus sylvestris | woodland with stream, side springs and tufa formations | |
| Mercurialis perennis | woodland with stream, side springs and tufa formations | |
| Metzgeria furcata | woodland with stream, side springs and tufa formations | epiphyte on ash |
| Mnium hornum | woodland with stream, side springs and tufa formations | logs (local) |
| Neckera complanata | woodland with stream, side springs and tufa formations | epiphyte on hazel |
| Nowellia curvifolia | woodland with stream, side springs and tufa formations | logs (local) |
| Orthodontium lineare | woodland with stream, side springs and tufa formations | logs (local), with immature sporophytes |
| Orthotrichum affine | woodland with stream, side springs and tufa formations | epiphyte on ash and hazel |
| Oxalis acetosella | woodland with stream, side springs and tufa formations | felled tree trunk by stream |
| Palustriella commutata | woodland with stream, side springs and tufa formations | on stones and occasional roots at spring head and on extensive tufa terrace below |
| Pellia endiviifolia | woodland with stream, side springs and tufa formations | frequent (associated with tufa) |
| Plagiochila asplenioides | woodland with stream, side springs and tufa formations | rare on soil-covered limestone rocks |
| Plagiomnium rostratum | woodland with stream, side springs and tufa formations | on stones in stream |
| Plagiomnium undulatum | woodland with stream, side springs and tufa formations | |
| Platyhypnidium riparioides | woodland with stream, side springs and tufa formations | local at spring head and below (steeper deeper cut sections of stream) |
| Polypodium vulgare | woodland with stream, side springs and tufa formations | epiphyte on trunk of Ash [sporangia checked microscopically, annulus of 14 cells average] |
| Primula vulgaris | woodland with stream, side springs and tufa formations | |
| Quercus robur | woodland with stream, side springs and tufa formations | |
| Radula complanata | woodland with stream, side springs and tufa formations | epiphyte on ash, with perianths |
| Rhizomnium punctaum | woodland with stream, side springs and tufa formations | felled tree trunk by stream, fruiting |
| Rhynchostegiella teneriffae | woodland with stream, side springs and tufa formations | shaded rocks at spring head (cells 40-44um, x7 longer than wide) |
| Rubus fruticosus agg. | woodland with stream, side springs and tufa formations | |
| Thamnobryum alopecurum | woodland with stream, side springs and tufa formations | frequent on limestone and as an epiphyte on bases of larger trees |
| Thuidium tamariscinum | woodland with stream, side springs and tufa formations | |
| Ulota bruchii | woodland with stream, side springs and tufa formations | epiphyte on hazel, fruiting |
| Zygodon viridissimus | woodland with stream, side springs and tufa formations | epiphyte on ash, fruiting |

# Midger Brook (spring in woodland) ST8005, 28/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Brachythecium rivulare | fast flowing spring in woodland | |
| Conocephalum conicum | fast flowing spring in woodland | |
| Cratoneuron filicinum | fast flowing spring in woodland | |
| Fissidens viridulus | fast flowing spring in woodland | clay bank beside stream, fruiting (cells 8um average, lf mucronate) |
| Pellia endiviifolia | fast flowing spring in woodland | |
| Plagiomnium rostratum | fast flowing spring in woodland | |
| Plagiomnium undulatum | fast flowing spring in woodland | |
| Platyhypnidium riparioides | fast flowing spring in woodland | |
| Pohlia melanodon | fast flowing spring in woodland | clay bank beside stream |

# Midger Brook (seepage area) ST8005, 28/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Ajuga reptans | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Asplenium scolopendrium | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Brachythecium rivulare | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Carex pendula | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Chrysosplenium oppositifolium | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Equisetum telmateia | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Ficaria verna ssp. verna | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Palustriella commutata | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Plagiomnium ellipticum? | seepage area with Palustriella commutata and tufa (open area within woodland) | fallen log at edge of seepage |
| Plagiomnium undulatum | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Ranunculus repens | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Ajuga reptans | seepage area with Palustriella commutata and tufa (open area within woodland) | associated with wide seepages (more open central section of site) |
| Allium ursinum | seepage area with Palustriella commutata and tufa (open area within woodland) | edge of seepages (more open central section of site), one place only |
| Angelica sylvestris | seepage area with Palustriella commutata and tufa (open area within woodland) | associated with wide seepages (more open central section of site) |
| Brachythecium rivulare | seepage area with Palustriella commutata and tufa (open area within woodland) | frequent in stream |
| Brachythecium rutabulum | seepage area with Palustriella commutata and tufa (open area within woodland) | mainly as an epiphyte on bases of trees |
| Bryum capillare | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on ash, fruiting |
| Calliergonella cuspidata | seepage area with Palustriella commutata and tufa (open area within woodland) | associated with wide seepages (more open central section of site) |
| Cardamine flexuosa | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Carex pendula | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Carex remota | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Carex sylvatica | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Cirriphyllum crassinervium | seepage area with Palustriella commutata and tufa (open area within woodland) | local on ground and tree bases |
| Cirriphyllum piliferum | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Conocephalum conicum | seepage area with Palustriella commutata and tufa (open area within woodland) | occasional |
| Corylus avellana | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Cratoneuron filicinum | seepage area with Palustriella commutata and tufa (open area within woodland) | frequent in stream |
| Chrysosplenium oppositifolium | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Deschampsia cespitosa | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Dryopteris dilatata | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Dryopteris filix-mas | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Eucladium verticillatum | seepage area with Palustriella commutata and tufa (open area within woodland) | dominating tufa block adjoining river and elsewhere on tufa [checked microscopically] |
| Eupatorium cannabinum | seepage area with Palustriella commutata and tufa (open area within woodland) | associated with wide seepages (more open central section of site) |
| Eurhynchium striatum | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Fagus sylvatica | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Fissidens adianthoides | seepage area with Palustriella commutata and tufa (open area within woodland) | large plants in tufa block adjoining river (with Eucladium) and on fallen trees crossing humid seepages, fruiting (lf cells 14-20un, spores 16-20um) |
| Fraxinus excelsior | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Frullania dilatata | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on hazel, with perianths |
| Frullania tamarisci | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on ash |
| Galium odoratum | seepage area with Palustriella commutata and tufa (open area within woodland) | edge of seepages (more open central section of site), one place only |
| Geranium robertianum | seepage area with Palustriella commutata and tufa (open area within woodland) | fallen tree crossing humid seepages |
| Hedera helix ssp. helix | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Hypnum cupressiforme | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on hazel |
| Ilex aquifolium | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Lonicera periclymenum | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Lysimachia nemorum | seepage area with Palustriella commutata and tufa (open area within woodland) | edge of seepages (more open central section of site), one place only |
| Mercurialis perennis | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Metzgeria furcata | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on ash and hazel |
| Metzgeria temporata | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on hazel [checked microscopically] |
| Mnium hornum | seepage area with Palustriella commutata and tufa (open area within woodland) | log |
| Neckera complanata | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on hazel |
| Orthotrichum affine | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on ash and hazel, fruiting |
| Oxalis acetosella | seepage area with Palustriella commutata and tufa (open area within woodland) | edge of seepages (more open central section of site), one place only |
| Oxyrrhynchium hians | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Palustriella commutata | seepage area with Palustriella commutata and tufa (open area within woodland) | dominant patches forming tufa terraces |
| Pellia endiviifolia | seepage area with Palustriella commutata and tufa (open area within woodland) | frequent (associated with tufa) |
| Peltigera sp. | seepage area with Palustriella commutata and tufa (open area within woodland) | fallen tree crossing humid seepages |
| Pertusaria sp. | seepage area with Palustriella commutata and tufa (open area within woodland) | prominent epiphyte on hazel |
| Plagiochila asplenioides | seepage area with Palustriella commutata and tufa (open area within woodland) | soil and soil-covered logs |
| Plagiochila porelloides | seepage area with Palustriella commutata and tufa (open area within woodland) | fallen tree crossing humid seepages (stems <2mm wide) |
| Plagiomnium undulatum | seepage area with Palustriella commutata and tufa (open area within woodland) | frequent |
| Polypodium vulgare | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on fallen Ash over seepages [sporangia checked microscopically, annulus of 14 cells average] |
| Quercus robur | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Radula complanata | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on hazel, with perianths |
| Ranunculus repens | seepage area with Palustriella commutata and tufa (open area within woodland) | associated with wide seepages (more open central section of site) |
| Rubus fruticosus agg. | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Sanicula europaea | seepage area with Palustriella commutata and tufa (open area within woodland) | edge of seepages (more open central section of site), one place only |
| Thamnobryum alopecurum | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Thuidium tamariscinum | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Ulota bruchii | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on hazel, fruiting |
| Viola odorata | seepage area with Palustriella commutata and tufa (open area within woodland) | |
| Zygodon viridissimus | seepage area with Palustriella commutata and tufa (open area within woodland) | epiphyte on ash, fruiting |

# Minchinhampton Brook SO8695, 27/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Acer campestre | wooded stream with side springs and some tufa | |
| Allium ursinum | wooded stream with side springs and some tufa | |
| Amblystegium serpens var. serpens | wooded stream with side springs and some tufa | epiphyte on hawthorn |
| Apium nodiflorum | wooded stream with side springs and some tufa | spring head (open within field) |
| Brachythecium rivulare | wooded stream with side springs and some tufa | frequent (especially at spring heads) |
| Brachythecium rutabulum | wooded stream with side springs and some tufa | epiphyte on elder |
| Cardamine flexuosa | wooded stream with side springs and some tufa | |
| Carex pendula | wooded stream with side springs and some tufa | |
| Chrysosplenium oppositifolium | wooded stream with side springs and some tufa | |
| Cirriphyllum piliferum | wooded stream with side springs and some tufa | |
| Clematis vitalba | wooded stream with side springs and some tufa | |
| Conocephalum conicum | wooded stream with side springs and some tufa | occasional |
| Corylus avellana | wooded stream with side springs and some tufa | |
| Crataegus monogyna | wooded stream with side springs and some tufa | |
| Cratoneuron filicinum | wooded stream with side springs and some tufa | |
| Cratoneuron filicinum | wooded stream with side springs and some tufa | spring head (open within field) |
| Cryphaea heteromalla | wooded stream with side springs and some tufa | epiphyte on hawthorn, fruiting |
| Deschampsia cespitosa | wooded stream with side springs and some tufa | |
| Dipsacus fullonum | wooded stream with side springs and some tufa | spring head (open within field) |
| Dryopteris filix-mas | wooded stream with side springs and some tufa | |
| Epilobium sp. | wooded stream with side springs and some tufa | spring head (open within field) |
| Equisetum telmateia | wooded stream with side springs and some tufa | local in wooded spring head |
| Ficaria verna ssp. verna | wooded stream with side springs and some tufa | |
| Fissidens crassipes | wooded stream with side springs and some tufa | locally frequent stands on tufa-encrusted limestone bed and loose flat stones within main stream (in woodland), fruiting [lf cells 10-14um] |
| Fissidens rufulus | wooded stream with side springs and some tufa | locally frequent stands on tufa-encrusted clay, loose flat stones within main stream (in woodland), fruiting [lf cells 8-10um, spores 24-26um, peristome teeth 36-44um wide] |
| Fissidens taxifolius | wooded stream with side springs and some tufa | frequent on clay banks, and tufa-encrusted tree roots |
| Fissidens viridulus | wooded stream with side springs and some tufa | clay beside main stream (in woodland), fruiting [lf cells 8-10um, lf mucronate] |
| Fraxinus excelsior | wooded stream with side springs and some tufa | |
| Frullania dilatata | wooded stream with side springs and some tufa | epiphyte on hawthorn |
| Geranium robertianum | wooded stream with side springs and some tufa | |
| Geum urbanum | wooded stream with side springs and some tufa | |
| Hedera helix ssp. helix | wooded stream with side springs and some tufa | |
| Homalothecium sericeum | wooded stream with side springs and some tufa | epiphyte on elder |
| Hypnum cupressiforme | wooded stream with side springs and some tufa | epiphyte on hawthorn |
| Ilex aquifolium | wooded stream with side springs and some tufa | |
| Kindbergia praelonga | wooded stream with side springs and some tufa | |
| Lonicera nitida | wooded stream with side springs and some tufa | planted beside stream (close to house & gardens) |
| Lophocolea bidentata | wooded stream with side springs and some tufa | frequent on roots, stones and tree bases beside stream |
| Lunularia cruciata | wooded stream with side springs and some tufa | occasional on soil beside main stream |
| Mercurialis perennis | wooded stream with side springs and some tufa | local |
| Metzgeria furcata | wooded stream with side springs and some tufa | epiphyte on hawthorn |
| Metzgeria violacea | wooded stream with side springs and some tufa | epiphyte on hawthorn |
| Microlejeunea ulicina | wooded stream with side springs and some tufa | epiphyte on hawthorn with Metzgeria furcata [checked microscopically; non fertile plants with under leaves] |
| Mnium hornum | wooded stream with side springs and some tufa | small plants on a tree base beside main stream |
| Nasturtium officinale s.l. | wooded stream with side springs and some tufa | spring head (open within field) |
| Orthotrichum affine | wooded stream with side springs and some tufa | epiphyte on hawthorn, fruiting |
| Orthotrichum lyellii | wooded stream with side springs and some tufa | epiphyte on hawthorn |
| Oxyrrhynchium hians | wooded stream with side springs and some tufa | |
| Pellia endiviifolia | wooded stream with side springs and some tufa | frequent |
| Plagiomnium rostratum | wooded stream with side springs and some tufa | locally frequent on limestone close to main stream, fruiting |
| Plagiomnium rostratum | wooded stream with side springs and some tufa | on concrete adjoining small stream |
| Plagiomnium undulatum | wooded stream with side springs and some tufa | |
| Platyhypnidium riparioides | wooded stream with side springs and some tufa | occasional on limestone in faster flowing sections of stream |
| Radula complanata | wooded stream with side springs and some tufa | epiphyte on hawthorn |
| Ranunculus repens | wooded stream with side springs and some tufa | |
| Rhynchostegium confertum | wooded stream with side springs and some tufa | epiphyte on elder and hawthorn trunks |
| Rubus fruticosus agg. | wooded stream with side springs and some tufa | |
| Rumex conglomeratus | wooded stream with side springs and some tufa | spring head (open within field), with old fruits |
| Schistidium crassipilum | wooded stream with side springs and some tufa | old piece of concrete beside spring head (open within field), fruiting |
| Scrophularia auriculata | wooded stream with side springs and some tufa | spring head (open within field) |
| Taraxacum sp. | wooded stream with side springs and some tufa | |
| Thamnobryum alopecurum | wooded stream with side springs and some tufa | |
| Ulota bruchii | wooded stream with side springs and some tufa | epiphyte on hawthorn, fruiting |
| Urtica dioica | wooded stream with side springs and some tufa | |
| Veronica beccabunga | wooded stream with side springs and some tufa | spring head (open within field) |
| Zygodon viridissimus | wooded stream with side springs and some tufa | epiphyte on elder |

# Sedbury Cliff, ST5593, 26/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Amblystegium serpens var. serpens | Cliff seepages with tufa within open areas of buddleia - bramble scrub | epiphyte on Ash |
| Asplenium scolopendrium | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Barbula convoluta | Cliff seepages with tufa within open areas of buddleia - bramble scrub | rare on slipped clay |
| Barbula unguiculata | Cliff seepages with tufa within open areas of buddleia - bramble scrub | occasional on slipped clay and fallen limestone rocks (fruiting) |
| Brachythecium rivulare | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Brachythecium rutabulum | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Bryum capillare | Cliff seepages with tufa within open areas of buddleia - bramble scrub | epiphyte on Ash, fruiting |
| Buddleja davidii | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Calliergonella cuspidata | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Carex pendula | Cliff seepages with tufa within open areas of buddleia - bramble scrub | open area of seepages below cliff |
| Clematis vitalba | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Cratoneuron filicinum | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Dicranella varia | Cliff seepages with tufa within open areas of buddleia - bramble scrub | occasional dominant stands associated with tufa on cliff face and on slipped clay |
| Didymodon tophaceus | Cliff seepages with tufa within open areas of buddleia - bramble scrub | occasional dominant stands forming tufa on cliff face, fruiting |
| Epilobium parviflorum | Cliff seepages with tufa within open areas of buddleia - bramble scrub | open area of seepages below cliff |
| Equisetum telmateia | Cliff seepages with tufa within open areas of buddleia - bramble scrub | open area of seepages below cliff |
| Eucladium verticillatum | Cliff seepages with tufa within open areas of buddleia - bramble scrub | locally dominant stands forming tufa on cliff face [checked microscopically] |
| Eupatorium cannabinum | Cliff seepages with tufa within open areas of buddleia - bramble scrub | open area of seepages below cliff |
| Fissidens bryoides | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Fissidens taxifolius | Cliff seepages with tufa within open areas of buddleia - bramble scrub | frequent on slipped clay and unusually as an epiphyte on lower trunks of mature buddleia (fruiting) |
| Fraxinus excelsior | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Frullania dilatata | Cliff seepages with tufa within open areas of buddleia - bramble scrub | epiphyte on Ash, with perianths |
| Hedera helix ssp. helix | Cliff seepages with tufa within open areas of buddleia - bramble scrub | frequent |
| Hypnum cupressiforme | Cliff seepages with tufa within open areas of buddleia - bramble scrub | epiphyte on Ash, fruiting |
| Leicolea turbinata | Cliff seepages with tufa within open areas of buddleia - bramble scrub | occasional dominant stands associated with tufa on cliff face [checked microscopically] |
| Lophocolea bidentata | Cliff seepages with tufa within open areas of buddleia - bramble scrub | occasional on slipped clay, logs and as an epiphyte on lower trunks of mature buddleia |
| Lunularia cruciata | Cliff seepages with tufa within open areas of buddleia - bramble scrub | local on slipped clay |
| Metzgeria furcata | Cliff seepages with tufa within open areas of buddleia - bramble scrub | epiphyte on mature buddleia |
| Orthotrichum affine | Cliff seepages with tufa within open areas of buddleia - bramble scrub | epiphyte on Ash, fruiting |
| Oxyrrhynchium hians | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Palustriella commutata | Cliff seepages with tufa within open areas of buddleia - bramble scrub | locally dominant stands forming tufa on cliff face |
| Pellia endiviifolia | Cliff seepages with tufa within open areas of buddleia - bramble scrub | frequent |
| Polypodium vulgare | Cliff seepages with tufa within open areas of buddleia - bramble scrub | epiphyte on trunk of Ash (nr. bottom of cliff) [sporangia checked microscopically, annulus of 12 cells average] |
| Rhynchostegium confertum | Cliff seepages with tufa within open areas of buddleia - bramble scrub | epiphyte on Ash, fruiting |
| Rubia peregrina | Cliff seepages with tufa within open areas of buddleia - bramble scrub | occasional |
| Rubus fruticosus agg. | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Salix cinerea | Cliff seepages with tufa within open areas of buddleia - bramble scrub | |
| Zygodon viridissimus | Cliff seepages with tufa within open areas of buddleia - bramble scrub | epiphyte on mature buddleia |

# Slade Brook SO5605, 26/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Allium ursinum | Wooded stream with flushes and small rocky gorges | |
| Alnus glutinosa | narrow wooded area bordering Slade Brook | |
| Anomodon viticulosus | Wooded stream with flushes and small rocky gorges | epiphyte on elm |
| Arum maculatum | Wooded stream with flushes and small rocky gorges | |
| Asplenium scolopendrium | Wooded stream with flushes and small rocky gorges | |
| Atrichum undulatum | narrow wooded area bordering Slade Brook | shaded clay banks beside stream |
| Brachythecium rivulare | Wooded stream with flushes and small rocky gorges | |
| Brachythecium rutabulum | Wooded stream with flushes and small rocky gorges | mostly on soil-covered boulders and tree bases, fruiting |
| Calypogeia arguta | Wooded stream with flushes and small rocky gorges | steep clay bank in gorge section of stream |
| Cardamine flexuosa | Wooded stream with flushes and small rocky gorges | |
| Carex pendula | Wooded stream with flushes and small rocky gorges | |
| Carex remota | Wooded stream with flushes and small rocky gorges | |
| Carex sylvatica | Wooded stream with flushes and small rocky gorges | |
| Chiloscyphus polyanthus | Wooded stream with flushes and small rocky gorges | occasional on limestone bed and flat loose rocks in stream (lower part of wooded section), loosely associated with tufa [plants non fertile] |
| Chrysosplenium oppositifolium | Wooded stream with flushes and small rocky gorges | |
| Cirriphyllum crassinervium | Wooded stream with flushes and small rocky gorges | local on soil covered limestone boulders mostly away from the stream |
| Cirriphyllum piliferum | Wooded stream with flushes and small rocky gorges | |
| Conocephalum conicum | Wooded stream with flushes and small rocky gorges | |
| Corylus avellana | Wooded stream with flushes and small rocky gorges | |
| Cratoneuron filicinum | Wooded stream with flushes and small rocky gorges | stones, roots and twigs, tufa forming |
| Deschampsia cespitosa | narrow wooded area bordering Slade Brook | dominating shaded island formed by split in stream |
| Dichodontium cf flavescens | Wooded stream with flushes and small rocky gorges | local beside main stream (lower part of wooded section) [plants with long narrow lvs (to x4 longer than wide) but not fertile] |
| Dryopteris dilatata | Wooded stream with flushes and small rocky gorges | |
| Eurhynchium striatum | Wooded stream with flushes and small rocky gorges | |
| Fagus sylvatica | Wooded stream with flushes and small rocky gorges | |
| Ficaria verna ssp. fertilis | Wooded stream with flushes and small rocky gorges | |
| Fissidens rivularis | Wooded stream with flushes and small rocky gorges | occasional on limestone bed and loose rocks in stream (mainly upper section below main spring head), often associated with tufa, fruiting [lf cells 8-10um] |
| Fissidens taxifolius | Wooded stream with flushes and small rocky gorges | frequent, fruiting |
| Fraxinus excelsior | Wooded stream with flushes and small rocky gorges | |
| Frullania dilatata | Wooded stream with flushes and small rocky gorges | epiphyte on ash and beech, with perianths |
| Galium odoratum | Wooded stream with flushes and small rocky gorges | |
| Hedera helix ssp. helix | Wooded stream with flushes and small rocky gorges | |
| Homalia trichomanoides | Wooded stream with flushes and small rocky gorges | epiphyte on trunk of large beech (beside stream in humid section with small gorge, local |
| Homalothecium sericeum | Wooded stream with flushes and small rocky gorges | epiphyte on ash and beech |
| Hyacinthoides non-scripta | Wooded stream with flushes and small rocky gorges | |
| Hypnum cupressiforme | Wooded stream with flushes and small rocky gorges | epiphyte on ash and beech |
| Ilex aquifolium | Wooded stream with flushes and small rocky gorges | |
| Isothecium myosuroides | Wooded stream with flushes and small rocky gorges | epiphyte on ash and beech |
| Kindbergia praelonga | Wooded stream with flushes and small rocky gorges | |
| Lapsana communis | narrow wooded area bordering Slade Brook | shaded clay banks beside stream |
| Lejeunea carvifolia | Wooded stream with flushes and small rocky gorges | epiphyte on trunk of large beech (beside stream in humid section with small gorge) [checked microscopically] |
| Lonicera nitida | planted close to house and garden | |
| Lophocolea bidentata | Wooded stream with flushes and small rocky gorges | stone and logs |
| Lophocolea heterophylla | Wooded stream with flushes and small rocky gorges | logs |
| Metzgeria furcata | Wooded stream with flushes and small rocky gorges | epiphyte on ash |
| Mnium hornum | Wooded stream with flushes and small rocky gorges | logs |
| Mnium marginatum | Wooded stream with flushes and small rocky gorges | local on limestone boulders in small ravine section of main stream [cells 16-24um, nerve ending below lf apex] |
| Nowellia curvifolia | Wooded stream with flushes and small rocky gorges | local on logs, with perianths |
| Orthotrichum affine | Wooded stream with flushes and small rocky gorges | epiphyte on ash, hazel and beech (fruiting) |
| Orthotrichum lyellii | Wooded stream with flushes and small rocky gorges | epiphyte on ash |
| Oxyrrhynchium hians | Wooded stream with flushes and small rocky gorges | |
| Palustriella commutata | Wooded stream with flushes and small rocky gorges | mostly on stones, locally on roots and twigs in upper section of stream just below main spring head, tufa forming |
| Pellia endiviifolia | Wooded stream with flushes and small rocky gorges | frequent, associated with tufa formation |
| Plagiochila asplenioides | Wooded stream with flushes and small rocky gorges | occasional on soil |
| Plagiochila porelloides | Wooded stream with flushes and small rocky gorges | local on soil-covered limestone and bases of mature trees beside stream |
| Plagiomnium rostratum | Wooded stream with flushes and small rocky gorges | rocks (limestone) around stream, loosely associated with tufa |
| Plagiomnium undulatum | Wooded stream with flushes and small rocky gorges | |
| Plagiothecium succulentum | Wooded stream with flushes and small rocky gorges | local on logs, fruiting (lf cells 16 x 130um, x8 long as wide) |
| Platyhypnidium riparioides | Wooded stream with flushes and small rocky gorges | on limestone in faster flowing sections of stream (especially where side springs join main stream), locally forming tufa |
| Poa trivialis | Wooded stream with flushes and small rocky gorges | |
| Polystichum aculeatum | Wooded stream with flushes and small rocky gorges | local |
| Polystichum setiferum | Wooded stream with flushes and small rocky gorges | |
| Polytrichastrum formosum | narrow wooded area bordering Slade Brook | shaded clay banks beside stream |
| Pseudotsuga menziesii | Wooded stream with flushes and small rocky gorges | |
| Pteridium aquilinum | narrow wooded area bordering Slade Brook | higher ground of shaded island formed by split in stream |
| Radula complanata | Wooded stream with flushes and small rocky gorges | epiphyte on ash and beech, with perianths |
| Rhizomnium punctaum | Wooded stream with flushes and small rocky gorges | local on logs, fruiting |
| Rhynchostegiella pumila | Wooded stream with flushes and small rocky gorges | shaded soil |
| Rhynchostegiella teneriffae | Wooded stream with flushes and small rocky gorges | shaded limestone boulders adjoining spring, fruiting |
| Rhynchostegium confertum | narrow wooded area bordering Slade Brook | epiphyte on elder, fruiting |
| Rubus fruticosus agg. | Wooded stream with flushes and small rocky gorges | |
| Sambucus nigra | Wooded stream with flushes and small rocky gorges | |
| Thamnobryum alopecurum | Wooded stream with flushes and small rocky gorges | abundant on limestone boulders and bases of mature trees |
| Thuidium tamariscinum | Wooded stream with flushes and small rocky gorges | |
| Thuja plicata | planted close to house and garden | |
| Tortella tortuosa | Wooded stream with flushes and small rocky gorges | local on limestone boulders in small ravine section of main stream |
| Ulmus sp. | Wooded stream with flushes and small rocky gorges | |
| Ulota bruchii | Wooded stream with flushes and small rocky gorges | epiphyte on ash, hazel and beech (fruiting) |
| Valeriana officinalis | Wooded stream with flushes and small rocky gorges | local beside main stream |
| Viola riviniana | Wooded stream with flushes and small rocky gorges | |
| Zygodon viridissimus | Wooded stream with flushes and small rocky gorges | epiphyte on ash |

# Toadsmoor SO8703, 19/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Angelica sylvestris | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Anomodon viticulosus | ˙open spring head and Palustriella tufa terraces and wooded stream below | frequent |
| Apium nodiflorum | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Asplenium scolopendrium | ˙open spring head and Palustriella tufa terraces and wooded stream below | epiphyte on bases of larger trees |
| Barbula unguiculata | ˙open spring head and Palustriella tufa terraces and wooded stream below | open tufa-encrusted soil bank beside stream |
| Brachythecium rivulare | ˙open spring head and Palustriella tufa terraces and wooded stream below | frequent below spring head |
| Brachythecium rutabulum | ˙open spring head and Palustriella tufa terraces and wooded stream below | mainly as an epiphyte on tree bases |
| Bryum capillare | ˙open spring head and Palustriella tufa terraces and wooded stream below | epiphyte on elder |
| Cardamine flexuosa | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Cardamine pratense | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Carex acutiformis | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Cirsium palustre | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Conocephalum conicum | ˙open spring head and Palustriella tufa terraces and wooded stream below | occasional |
| Crataegus monogyna | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Cratoneuron filicinum | ˙open spring head and Palustriella tufa terraces and wooded stream below | frequent on limestone and roots (forming tufa) |
| Cryphaea heteromalla | ˙open spring head and Palustriella tufa terraces and wooded stream below | epiphyte on ash, fruiting |
| Deschampsia cespitosa | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Dryopteris filix-mas | ˙open spring head and Palustriella tufa terraces and wooded stream below | epiphyte on bases of larger trees |
| Epilobium hirsutum | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Eucladium verticillatum | ˙open spring head and Palustriella tufa terraces and wooded stream below | shaded rock crevices beside spring head and occasional on tufa below [checked microscopically] |
| Eupatorium cannabinum | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Filipendula ulmaria | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Fissidens pusillus | ˙open spring head and Palustriella tufa terraces and wooded stream below | local on flat stones and lightly tufa-encrusted flat stones (limestone) within stream bed (wooded lower part of site) [spores 12-14um, lf border not reaching nerve, perichaetial lvs to x7 longer than wide] |
| Fissidens taxifolius | ˙open spring head and Palustriella tufa terraces and wooded stream below | occasional below under scrub |
| Frullania dilatata | ˙open spring head and Palustriella tufa terraces and wooded stream below | epiphyte on ash |
| Galium aparine | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Glechoma hederacea | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Glyceria fluitans | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Hedera helix ssp. helix | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Holcus lanatus | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Homalothecium sericeum | ˙open spring head and Palustriella tufa terraces and wooded stream below | epiphyte on elder |
| Hypericum tetrapterum | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Hypnum cupressiforme | ˙open spring head and Palustriella tufa terraces and wooded stream below | epiphyte on elder |
| Iris pseudacorus | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Isothecium myosuroides | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Juncus inflexus | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Kindbergia praelonga | ˙open spring head and Palustriella tufa terraces and wooded stream below | mainly as an epiphyte on tree bases |
| Lamiastrum galeobdolon | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Lunularia cruciata | ˙open spring head and Palustriella tufa terraces and wooded stream below | soil beside stream in woodland (lower part of site) |
| Mentha aquatica | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Myosotis scorpioides | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Orthotrichum affine | ˙open spring head and Palustriella tufa terraces and wooded stream below | epiphyte on hawthorn and elder |
| Oxyrrhynchium hians | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Palustriella commutata | ˙open spring head and Palustriella tufa terraces and wooded stream below | locally abundant (forming tufa terraces) below spring head |
| Pellia endiviifolia | ˙open spring head and Palustriella tufa terraces and wooded stream below | frequent (forming tufa terraces) |
| Phascum cuspidatum | ˙open spring head and Palustriella tufa terraces and wooded stream below | open tufa-encrusted soil bank beside stream |
| Plagiomnium rostratum | ˙open spring head and Palustriella tufa terraces and wooded stream below | soil-covered limestone beside stream and in open area of marsh below main spring head |
| Plagiomnium undulatum | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Poa trivialis | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Primula veris | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Pulicaris dysenterica | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Ranunculus repens | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Rubus fruticosus agg. | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Rumex conglomeratus | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head 9with old seed heads) |
| Sambucus nigra | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Schistidium crassipilum | ˙open spring head and Palustriella tufa terraces and wooded stream below | limestone crag beside spring head |
| Scrophularia auriculata | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |
| Syntrichia montana | ˙open spring head and Palustriella tufa terraces and wooded stream below | limestone crag beside spring head |
| Ulota bruchii | ˙open spring head and Palustriella tufa terraces and wooded stream below | epiphyte on ash, fruiting |
| Urtica dioica | ˙open spring head and Palustriella tufa terraces and wooded stream below | |
| Veronica beccabunga | ˙open spring head and Palustriella tufa terraces and wooded stream below | open area of marsh below main spring head |

# Woodchester Park (NW of Nailsworth) SO8200, 18/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Ajuga reptans | woodland with flushes and tufa | open area of seepages just below main spring head |
| Amblystegium serpens var. serpens | woodland with flushes and tufa | logs |
| Angelica sylvestris | woodland with flushes and tufa | open area of seepages just below main spring head |
| Apium nodiflorum | woodland with flushes and tufa | main spring head |
| Arum maculatum | woodland with flushes and tufa | |
| Asplenium scolopendrium | woodland with flushes and tufa | main spring head |
| Betula pendula | woodland with flushes and tufa | |
| Brachythecium rivulare | woodland with flushes and tufa | most abundant near main spring head |
| Brachythecium rutabulum | woodland with flushes and tufa | mostly on rocks and tree bases |
| Calliergonella cuspidata | woodland with flushes and tufa | local beside main stream (lower part of site) |
| Cardamine flexuosa | woodland with flushes and tufa | |
| Carex pendula | woodland with flushes and tufa | main spring head |
| Carex sylvatica | woodland with flushes and tufa | |
| Chrysosplenium oppositifolium | woodland with flushes and tufa | open area of seepages just below main spring head |
| Cirriphyllum piliferum | woodland with flushes and tufa | local beside stream in lower part of site |
| Clematis vitalba | woodland with flushes and tufa | |
| Conocephalum conicum | woodland with flushes and tufa | locally abundant |
| Corylus avellana | woodland with flushes and tufa | |
| Cratoneuron filicinum | woodland with flushes and tufa | main spring head (forming tufa), stones and roots throughout site and robust plants adjoining fast flowing outfall of reservoir |
| Cryphaea heteromalla | woodland with flushes and tufa | epiphyte on hazel |
| Deschampsia cespitosa | woodland with flushes and tufa | |
| Dicranoweissia cirrata | woodland with flushes and tufa | epiphyte on birch |
| Dryopteris dilatata | woodland with flushes and tufa | |
| Dryopteris filix-mas | woodland with flushes and tufa | margins of main spring head |
| Epilobium sp. | woodland with flushes and tufa | beside stream (below confluence of springs) |
| Equisetum telmateia | woodland with flushes and tufa | local in small side channel (lower part of site) |
| Eucladium verticillatum | woodland with flushes and tufa | tufa-encrusted twig in stream and tufa elsewhere (below confluence of springs) [checked microscopically] |
| Eupatorium cannabinum | woodland with flushes and tufa | open area of seepages just below main spring head |
| Ficaria verna ssp. verna | Woodchester Park, NW of Nailsworth | |
| Fissidens pusillus | woodland with flushes and tufa | tufa-encrusted clay within stream (lf cells 6-10um, apex acute) |
| Fissidens taxifolius | woodland with flushes and tufa | main spring head (forming tufa) |
| Flavoparmelia caperata | woodland with flushes and tufa | epiphyte on upper canopy branches |
| Frullania dilatata | woodland with flushes and tufa | epiphyte on hazel |
| Galium aparine | woodland with flushes and tufa | |
| Galium odoratum | woodland with flushes and tufa | very local (lower part of site) |
| Glechoma hederacea | woodland with flushes and tufa | margins of main spring head |
| Hedera helix ssp. helix | woodland with flushes and tufa | |
| Hypnum cupressiforme | woodland with flushes and tufa | epiphyte on hazel |
| Hypogymnia tubulosa | woodland with flushes and tufa | epiphyte on upper canopy branches |
| Ilex aquifolium | woodland with flushes and tufa | |
| Isothecium myosuroides | woodland with flushes and tufa | occasional on tree bases |
| Juncus effusus | woodland with flushes and tufa | main spring head |
| Kindbergia praelonga | woodland with flushes and tufa | |
| Larix decidua | woodland with flushes and tufa | |
| Lophocolea bidentata | woodland with flushes and tufa | logs, tree bases and occasionally on tufa |
| Mentha aquatica | woodland with flushes and tufa | open area of seepages just below main spring head |
| Mercurialis perennis | woodland with flushes and tufa | local |
| Metzgeria furcata | woodland with flushes and tufa | epiphyte on hazel |
| Metzgeria temporata | woodland with flushes and tufa | epiphyte on goat willow |
| Metzgeria violacea | woodland with flushes and tufa | epiphyte on elder |
| Orthotrichum affine | woodland with flushes and tufa | epiphyte on hazel and elder |
| Orthotrichum lyellii | woodland with flushes and tufa | epiphyte on elder |
| Orthotrichum pulchellum | woodland with flushes and tufa | epiphyte on elder and goat willow |
| Oxalis acetosella | woodland with flushes and tufa | very local (lower part of site) |
| Oxyrrhynchium hians | woodland with flushes and tufa | |
| Pellia endiviifolia | woodland with flushes and tufa | main spring head (forming tufa) |
| Plagiochila asplenioides | woodland with flushes and tufa | local on soil beside main stream (lower part of site) |
| Plagiomnium rostratum | woodland with flushes and tufa | local on rocks and soil beside stream |
| Plagiomnium undulatum | woodland with flushes and tufa | |
| Platyhypnidium riparioides | woodland with flushes and tufa | fast flowing outfall of reservoir only (base of site) |
| Poa trivialis | woodland with flushes and tufa | |
| Polypodium vulgare | woodland with flushes and tufa | epiphyte on tree base beside seepages [sporangia checked microscopically, annulus of 14 cells average] |
| Primula vulgaris | woodland with flushes and tufa | open area of seepages just below main spring head |
| Rhizomnium punctaum | woodland with flushes and tufa | log beside stream (below confluence of springs) |
| Rosa canina agg. | woodland with flushes and tufa | |
| Rubus fruticosus agg. | woodland with flushes and tufa | |
| Salix caprea | woodland with flushes and tufa | |
| Sambucus nigra | woodland with flushes and tufa | |
| Thamnobryum alopecurum | woodland with flushes and tufa | occasional |
| Urtica dioica | woodland with flushes and tufa | main spring head |
| Zygodon viridissimus | woodland with flushes and tufa | epiphyte on elder |
| Allium ursinum | woodland with flushes and tufa | |
| Angelica sylvestris | woodland with flushes and tufa | |
| Asplenium scolopendrium | woodland with flushes and tufa | |
| Athyrium filix-femina | woodland with flushes and tufa | local |
| Brachythecium rivulare | woodland with flushes and tufa | in stream (associated with tufa) |
| Brachythecium rutabulum | woodland with flushes and tufa | mostly on rocks and tree bases |
| Cardamine flexuosa | woodland with flushes and tufa | |
| Carex pendula | woodland with flushes and tufa | |
| Carex remota | woodland with flushes and tufa | |
| Carex sylvatica | woodland with flushes and tufa | |
| Chrysosplenium oppositifolium | woodland with flushes and tufa | |
| Conocephalum conicum | woodland with flushes and tufa | local |
| Cratoneuron filicinum | woodland with flushes and tufa | in stream (associated with tufa) |
| Cryphaea heteromalla | woodland with flushes and tufa | epiphyte on ash |
| Deschampsia cespitosa | woodland with flushes and tufa | |
| Dryopteris filix-mas | woodland with flushes and tufa | |
| Equisetum telmateia | woodland with flushes and tufa | very local |
| Eurhynchium striatum | woodland with flushes and tufa | local |
| Fagus sylvatica | woodland with flushes and tufa | |
| Ficaria verna ssp. verna | woodland with flushes and tufa | |
| Fissidens crassipes | woodland with flushes and tufa | on tufa in faster flowing top of stream with Platyhypnidium riparioides (lf cells 19-14um, border not confluent with nerve) |
| Fissidens gracilifolius | woodland with flushes and tufa | top of rock beside stream (away from water flow) |
| Fissidens pusillus | woodland with flushes and tufa | on tufa in faster flowing top of stream |
| Fissidens taxifolius | woodland with flushes and tufa | in stream (associated with tufa), fruiting |
| Fraxinus excelsior | woodland with flushes and tufa | |
| Geranium robertianum | woodland with flushes and tufa | |
| Glechoma hederacea | woodland with flushes and tufa | |
| Hedera helix ssp. helix | woodland with flushes and tufa | |
| Kindbergia praelonga | woodland with flushes and tufa | |
| Lamiastrum galeobdolon | woodland with flushes and tufa | |
| Mentha aquatica | woodland with flushes and tufa | local in open area of seepage (below main spring head) |
| Mercurialis perennis | woodland with flushes and tufa | local |
| Metzgeria furcata | woodland with flushes and tufa | epiphyte on ash |
| Myosotis scorpioides | woodland with flushes and tufa | local in open area of seepage (below main spring head) |
| Orthotrichum affine | woodland with flushes and tufa | epiphyte on ash, fruiting |
| Pellia endiviifolia | woodland with flushes and tufa | in stream (associated with tufa) |
| Plagiomnium rostratum | woodland with flushes and tufa | stones and roots in stream |
| Plagiomnium undulatum | woodland with flushes and tufa | in stream (associated with tufa) |
| Platyhypnidium riparioides | woodland with flushes and tufa | local in faster flowing sections of stream |
| Poa trivialis | woodland with flushes and tufa | |
| Polystichum setiferum | woodland with flushes and tufa | |
| Pseudotsuga menziesii | woodland with flushes and tufa | |
| Radula complanata | woodland with flushes and tufa | epiphyte on ash, with perianhs |
| Ramalina fasgiata | woodland with flushes and tufa | epiphyte on ash |
| Ranunculus repens | woodland with flushes and tufa | |
| Rhytidiadelphus squarrosus | woodland with flushes and tufa | local |
| Silene dioica | woodland with flushes and tufa | local |
| Thamnobryum alopecurum | woodland with flushes and tufa | |
| Thuidium tamariscinum | woodland with flushes and tufa | |
| Viola riviniana | woodland with flushes and tufa | |

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Acer pseudoplatanus | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Allium ursinum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | lower down site closer to reservoir (local) |
| Amblystegium serpens var. serpens | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | epiphyte on ash and beech trunks |
| Arum maculatum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | lower down site closer to reservoir |
| Asplenium scolopendrium | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | several plants in one place only (steep clay bank adjoining wide outfall of |
| Blechnam spicant | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | main stream into reservoir) |
| Brachythecium rivulare | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | mostly below main spring head |
| Brachythecium rutabulum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | on rocks and bases of trees |
| Cardamine flexuosa | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | lower down site closer to reservoir |
| Carex pendula | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Carex remota | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Carex sylvatica | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | lower down site closer to reservoir (local) |
| Chrysosplenium oppositifolium | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | more prominent lower down site closer to reservoir |
| Clematis vitalba | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Conocephalum conicum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Crataegus monogyna | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | throughout the site below spring head on rock, tree roots, tufa, tufa-encrusted |
| Cratoneuron filicinum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | rocks & tree roots |
| Cryphaea heteromalla | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | epiphyte on hazel, fruiting |
| Deschampsia cespitosa | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Dryopteris dilatata | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Equisetum telmateia | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Eucladium verticillatum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | occasional on tufa-encrusted tree roots [checked microscopically] |
| Eurhynchium striatum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | lower down site closer to reservoir |
| Fagus sylvatica | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | relatively frequent in central part of site on limestone, tufa, tufa-encrusted rocks and tree roots within stream, fruiting (spores 10-14um, lf cells 8-10um, |
| Fissidens pusillus | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | perichaetial lvs to x6 longer than wide, acute) |
| Fissidens taxifolius | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | steep (and mildly tufa-encrusted) clay bank beside stream, fruiting (spores 10- |
| Fissidens viridulus | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | 14um, lf cells 8-10um, pericheatial lvs little differentiated, lvs mucronate) |
| Fraxinus excelsior | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Frullania dilatata | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | epiphyte on hazel, with perianths |
| Galium odoratum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | lower down site closer to reservoir (local) |
| Geranium robertianum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Glechoma hederacea | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | lower down site closer to reservoir |
| Homalothecium sericeum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | epiphyte on ash |
| Hypnum cupressiforme | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | epiphyte on trunks of ash and beech |
| Ilex aquifolium | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Kindbergia praelonga | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | on rocks and bases of trees |
| Lamiastrum galeobdolon | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | lower down site closer to reservoir (local) |
| Lophocolea bidentata | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | limestone, trees bases and tree roots, logs close to main stream |
| Lophocolea heterophylla | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | logs (local) |
| Mentha aquatica | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | just below main spring head |
| Metzgeria temporata | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | epiphyte on beech |
| Metzgeria violacea | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | epiphyte on hazel |
| Mnium hornum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | logs (local) |
| Orthotrichum affine | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | epiphyte on hazel, fruiting |
| Oxalis acetosella | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | lower down site closer to reservoir (local) |
| Oxyrrhynchium hians | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | frequent (sometimes loosely associated with tufa) |
| Palustriella commutata | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | locally dominant on stones and forming small tufa terraces in many places (especially confluences of side springs with main spring) |
| Pellia endiviifolia | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Picea abies | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Plagiochila asplenioides | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | occasional on shaded limestone, tufa and tufa-encrusted limestone close to |
| Plagiomnium rostratum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | main stream |
| Plagiomnium undulatum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Plagiothecium succulentum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | logs (local)[lf cells 16-20 x 100-120um] |
| Platyhypnidium riparioides | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | occasional on limestone and tufa within main stream (faster flowing sections with cascades) |
| Poa trivialis | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Polypodium vulgare | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | epiphyte on fallen Ash beside main stream close to reservoir [sporangia |
| Radula complanata | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | checked microscopically, annulus of 14 cells average] |
| Rhizomnium punctaum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | epiphyte on hazel, with perianths |
| Rhynchostegiella teneriffae | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | logs (local) |
| Rumex conglomeratus | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | occasional on shaded limestone, tufa and tufa-encrusted limestone in small gorge sections of main stream, (often by cascades), [lf cells 32-44], often with Fissidens pusillus |
| Sambucus nigra | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | just below main spring head (with old seed heads) |
| Thamnobryum alopecurum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Thuidium tamariscinum | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | |
| Urtica dioica | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | lower down site closer to reservoir |
| Zygodon viridissimus | 'spring head and side springs within Norway Spruce plantation and feeding into reservoir | just below main spring head |
| | | epiphyte on ash |

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Acer pseudoplatanus | 'woodland spring head and stream with tufa | |
| Anomodon viticulosus | 'woodland spring head and stream with tufa | limestone wall by springhead |
| Asplenium scolopendrium | 'woodland spring head and stream with tufa | |
| Brachythecium rivulare | 'woodland spring head and stream with tufa | mostly at spring head |
| Brachythecium rutabulum | 'woodland spring head and stream with tufa | mostly on rocks and tree bases |
| Cardamine flexuosa | 'woodland spring head and stream with tufa | |
| Carex pendula | 'woodland spring head and stream with tufa | |
| Carex remota | 'woodland spring head and stream with tufa | |
| Carex sylvatica | 'woodland spring head and stream with tufa | |
| Chrysosplenium oppositifolium | 'woodland spring head and stream with tufa | mostly at spring head |
| Conocephalum conicum | 'woodland spring head and stream with tufa | occasional |
| Cratoneuron filicinum | 'woodland spring head and stream with tufa | mostly at spring head |
| Deschampsia cespitosa | 'woodland spring head and stream with tufa | |
| Dryopteris filix-mas | 'woodland spring head and stream with tufa | |
| Eurhynchium striatum | 'woodland spring head and stream with tufa | local |
| Fagus sylvatica | 'woodland spring head and stream with tufa | |
| Ficaria verna ssp. verna | 'woodland spring head and stream with tufa | |
| Fissidens taxifolius | 'woodland spring head and stream with tufa | frequent, often associated with tufa, fruiting |
| Fraxinus excelsior | 'woodland spring head and stream with tufa | |
| Frullania dilatata | 'woodland spring head and stream with tufa | epiphyte on ash |
| Geranium robertianum | 'woodland spring head and stream with tufa | |
| Hypnum cupressiforme | 'woodland spring head and stream with tufa | epiphyte on bases of larger trees |
| Ilex aquifolium | 'woodland spring head and stream with tufa | |
| Kindbergia praelonga | 'woodland spring head and stream with tufa | mainly as an epiphyte on bases of larger trees |
| Lamiastrum galeobdolon | 'woodland spring head and stream with tufa | |
| Mercurialis perennis | 'woodland spring head and stream with tufa | local |
| Metzgeria furcata | 'woodland spring head and stream with tufa | epiphyte on ash |
| Metzgeria violacea | 'woodland spring head and stream with tufa | epiphyte on ash |
| Neckera complanata | 'woodland spring head and stream with tufa | limestone wall by springhead |
| Orthotrichum affine | 'woodland spring head and stream with tufa | |
| Oxyrrhynchium hians | 'woodland spring head and stream with tufa | epiphyte on ash |
| Pellia endiviifolia | 'woodland spring head and stream with tufa | mostly at spring head |
| Poa trivialis | 'woodland spring head and stream with tufa | |
| Polystichum setiferum | 'woodland spring head and stream with tufa | |
| Populus x canadensis | 'woodland spring head and stream with tufa | |
| Porella platyphylla | 'woodland spring head and stream with tufa | limestone wall by springhead |
| Pseudotsuga menziesii | 'woodland spring head and stream with tufa | local planting |
| Ranunculus repens | 'woodland spring head and stream with tufa | |
| Rubus fruticosus agg. | 'woodland spring head and stream with tufa | |
| Stellaria holostea | 'woodland spring head and stream with tufa | local (lower down site) |
| Thamnobryum alopecurum | 'woodland spring head and stream with tufa | limestone, tree bases and limestone wall by springhead |
| Urtica dioica | 'woodland spring head and stream with tufa | |
| Zygodon viridissimus | 'woodland spring head and stream with tufa | epiphyte on ash |
| Anomodon viticulosus | 'woodland | limestone outcrop beside track |
| Ctenidium molluscum | 'woodland | limestone outcrop beside track |
| Encalytpta streptocarpa | 'woodland | limestone outcrop beside track |
| Eurhynchium striatum | 'woodland | limestone outcrop beside track |
| Seligeria pusilla | 'woodland | limestone outcrop beside track, fruiting (seta to 2.8mm, spores 10um) |
| Rhytidiadelphus triquetrus | 'woodland | limestone outcrop beside track |
| Tortella tortuosa | 'woodland | limestone outcrop beside track |
| Allium ursinum | 'woodland spring head and stream | |
| Brachythecium rivulare | 'woodland spring head and stream | |
| Brachythecium rutabulum | 'woodland spring head and stream | mostly on rocks and tree bases |
| Carex pendula | 'woodland spring head and stream | |
| Chrysosplenium oppositifolium | 'woodland spring head and stream | |
| Cratoneuron filicinum | 'woodland spring head and stream | |
| Deschampsia cespitosa | 'woodland spring head and stream | |
| Dryopteris filix-mas | 'woodland spring head and stream | |
| Fagus sylvatica | 'woodland spring head and stream | |
| Fissidens bryoides | 'woodland spring head and stream | clay bank, fruiting (plants with gemiferous male buds, margin joining nerve at apex) |
| Fissidens taxifolius | 'woodland spring head and stream | |
| Fraxinus excelsior | 'woodland spring head and stream | |
| Frullania dilatata | 'woodland spring head and stream | epiphyte on beech |
| Hypnum cupressiforme | 'woodland spring head and stream | epiphyte on beech |
| Isothecium myosuroides | 'woodland spring head and stream | epiphyte on bases of larger trees |
| Kindbergia praelonga | 'woodland spring head and stream | mostly on rocks and tree bases |
| Lamiastrum galeobdolon | 'woodland spring head and stream | |
| Lophocolea heterophylla | 'woodland spring head and stream | log |
| Metzgeria furcata | 'woodland spring head and stream | epiphyte on ash and beech |
| Mnium hornum | 'woodland spring head and stream | log |
| Orthodontium lineare | 'woodland spring head and stream | log (one place only) |
| Orthotrichum affine | 'woodland spring head and stream | epiphyte on ash, fruiting |
| Oxyrrhynchium hians | 'woodland spring head and stream | |
| Plagiochila asplenioides | 'woodland spring head and stream | limestone rock beside stream (local) |
| Plagiothecium succulentum | 'woodland spring head and stream | log, fruiting (lf cells 16-20 x 100-160um) |
| Poa trivialis | 'woodland spring head and stream | |
| Polystichum setiferum | 'woodland spring head and stream | |
| Zygodon viridissimus | 'woodland spring head and stream | epiphyte on ash |
| Allium ursinum | 'woodland spring head and stream with Palustriella tufa terraces | |
| Anomodon viticulosus | 'woodland spring head and stream with Palustriella tufa terraces | old wall (central part of site) |
| Arum maculatum | 'woodland spring head and stream with Palustriella tufa terraces | |
| Asplenium scolopendrium | 'woodland spring head and stream with Palustriella tufa terraces | |
| Brachythecium rivulare | 'woodland spring head and stream with Palustriella tufa terraces | |
| Brachythecium rutabulum | 'woodland spring head and stream with Palustriella tufa terraces | epiphyte on elder stems in open central part of site (marsh), above height of flood water |
| Cardamine flexuosa | 'woodland spring head and stream with Palustriella tufa terraces | open central part of site (marsh) |
| Carex pendula | 'woodland spring head and stream with Palustriella tufa terraces | |
| Carex remota | 'woodland spring head and stream with Palustriella tufa terraces | |
| Carex sylvatica | 'woodland spring head and stream with Palustriella tufa terraces | |
| Chrysosplenium oppositifolium | 'woodland spring head and stream with Palustriella tufa terraces | rather local |
| Conocephalum conicum | 'woodland spring head and stream with Palustriella tufa terraces | occasional |
| Corylus avellana | 'woodland spring head and stream with Palustriella tufa terraces | |
| Cratoneuron filicinum | 'woodland spring head and stream with Palustriella tufa terraces | mostly nr. spring head on rocks and roots (often with tufa) |
| Cryphaea heteromalla | 'woodland spring head and stream with Palustriella tufa terraces | epiphyte on elder stems in open central part of site (marsh), fruiting |
| Ctenidium molluscum | 'woodland spring head and stream with Palustriella tufa terraces | old wall (central part of site) |
| Deschampsia cespitosa | 'woodland spring head and stream with Palustriella tufa terraces | |
| Dryopteris dilatata | 'woodland spring head and stream with Palustriella tufa terraces | |
| Dryopteris filix-mas | 'woodland spring head and stream with Palustriella tufa terraces | |
| Equisetum telmateia | 'woodland spring head and stream with Palustriella tufa terraces | local |
| Eupatorium cannabinum | 'woodland spring head and stream with Palustriella tufa terraces | |
| Eurhynchium striatum | 'woodland spring head and stream with Palustriella tufa terraces | |
| Fagus sylvatica | 'woodland spring head and stream with Palustriella tufa terraces | |
| Fissidens taxifolius | 'woodland spring head and stream with Palustriella tufa terraces | frequent on rocks and roots by stream, fruiting (often associated with tufa) |
| Fraxinus excelsior | 'woodland spring head and stream with Palustriella tufa terraces | |
| Frullania dilatata | 'woodland spring head and stream with Palustriella tufa terraces | epiphyte on ash, fruiting |
| Geranium robertianum | 'woodland spring head and stream with Palustriella tufa terraces | old wall (central part of site) |
| Geum urbanum | 'woodland spring head and stream with Palustriella tufa terraces | |
| Glechoma hederacea | 'woodland spring head and stream with Palustriella tufa terraces | |
| Hypnum cupressiforme | 'woodland spring head and stream with Palustriella tufa terraces | epiphyte on trunks of larger trees |
| Ilex aquifolium | 'woodland spring head and stream with Palustriella tufa terraces | |
| Isothecium myosuroides | 'woodland spring head and stream with Palustriella tufa terraces | epiphyte on trunks of larger trees |
| Juncus inflexus | 'woodland spring head and stream with Palustriella tufa terraces | open central part of site (marsh) |
| Kindbergia praelonga | 'woodland spring head and stream with Palustriella tufa terraces | mainly as an epiphyte on trunks of larger trees |
| Lamiastrum galeobdolon | 'woodland spring head and stream with Palustriella tufa terraces | |
| Lophocolea bidentata | 'woodland spring head and stream with Palustriella tufa terraces | on rocks, tree bases and logs |
| Mercurialis perennis | 'woodland spring head and stream with Palustriella tufa terraces | open central part of site (marsh) |
| Metzgeria violacea | 'woodland spring head and stream with Palustriella tufa terraces | epiphyte on elder stems in open central part of site (marsh) |
| Orthotrichum affine | 'woodland spring head and stream with Palustriella tufa terraces | epiphyte on ash and elder, fruiting |
| Orthotrichum lyellii | 'woodland spring head and stream with Palustriella tufa terraces | epiphyte on ash |
| Oxyrrhynchium hians | 'woodland spring head and stream with Palustriella tufa terraces | |
| Palustriella commutata | 'woodland spring head and stream with Palustriella tufa terraces | on rocks, occasionally roots below spring head forming extensive tufa terraces |
| Pellia endiviifolia | 'woodland spring head and stream with Palustriella tufa terraces | abundant (associated with tufa) and large plants submerged in water tank |
| Peltigera sp. | 'woodland spring head and stream with Palustriella tufa terraces | fallen tree (open central part of site) |
| Plagiomnium rostratum | 'woodland spring head and stream with Palustriella tufa terraces | log in stream and on tufa at spring head |
| Plagiomnium undulatum | 'woodland spring head and stream with Palustriella tufa terraces | |
| Platyhypnidium riparioides | 'woodland spring head and stream with Palustriella tufa terraces | in deeper water of tank (at spring head) |
| Rhizomnium punctaum | 'woodland spring head and stream with Palustriella tufa terraces | log beside stream |
| Rubus fruticosus agg. | 'woodland spring head and stream with Palustriella tufa terraces | |
| Sambucus nigra | 'woodland spring head and stream with Palustriella tufa terraces | |
| Thamnobryum alopecurum | 'woodland spring head and stream with Palustriella tufa terraces | |
| Thuidium tamariscinum | 'woodland spring head and stream with Palustriella tufa terraces | local in lower part of site |
| Ulota bruchii | 'woodland spring head and stream with Palustriella tufa terraces | epiphyte on elder stems in open central part of site (marsh), fruiting |
| Ulota bruchii | 'woodland spring head and stream with Palustriella tufa terraces | epiphyte on elder stems in open central part of site (marsh) |

# Strawberry Banks SO9003 , 19/01/2017

| SPECIES | SITE DESCRIPTION | NOTES |
|---|---|---|
| Allium ursinum | open spring heads and Palustriella tufa terraces and steep wooded stream below | local (in woodland below) |
| Amblystegium serpens var. serpens | open spring heads and Palustriella tufa terraces and steep wooded stream below | tree bases and stones beside stream |
| Angelica sylvestris | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Anomodon viticulosus | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on lower trunk of beech |
| Apium nodiflorum | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Arum maculatum | open spring heads and Palustriella tufa terraces and steep wooded stream below | local (in woodland below) |
| Asplenium scolopendrium | open spring heads and Palustriella tufa terraces and steep wooded stream below | frequent on banks beside stream in woodland and under scrub at spring head |
| Brachythecium rivulare | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Brachythecium rutabulum | open spring heads and Palustriella tufa terraces and steep wooded stream below | frequent at spring head and beside woodland stream below |
| Calliergonella cuspidata | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Cardamine flexuosa | open spring heads and Palustriella tufa terraces and steep wooded stream below | occasional by stream in woodland |
| Cardamine pratense | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Centaurea nigra | open spring heads and Palustriella tufa terraces and steep wooded stream below | immediate edge of open area of marsh below main spring head |
| Chrysosplenium oppositifolium | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Cirriphyllum piliferum | open spring heads and Palustriella tufa terraces and steep wooded stream below | local (in woodland below) |
| Cirsium palustre | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Conocephalum conicum | open spring heads and Palustriella tufa terraces and steep wooded stream below | occasional |
| Corylus avellana | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Crataegus monogyna | open spring heads and Palustriella tufa terraces and steep wooded stream below | part od scrub at spring head |
| Cratoneuron filicinum | open spring heads and Palustriella tufa terraces and steep wooded stream below | frequent on limestone and tree roots beside stream (often with tufa) |
| Cryphaea heteromalla | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on ash twigs, fruiting |
| Ctenidium molluscum | open spring heads and Palustriella tufa terraces and steep wooded stream below | local (on limestone blocks in woodland below) |
| Didymodon sinuosus | open spring heads and Palustriella tufa terraces and steep wooded stream below | occasional on limestone, tree roots beside stream in woodland (once on tufa with Eucladium) |
| Dryopteris dilatata | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Epilobium hirsutum | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Equisetum telmateia | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head (local) |
| Eucladium verticillatum | open spring heads and Palustriella tufa terraces and steep wooded stream below | occasional on tufa, tufa-encrusted roots by stream below in woodland [checked microscopically] |
| Eupatorium cannabinum | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Eurhynchium striatum | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Fagus sylvatica | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Festuca rubra | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Ficaria verna ssp. verna | open spring heads and Palustriella tufa terraces and steep wooded stream below | mainly as an epiphyte on tree bases |
| Filipendula ulmaria | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Fissidens crassipes | open spring heads and Palustriella tufa terraces and steep wooded stream below | occasional on tufa in bed of woodland stream, fruiting (cells 10-14um, spores 22-28um) |
| Fissidens dubius | open spring heads and Palustriella tufa terraces and steep wooded stream below | soil covered limestone beside stream within woodland (one place only), fruiting (lv cells 8-10um) |
| Fissidens pusillus | open spring heads and Palustriella tufa terraces and steep wooded stream below | frequent on limestone and tufa in bed of woodland stream, fruiting (cells 8-10um, spores 12-14um, lf border not reaching nerve, perichaetial lvs to x7 longer than wide) |
| Fissidens taxifolius | open spring heads and Palustriella tufa terraces and steep wooded stream below | frequent, fruiting (associated with tufa) |
| Fragaria vesca | open spring heads and Palustriella tufa terraces and steep wooded stream below | under scrub at main spring head |
| Fraxinus excelsior | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Frullania dilatata | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on ash, with perianths |
| Galium odoratum | open spring heads and Palustriella tufa terraces and steep wooded stream below | local (in woodland below) |
| Geranium robertianum | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Geum urbanum | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Glyceria fluitans | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Hedera helix ssp. helix | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Homalothecium sericeum | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on hawthorn at spring head |
| Hypericum tetrapterum | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head [old stems downy] |
| Hypnum cupressiforme | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on bases of larger trees |
| Ilex aquifolium | open spring heads and Palustriella tufa terraces and steep wooded stream below | seedlings under scrub at main spring head |
| Isothecium alopecuroides | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on roots of large ash (one place only) |
| Isothecium myosuroides | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on bases of larger trees |
| Juncus inflexus | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Kindbergia praelonga | open spring heads and Palustriella tufa terraces and steep wooded stream below | mainly as an epiphyte on tree bases |
| Lamiastrum galeobdolon | open spring heads and Palustriella tufa terraces and steep wooded stream below | local (in woodland below) |
| Lophocolea bidentata | open spring heads and Palustriella tufa terraces and steep wooded stream below | tree bases, roots and stones beside stream, in open area of marsh below main spring head |
| Mentha aquatica | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Metzgeria furcata | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on hazel |
| Mnium hornum | open spring heads and Palustriella tufa terraces and steep wooded stream below | old stumps and minute plants on tree roots |
| Myosotis scorpioides | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Nasturtium officinale s.l. | open spring heads and Palustriella tufa terraces and steep wooded stream below | in spring water at spring head |
| Neckera complanata | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on lower trunk of beech |
| Orthotrichum affine | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on ash twigs, fruiting |
| Orthotrichum pulchellum | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on ash twigs, fruiting |
| Oxalis acetosella | open spring heads and Palustriella tufa terraces and steep wooded stream below | local (log in woodland below) |
| Oxyrrhynchium hians | open spring heads and Palustriella tufa terraces and steep wooded stream below | frequent on clay banks beside stream in woodland |
| Palustriella commutata | open spring heads and Palustriella tufa terraces and steep wooded stream below | locally dominant forming tufa terraces below spring head |
| Pellia endiviifolia | open spring heads and Palustriella tufa terraces and steep wooded stream below | frequent in channel |
| Plagiochila asplenioides | open spring heads and Palustriella tufa terraces and steep wooded stream below | clay banks beside stream in woodland |
| Plagiomnium rostratum | open spring heads and Palustriella tufa terraces and steep wooded stream below | limestone and tree roots beside stream (occasionally associated with tufa), in open area of marsh below main spring head |
| Plagiomnium undulatum | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Platyhypnidium riparioides | open spring heads and Palustriella tufa terraces and steep wooded stream below | on rocks within small gorge sections of woodland |
| Poa trivialis | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Polystichum setiferum | open spring heads and Palustriella tufa terraces and steep wooded stream below | local (in woodland below) |
| Poterium sanguisorba | open spring heads and Palustriella tufa terraces and steep wooded stream below | on ant hill closely adjoining open area of marsh below main spring head |
| Primula veris | open spring heads and Palustriella tufa terraces and steep wooded stream below | on ant hill closely adjoining open area of marsh below main spring head |
| Primula vulgaris | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Prunella vulgaris | open spring heads and Palustriella tufa terraces and steep wooded stream below | immediate edge of open area of marsh below main spring head |
| Radula complanata | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on ash, with perianths |
| Ranunculus repens | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Rhytidiadelphus triquetrus | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Rubus fruticosus agg. | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Rumex conglomeratus | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head (with old seed heads) |
| Salix caprea | open spring heads and Palustriella tufa terraces and steep wooded stream below | |
| Sanicula europaea | open spring heads and Palustriella tufa terraces and steep wooded stream below | local (in woodland below) |
| Schistidium crassipilum | open spring heads and Palustriella tufa terraces and steep wooded stream below | limestone rock at immediate edge of open area of marsh below main spring head |
| Taraxacum sp. | open spring heads and Palustriella tufa terraces and steep wooded stream below | immediate edge of open area of marsh below main spring head |
| Thamnobryum alopecurum | open spring heads and Palustriella tufa terraces and steep wooded stream below | frequent |
| Thuidium tamariscinum | open spring heads and Palustriella tufa terraces and steep wooded stream below | local (in woodland below) |
| Trifolium repens | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Ulota bruchii | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on hazel, fruiting |
| Valeriana dioica | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Veronica beccabunga | open spring heads and Palustriella tufa terraces and steep wooded stream below | open area of marsh below main spring head |
| Zygodon viridissimus | open spring heads and Palustriella tufa terraces and steep wooded stream below | epiphyte on ash twigs, fruiting, epiphyte on hawthorn at spring head |

## APPENDIX 3. WATER CHEMISTRY

UKAS TESTING
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British Geological Survey
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ANALYTICAL GEOCHEMISTRY LABORATORIES

# ANALYSIS REPORT COVER NOTE

This report consists of a 2 page Analysis Report Cover Note and 5 pages of test data

| | | | |
|---|---|---|---|
| Report Number: | 13959/1 | Customer Ref/Order No: | NEE 3979R |
| Report Date: | 03 March 2017 | Sample(s) received on: | 03 February 2017 |
| Issue Status: | Complete | Analysis commenced on: | 7 February 2017 |

*Sample Details*

All 24 Tufa spring water samples were received in good condition. Twenty four F/UA subsamples and only 23 F/A 1% $HNO_3$ subsamples were provided. Sample 13959-0018 was only provided as a F/UA and therefore upon receipt to the laboratory a subsample was created and acidified.

Unless previously agreed otherwise in writing, samples will be retained for three months from the date of issue of this report prior to disposal. Please contact the Laboratory if you wish to make alternative arrangements. This excludes any subcontracted analysis.

*Analysis Details*

| Determinands | Test Method | Procedure | Notes |
|---|---|---|---|
| Ca, Mg, Na, K, Si, Ba, Sr, Mn, Total Fe, Li, Be, B, Al, Ti, V, Cr, Co, Ni, Cu, Zn, Ga, As, Se, Rb, Y, Zr, Nb, Mo, Cd, Sn, Sb, Cs, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Tl, Pb, Th, U | ICP-MS | AG 2.3.18 | UKAS |
| Total P, Total S, Ag | ICP-MS | | N |
| $Cl^-$, $SO_4^{2-}$, $NO_3^-$, $NO_2^-$, $Br^-$, $F^-$, $HPO_4^{2-}$ | Ion chromatography | AG 2.3.19 | UKAS |
| Alkalinity | Potentiometric titration | AGN 2.3.7 | UKAS |
| Electrical conductivity | Potentiometric electrode | | N |

Tests marked UKAS in the above table are included in the UKAS Accreditation Schedule for this Laboratory; those marked N are not. Tests marked S have been subcontracted to an outside laboratory who either hold (S1) or do not hold (S2) UKAS accreditation for the method concerned.

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

ANALYTICAL GEOCHEMISTRY LABORATORIES

# ANALYSIS REPORT COVER NOTE

Sampling is outside the control of the laboratory and no knowledge of the sampling procedures or sample storage conditions prior to receipt by the laboratory is assumed. Sample preservation and storage are known to have deviated from the laboratory's normal recommended practice as follows:

| Samples affected | Determinands | Details of variation |
|---|---|---|
| 13959-0018 | All ICP-MS analytes | Samples received unpreserved |
| 13959-0001 to -0024 | Electrical conductivity | Analysis greater than 1 day after sampling |

Clients should be aware that in these circumstances changes may occur in concentrations of determinands between the time of sampling and analysis. The determined concentrations reported may therefore not be reflective of the concentrations present at the time of sampling, and clients are advised to take account of this possibility during use or interpretation of the data.

Other field data supplied by the client have been included in this report.

Ionic charge balance for all samples (except 13959-0018) exceed the usually acceptable range of ±5% but is less than ±28%. As discussed with the client this is possibly due to the nature of the samples.

Because of limitations with the current software used for reporting data, the number of significant figures quoted in the attached table may not be representative of the actual uncertainty. Data should be considered accurate to no more than three significant figures.

This report is issued under complete status. All analyses requested have been completed and results are issued with full compliance of data verification.

We would be pleased to receive any feedback you may have on the quality of our service.

Report authorised by: ..... ..... Date: .....03/03/17.....

Dr Michael Watts, Head of Inorganic Geochemistry

| LIMS Code | Site | Date | No | Field Temp °C | Field pH | Field EC µS cm$^{-1}$ | EC µS cm$^{-1}$ | Ca mg l$^{-1}$ | Mg mg l$^{-1}$ | Na mg l$^{-1}$ | K mg l$^{-1}$ | $CO_3^{2-}$ mg l$^{-1}$ | $HCO_3^-$ mg l$^{-1}$ | $Cl^-$ mg l$^{-1}$ | $SO_4^{2-}$ mg l$^{-1}$ | $NO_3^-$ mg l$^{-1}$ | N mg/l | Ionic Balance % | $Br^-$ mg l$^{-1}$ | $NO_2^-$ mg l$^{-1}$ | Total P mg l$^{-1}$ | Total S mg l$^{-1}$ | Si mg l$^{-1}$ | $SiO_2$ mg l$^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ICP-MS DL | | | | | | | | 0.3 | 0.01 | 0.2 | 0.02 | | | | | | | | | | 0.01 | 1 | 0.05 | |
| 13959-0015 | Alder Carr | 22.1.2017 | 13 | 10.3 | 7.28 | 712 | 573 | 106 | 8.38 | 21.1 | 1.86 | n/a | 236 | 41.7 | 26.1 | 7.89 | 1.79 | 9.92 | <0.1 | <0.05 | <0.01 | 11 | 3.75 | 8.02 |
| 13959-0023 | Aust Clif | 29.1.2017 | 20 | 9.5 | 8.03 | 621 | 512 | 86.8 | 14.7 | 13.7 | 4.69 | n/a | 209 | 17.1 | 63.0 | 0.292 | 0.066 | 9.10 | 0.079 | <0.025 | 0.01 | 23 | 4.03 | 8.62 |
| 13959-0019 | Bathurst Estate | 27.1.2017 | 17 | 10.1 | 7.77 | 492 | 370 | 91.1 | 2.18 | 5.1 | 0.63 | n/a | 162 | 9.11 | 13.1 | 19.4 | 4.39 | 17.47 | <0.05 | <0.025 | <0.01 | 5 | 2.29 | 4.90 |
| 13959-0004 | Cranham Woods (top) | 19.1.2017 | 3.1 | 9.9 | 7.45 | 625 | 382 | 99.3 | 2.12 | 8.4 | 0.53 | 45 | 96 | 15.1 | 9.00 | 6.86 | 1.55 | 18.09 | <0.05 | <0.025 | <0.01 | 5 | 3.40 | 7.27 |
| 13959-0005 | Cranham Woods (bottom) | 19.1.2017 | 3.2 | 6.7 | 8.03 | 523 | 318 | 91.4 | 2.20 | 8.0 | 0.80 | 63 | 19 | 14.3 | 9.07 | 7.43 | 1.68 | 24.40 | <0.05 | <0.025 | <0.01 | 4 | 3.38 | 7.23 |
| 13959-0024 | Dowdeswell | 29.1.2017 | 21 | 10.7 | 7.81 | 446 | 383 | 84.7 | 2.05 | 6.1 | 0.58 | n/a | 183 | 7.87 | 8.25 | 11.7 | 2.65 | 13.30 | <0.05 | <0.025 | <0.01 | 4 | 2.16 | 4.62 |
| 13959-0012 | Fishponds Wood | 21.1.2017 | 10 | 9.1 | 7.40 | 550 | 466 | 109 | 2.62 | 7.3 | 0.50 | n/a | 204 | 14.3 | 20.5 | 33.2 | 7.52 | 11.81 | <0.05 | <0.025 | <0.01 | 9 | 2.28 | 4.88 |
| 13959-0011 | Horsley Wood | 21.1.2017 | 9 | 7.0 | 8.21 | 611 | 427 | 114 | 4.10 | 6.3 | 1.92 | n/a | 207 | 9.35 | 29.8 | 9.24 | 2.09 | 18.03 | <0.05 | <0.025 | <0.01 | 12 | 3.47 | 7.42 |
| 13959-0013 | Kingscote Wood | 21.1.2017 | 11 | 9.4 | 7.58 | 533 | 425 | 89.8 | 2.76 | 6.0 | 0.56 | n/a | 174 | 13.3 | 19.8 | 31.0 | 7.01 | 9.30 | <0.05 | <0.025 | <0.01 | 8 | 2.29 | 4.90 |
| 13959-0014 | Kingscote Wood | 21.1.2017 | 12 | 9.0 | 8.11 | 563 | 424 | 106 | 2.89 | 7.0 | 1.33 | n/a | 174 | 13.2 | 20.1 | 30.3 | 6.86 | 17.13 | <0.05 | <0.025 | <0.01 | 9 | 2.48 | 5.31 |
| 13959-0018 | Lydney Cliff | 26.1.2017 | 16 | 7.2 | 8.29 | 628 | 567 | 74.1 | 12.8 | 14.6 | 13.4 | n/a | 164 | 31.1 | 98.2 | 3.96 | 0.896 | 0.41 | 0.056 | <0.025 | <0.01 | 34 | 4.01 | 8.58 |
| 13959-0021 | Midger Woods (main) | 28.1.2017 | 19.1 | 10.1 | 7.43 | 583 | 520 | 106 | 4.94 | 8.7 | 2.97 | n/a | 202 | 13.2 | 30.5 | 49.5 | 11.2 | 9.30 | <0.05 | <0.025 | 0.03 | 13 | 2.41 | 5.16 |
| 13959-0022 | Midger Woods (fissidens) | 28.1.2017 | 19.2 | 7.2 | 8.31 | 609 | 493 | 91.3 | 9.31 | 11.0 | 4.10 | n/a | 164 | 18.5 | 76.1 | 7.17 | 1.62 | 9.24 | <0.05 | <0.025 | <0.01 | 29 | 3.13 | 6.70 |
| 13959-0020 | Minchiampton | 27.1.2017 | 18 | 9.6 | 8.37 | 511 | 420 | 91.0 | 3.01 | 12.3 | 1.20 | n/a | 176 | 18.3 | 23.5 | 11.0 | 2.50 | 13.66 | <0.05 | <0.025 | 0.04 | 10 | 2.35 | 5.03 |
| 13959-0017 | Slade Brook | 26.1.2017 | 15 | 10.0 | 7.41 | 684 | 572 | 93.5 | 23.3 | 5.5 | 1.22 | n/a | 276 | 10.5 | 34.4 | 31.7 | 7.17 | 6.26 | <0.05 | <0.025 | <0.01 | 14 | 2.20 | 4.71 |
| 13959-0009 | Strawberry Bank | 21.1.2017 | 7 | 10.4 | 7.61 | 529 | 411 | 89.2 | 2.71 | 8.7 | 2.36 | n/a | 163 | 12.1 | 16.4 | 33.8 | 7.65 | 13.49 | <0.05 | <0.025 | <0.01 | 7 | 2.30 | 4.92 |
| 13959-0010 | Toadsmoor | 20.1.2017 | 8 | 8.9 | 8.17 | 606 | 468 | 101 | 4.06 | 7.1 | 1.58 | 80 | 40 | 13.1 | 29.4 | 28.2 | 6.38 | 9.32 | <0.05 | <0.025 | 0.01 | 12 | 3.09 | 6.61 |
| 13959-0001 | Woodchester Park | 18.1.2017 | 1 | 9.6 | 8.09 | 550 | 360 | 102 | 2.67 | 6.6 | 1.63 | 74 | 15 | 11.6 | 18.6 | 7.90 | 1.79 | 22.57 | <0.05 | <0.025 | <0.01 | 8 | 2.76 | 5.90 |
| 13959-0016 | Woodchester Park | 22.1.2017 | 14 | 9.1 | 8.03 | 1075 | 797 | 190 | 5.95 | 23.6 | 7.80 | n/a | 199 | 50.2 | 157 | 24.3 | 5.51 | 14.54 | <0.2 | <0.1 | <0.01 | 64 | 3.41 | 7.30 |
| 13959-0002 | Woodchester Park | 18.1.2017 | 2.1 | 6.6 | 8.65 | 680 | 516 | 126 | 2.77 | 9.4 | 0.92 | n/a | 153 | 13.8 | 116 | 12.7 | 2.87 | 11.56 | <0.05 | <0.025 | <0.01 | 43 | 2.15 | 4.60 |
| 13959-0003 | Woodchester Park | 18.1.2017 | 2.2 | 7.1 | 8.49 | 510 | 300 | 89.5 | 2.45 | 8.0 | 0.79 | n/a | 122 | 14.9 | 15.5 | 8.37 | 1.89 | 27.29 | <0.05 | <0.025 | <0.01 | 7 | 2.52 | 5.39 |
| 13959-0006 | Workmans Wood (WW1) | 20.1.2017 | 4 | 9.9 | 7.69 | 573 | 353 | 91.8 | 2.33 | 10.0 | 4.09 | 42 | 39 | 19.0 | 15.1 | 23.3 | 5.26 | 23.72 | <0.05 | <0.025 | 0.12 | 7 | 3.90 | 8.34 |
| 13959-0007 | Workmans Wood (WW2) | 20.1.2017 | 5 | 7.1 | 8.24 | 575 | 390 | 98.0 | 2.35 | 7.5 | 0.47 | 51 | 61 | 16.7 | 21.9 | 9.31 | 2.11 | 17.91 | <0.05 | <0.025 | <0.01 | 9 | 4.92 | 10.5 |
| 13959-0008 | Workmans Wood (WW3) | 20.1.2017 | 6 | 7.5 | 7.74 | 569 | 385 | 106 | 4.00 | 6.1 | 0.95 | 55 | 63 | 10.8 | 18.8 | 13.5 | 3.05 | 22.27 | <0.05 | <0.025 | <0.01 | 8 | 3.76 | 8.04 |

| LIMS Code | Site | Date | No | Total Ba | Sr | Mn | Fe | Li | Be | B | Al | Ti | V | Cr | Co | Ni | Cu | Zn | Ga | As | Se | Rb | Y | Zr | Nb | Mo | Ag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ |
| ICP-MS DL | | | | 0.1 | 0.1 | 0.2 | 1 | 1 | 0.01 | 10 | 1 | 0.05 | 0.1 | 0.05 | 0.01 | 0.1 | 0.4 | 0.5 | 0.03 | 0.02 | 0.1 | 0.01 | 0.005 | 0.05 | 0.02 | 0.03 | 0.05 |
| 13959-0015 | Alder Carr | 22.1.2017 | 13 | 4.8 | 536 | 4.5 | 250 | 13 | <0.01 | 65 | 5 | 0.09 | 0.4 | 0.18 | 0.12 | 0.3 | <0.4 | 0.5 | <0.03 | 0.23 | 0.2 | 0.50 | 0.042 | <0.05 | <0.02 | 0.07 | <0.05 |
| 13959-0023 | Aust Clif | 29.1.2017 | 20 | 57.4 | 414 | 3.9 | 17 | 16 | <0.01 | 55 | 11 | 0.09 | <0.1 | 0.12 | 0.06 | 2.5 | 3.2 | 11.3 | <0.03 | 0.17 | 0.4 | 1.50 | 0.039 | <0.05 | <0.02 | 0.88 | <0.05 |
| 13959-0019 | Bathurst Estate | 27.1.2017 | 17 | 7.1 | 113 | 0.3 | 1 | <1 | <0.01 | 14 | 1 | <0.05 | 0.1 | 0.06 | 0.02 | 0.2 | <0.4 | 0.9 | <0.03 | 0.11 | 0.1 | 0.27 | <0.005 | <0.05 | <0.02 | 0.05 | <0.05 |
| 13959-0004 | Cranham Woods (top) | 19.1.2017 | 3.1 | 22.0 | 158 | 0.6 | <1 | 1 | <0.01 | 17 | <1 | <0.05 | <0.1 | <0.05 | 0.02 | 0.1 | <0.4 | 7.6 | <0.03 | 0.08 | 0.1 | 0.21 | 0.007 | <0.05 | <0.02 | 0.05 | <0.05 |
| 13959-0005 | Cranham Woods (bottom) | 19.1.2017 | 3.2 | 9.8 | 159 | <0.2 | <1 | 1 | <0.01 | <10 | <1 | <0.05 | <0.1 | <0.05 | 0.02 | <0.1 | <0.4 | 4.8 | <0.03 | 0.11 | 0.1 | 0.39 | <0.005 | <0.05 | <0.02 | 0.07 | <0.05 |
| 13959-0024 | Dowdeswell | 29.1.2017 | 21 | 274 | 136 | <0.2 | <1 | 2 | <0.01 | 32 | <1 | <0.05 | 0.2 | 0.19 | 0.06 | 0.1 | <0.4 | 77.1 | <0.03 | 0.34 | 0.2 | 0.14 | 0.008 | <0.05 | <0.02 | 0.03 | <0.05 |
| 13959-0012 | Fishponds Wood | 21.1.2017 | 10 | 27.9 | 162 | <0.2 | <1 | 1 | <0.01 | 19 | <1 | <0.05 | 0.2 | 0.13 | 0.03 | 0.1 | <0.4 | 11.9 | <0.03 | 0.08 | 0.2 | 0.13 | 0.016 | <0.05 | <0.02 | 0.09 | <0.05 |
| 13959-0011 | Horsley Wood | 21.1.2017 | 9 | 7.1 | 242 | 2.9 | 6 | 3 | <0.01 | 21 | 3 | 0.06 | 0.2 | <0.05 | 0.04 | 0.3 | <0.4 | <0.5 | <0.03 | 0.14 | 0.3 | 1.04 | 0.012 | <0.05 | <0.02 | 0.10 | <0.05 |
| 13959-0013 | Kingscote Wood | 21.1.2017 | 11 | 25.0 | 174 | 0.2 | <1 | 2 | <0.01 | 33 | <1 | <0.05 | <0.1 | 0.07 | 0.03 | 0.1 | <0.4 | 17.8 | <0.03 | 0.09 | 0.2 | 0.19 | 0.013 | <0.05 | <0.02 | 0.09 | <0.05 |
| 13959-0014 | Kingscote Wood | 21.1.2017 | 12 | 6.7 | 166 | <0.2 | <1 | 1 | <0.01 | 18 | <1 | <0.05 | <0.1 | 0.07 | 0.03 | 0.2 | <0.4 | <0.5 | <0.03 | 0.12 | 0.2 | 0.56 | <0.005 | <0.05 | <0.02 | 0.14 | <0.05 |
| 13959-0018 | Lydney Cliff | 26.1.2017 | 16 | 45.2 | 225 | 0.4 | <1 | 14 | <0.01 | 65 | <1 | <0.05 | <0.1 | <0.05 | 0.04 | 1.6 | 1.5 | 0.8 | <0.03 | 0.11 | 1.1 | 2.24 | <0.005 | <0.05 | <0.02 | 1.66 | <0.05 |
| 13959-0021 | Midger Woods (main) | 28.1.2017 | 19.1 | 12.5 | 310 | 1.9 | 16 | 3 | <0.01 | 41 | 11 | 0.11 | 0.1 | 0.09 | 0.07 | 1.1 | 1.5 | 16.7 | <0.03 | 0.17 | 0.1 | 0.99 | 0.039 | <0.05 | <0.02 | 0.18 | <0.05 |
| 13959-0022 | Midger Woods (fissidens) | 28.1.2017 | 19.2 | 14.1 | 403 | 1.1 | 2 | 11 | <0.01 | 50 | <1 | <0.05 | <0.1 | <0.05 | 0.04 | 0.4 | 1.2 | 3.3 | <0.03 | 0.13 | 0.1 | 1.34 | 0.007 | <0.05 | <0.02 | 0.16 | <0.05 |
| 13959-0020 | Minchiampton | 27.1.2017 | 18 | 353 | 155 | 0.7 | 5 | 3 | <0.01 | 136 | 4 | 0.12 | 0.2 | 0.16 | 0.04 | 0.2 | <0.4 | 40.0 | <0.03 | 0.31 | 0.3 | 0.44 | 0.024 | <0.05 | <0.02 | 0.15 | <0.05 |
| 13959-0017 | Slade Brook | 26.1.2017 | 15 | 52.7 | 103 | <0.2 | <1 | 1 | <0.01 | 26 | <1 | <0.05 | 0.2 | 0.36 | 0.03 | <0.1 | <0.4 | 11.1 | <0.03 | 0.09 | 0.3 | 0.30 | 0.036 | <0.05 | <0.02 | <0.03 | <0.05 |
| 13959-0009 | Strawberry Bank | 21.1.2017 | 7 | 318 | 115 | <0.2 | <1 | <1 | <0.01 | 43 | <1 | <0.05 | 0.1 | 0.18 | 0.05 | 0.1 | <0.4 | 66.7 | <0.03 | 0.18 | 0.1 | 0.45 | 0.011 | <0.05 | <0.02 | 0.10 | <0.05 |
| 13959-0010 | Toadsmoor | 20.1.2017 | 8 | 64.4 | 175 | <0.2 | <1 | 2 | <0.01 | 22 | <1 | <0.05 | 0.1 | 0.13 | 0.03 | 0.2 | <0.4 | 10.8 | <0.03 | 0.17 | 0.1 | 0.61 | 0.006 | <0.05 | <0.02 | 0.13 | <0.05 |
| 13959-0001 | Woodchester Park | 18.1.2017 | 1 | 34.5 | 154 | 0.6 | 2 | 2 | <0.01 | 21 | <1 | <0.05 | <0.1 | 0.06 | 0.03 | 0.9 | 0.4 | 9.7 | <0.03 | 0.10 | 0.2 | 0.42 | 0.014 | <0.05 | <0.02 | 0.13 | <0.05 |
| 13959-0016 | Woodchester Park | 22.1.2017 | 14 | 16.1 | 318 | 0.5 | 5 | 3 | <0.01 | 38 | <1 | <0.05 | <0.1 | <0.05 | 0.09 | 0.9 | 0.8 | <0.5 | <0.03 | 0.16 | 0.2 | 1.52 | 0.009 | <0.05 | <0.02 | 0.11 | <0.05 |
| 13959-0002 | Woodchester Park | 18.1.2017 | 2.1 | 6.5 | 162 | 0.7 | 2 | <1 | <0.01 | 19 | <1 | <0.05 | <0.1 | <0.05 | 0.05 | 0.3 | 0.5 | <0.5 | <0.03 | 0.13 | 0.1 | 0.27 | 0.022 | <0.05 | <0.02 | 0.10 | <0.05 |
| 13959-0003 | Woodchester Park | 18.1.2017 | 2.2 | 4.4 | 143 | 0.2 | 2 | 1 | <0.01 | 12 | <1 | <0.05 | <0.1 | 0.10 | 0.03 | 0.4 | 1.0 | <0.5 | <0.03 | 0.13 | 0.2 | 0.19 | 0.010 | <0.05 | <0.02 | 0.10 | <0.05 |
| 13959-0006 | Workmans Wood (WW1) | 20.1.2017 | 4 | 399 | 144 | <0.2 | <1 | 1 | <0.01 | 38 | <1 | <0.05 | 0.4 | 0.34 | 0.03 | 0.2 | <0.4 | 96.9 | <0.03 | 0.92 | 0.2 | 1.31 | 0.010 | <0.05 | <0.02 | 0.35 | <0.05 |
| 13959-0007 | Workmans Wood (WW2) | 20.1.2017 | 5 | 229 | 164 | 0.2 | 2 | 2 | <0.01 | 20 | <1 | <0.05 | 0.1 | 0.13 | 0.03 | 0.2 | <0.4 | 46.3 | <0.03 | 0.14 | 0.1 | 0.16 | 0.021 | <0.05 | <0.02 | 0.10 | <0.05 |
| 13959-0008 | Workmans Wood (WW3) | 20.1.2017 | 6 | 6.8 | 198 | <0.2 | 2 | 2 | <0.01 | 15 | <1 | <0.05 | <0.1 | <0.05 | 0.03 | 0.1 | <0.4 | <0.5 | <0.03 | 0.15 | 0.2 | 0.39 | 0.008 | <0.05 | <0.02 | 0.10 | <0.05 |

| LIMS Code | Site | Date | No | Cd | Sn | Sb | Cs | Pr | Nd | Sm | Eu | Gd | Tb | Dy | Ho | Er | Tm | Yb | Lu | Hf | Ta | W | Tl | Pb | Th | U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ | µg l$^{-1}$ |
| ICP-MS DL | | | | 0.01 | 0.02 | 0.005 | 0.005 | 0.003 | 0.01 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.01 | 0.02 | 0.05 | 0.01 | 0.02 | 0.04 | 0.002 |
| 13959-0015 | Alder Carr | 22.1.2017 | 13 | <0.01 | <0.02 | 0.023 | <0.00 | 0.012 | 0.05 | 0.009 | <0.00 | 0.010 | <0.00 | 0.006 | <0.00 | 0.004 | <0.00 | 0.002 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.16 | <0.04 | 0.482 |
| 13959-0023 | Aust Clif | 29.1.2017 | 20 | 0.02 | 0.04 | 0.144 | 0.024 | 0.012 | 0.05 | 0.010 | <0.00 | 0.009 | <0.00 | 0.007 | <0.00 | 0.004 | <0.00 | 0.004 | <0.00 | <0.01 | <0.02 | <0.05 | 0.13 | 0.91 | <0.04 | 2.43 |
| 13959-0019 | Bathurst Estate | 27.1.2017 | 17 | <0.01 | <0.02 | 0.015 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.22 | <0.04 | 0.294 |
| 13959-0004 | Cranham Woods (top) | 19.1.2017 | 3.1 | <0.01 | <0.02 | 0.049 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.04 | <0.04 | 0.206 |
| 13959-0005 | Cranham Woods (bottom) | 19.1.2017 | 3.2 | <0.01 | <0.02 | 0.041 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | <0.02 | <0.04 | 0.273 |
| 13959-0024 | Dowdeswell | 29.1.2017 | 21 | <0.01 | <0.02 | 0.107 | <0.00 | <0.00 | <0.01 | 0.003 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | 0.003 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.05 | <0.04 | 0.169 |
| 13959-0012 | Fishponds Wood | 21.1.2017 | 10 | <0.01 | <0.02 | 0.051 | <0.00 | <0.00 | 0.01 | 0.002 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.05 | <0.04 | 0.253 |
| 13959-0011 | Horsley Wood | 21.1.2017 | 9 | <0.01 | <0.02 | 0.013 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.19 | <0.04 | 0.355 |
| 13959-0013 | Kingscote Wood | 21.1.2017 | 11 | <0.01 | <0.02 | 0.050 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | <0.02 | <0.04 | 0.245 |
| 13959-0014 | Kingscote Wood | 21.1.2017 | 12 | <0.01 | <0.02 | 0.019 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.14 | <0.04 | 0.267 |
| 13959-0018 | Lydney Cliff | 26.1.2017 | 16 | <0.01 | <0.02 | 0.228 | 0.024 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | 0.11 | <0.02 | <0.04 | 0.987 |
| 13959-0021 | Midger Woods (main) | 28.1.2017 | 19.1 | 0.02 | 0.03 | 0.043 | 0.005 | 0.010 | 0.04 | 0.009 | 0.003 | 0.009 | <0.00 | 0.007 | <0.00 | 0.004 | <0.00 | 0.004 | <0.00 | <0.01 | <0.02 | <0.05 | 0.02 | 0.67 | <0.04 | 0.266 |
| 13959-0022 | Midger Woods (fissidens) | 28.1.2017 | 19.2 | <0.01 | <0.02 | 0.064 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | 0.02 | 0.06 | <0.04 | 0.392 |
| 13959-0020 | Minchiampton | 27.1.2017 | 18 | 0.01 | <0.02 | 0.218 | <0.00 | 0.004 | 0.02 | 0.006 | <0.00 | 0.004 | <0.00 | 0.004 | <0.00 | 0.002 | <0.00 | 0.004 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.07 | <0.04 | 0.185 |
| 13959-0017 | Slade Brook | 26.1.2017 | 15 | <0.01 | <0.02 | 0.045 | <0.00 | 0.003 | 0.02 | 0.003 | <0.00 | 0.003 | <0.00 | 0.004 | <0.00 | 0.003 | <0.00 | 0.003 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.35 | <0.04 | 0.163 |
| 13959-0009 | Strawberry Bank | 21.1.2017 | 7 | <0.01 | <0.02 | 0.145 | <0.00 | <0.00 | <0.01 | 0.004 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | 0.002 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.11 | <0.04 | 0.305 |
| 13959-0010 | Toadsmoor | 20.1.2017 | 8 | <0.01 | <0.02 | 0.064 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.12 | <0.04 | 0.261 |
| 13959-0001 | Woodchester Park | 18.1.2017 | 1 | 0.01 | <0.02 | 0.079 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.06 | <0.04 | 0.320 |
| 13959-0016 | Woodchester Park | 22.1.2017 | 14 | <0.01 | <0.02 | 0.051 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 1.95 | 0.06 | 0.505 |
| 13959-0002 | Woodchester Park | 18.1.2017 | 2.1 | <0.01 | <0.02 | 0.034 | <0.00 | 0.003 | <0.01 | 0.003 | <0.00 | 0.003 | <0.00 | 0.003 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | <0.02 | <0.04 | 0.321 |
| 13959-0003 | Woodchester Park | 18.1.2017 | 2.2 | <0.01 | <0.02 | 0.025 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.03 | <0.04 | 0.255 |
| 13959-0006 | Workmans Wood (WW1) | 20.1.2017 | 4 | <0.01 | <0.02 | 0.200 | <0.00 | <0.00 | <0.01 | 0.003 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | 0.003 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.10 | <0.04 | 0.209 |
| 13959-0007 | Workmans Wood (WW2) | 20.1.2017 | 5 | <0.01 | <0.02 | 0.099 | <0.00 | <0.00 | <0.01 | 0.003 | <0.00 | 0.004 | <0.00 | 0.003 | <0.00 | <0.00 | <0.00 | 0.002 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | 0.07 | <0.04 | 0.219 |
| 13959-0008 | Workmans Wood (WW3) | 20.1.2017 | 6 | <0.01 | <0.02 | 0.024 | <0.00 | <0.00 | <0.01 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.00 | <0.01 | <0.02 | <0.05 | <0.01 | <0.02 | <0.04 | 0.230 |