

Havant Thicket Reservoir Project

Environmental Statement Volume 4 - Appendices

Appendix A9 Biodiversity

A9.3 Aquatic Ecology

Portsmouth Water Ltd.

31/08/20

Atkins Doc No.: HTR-ATK-ZZ-ZZ-RP-Z-0147

Atkins Revision No.: C01

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This document has 39 pages including the cover.

Document history

PW Revision	Status	Purpose description	Originated	Checked	Reviewed	Authorised	Date
C01	B1	Final	NL	AB	IM	LJB	31/08 /20
P01	S3	First Issue	NL	AB	IM	CB	22/05 /20

Client signoff

Client	Portsmouth Water Ltd.
Project	Havant Thicket Reservoir Project
Job number	5169117
Client signature / date	

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Introduction

- 1.1. This Technical Appendix details the aquatic ecological baseline for the proposed new Havant Thicket Reservoir and associated pipeline route (hereafter referred to as the Scheme).
- 1.2. This is not a stand-alone report and should be read in conjunction with Chapter 9 Biodiversity in Volume 2 of the Environmental Statement (ES).
- 1.3. The methodology section defines the study areas for watercourses and standing water bodies (ponds and lakes) and the screening approach taken to identify potentially Important Ecological Features (IEFs) to be taken forward to Ecological Impact Assessment (EclA). It also outlines the methodology for background data record collation and supporting field survey, together with information on the difficulties encountered during the data collation process.
- 1.4. The aquatic ecological baseline is provided in paragraphs 1.44 to 1.97 of this Technical Appendix, followed by criteria applied in defining the nature conservation value of the aquatic features in paragraphs 1.98 to 0.
- 1.5. Pertinent field survey data records are presented as a series of appendices to this report.

Methodology

Study area

- 1.6. The 'Site' includes all the land in the red line boundary: the reservoir footprint, the pipeline route and land around the reservoir site being used for ecological mitigation and compensation.
- 1.7. A study area of 150 m from the Site has been used to support the identification of aquatic features (watercourses and standing water bodies) that could potentially be affected by the Scheme. Where a watercourse has been identified within 150 m of the Site, the study area was extended up to 2 km upstream and downstream on that feature to identify any species/habitat records for the specific watercourse, in order to inform the baseline conditions (background record study area). This is considered an appropriate extent within which to identify aquatic receptors potentially affected by the Scheme, through for example, habitat loss, physical modification, disturbance and/or changes to water quality/quantity.

Identification of aquatic features

- 1.8. All watercourses and standing water bodies within the study area were identified from geospatial analysis and Ordnance Survey (OS) mapping (namely the OS Open Rivers dataset) and review of existing Scheme reports.
- 1.9. In the identification of aquatic features, watercourses are defined as either:
 - Main River:
 - A watercourse shown on the statutory Main River map dataset¹. These are typically larger streams and rivers, but some of them are small watercourses of significance. They include certain structures that control or regulate the flow of water in, into or out of the channel.
 - The Environment Agency has permissive powers, but not a duty, to carry out maintenance, improvement or construction work on designated Main Rivers. The Environment Agency has powers to regulate the activities of other affecting rivers and their flood plains under the Environmental Permitting Regulations 2016, the Water Resources Act 1991 and land drainage byelaws; or
 - Ordinary Watercourse:
 - All other watercourses are defined as Ordinary Watercourses. The Lead Local Flood Authority (LLFA) or, if within an Internal Drainage District, the Internal Drainage Board (IDB) have similar permissive powers to maintain and improve Ordinary Watercourses.

¹ Environment Agency (2019) Main River Map for England [online] Available at: <https://environment.maps.arcgis.com/apps/webappviewer/index.html?id=17cd53dfc524433980cc333726a56386> [Accessed 13 May 2020].

- The LLFA or IDB have powers to regulate works under the provision of the Land Drainage Act 1991 and local byelaws.
 - Ordinary Watercourses include rivers, stream, land and roadside ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers within the meaning of the Water Industry Act 1991) and passages through which water flows.
- 1.10. Where available, the name of the watercourse is provided as it appears on OS mapping. If the watercourse is unnamed, it has been identified as such, and the name of the receiving watercourse used as a descriptor, e.g. unnamed tributary of Riders Lane Stream.
- 1.11. For the purposes of this assessment standing water bodies have been defined as either:
- Ponds:
 - Artificial or natural standing water bodies less than 2 ha (20,000 m²) in area; or
 - Lakes:
 - Artificial or natural standing water bodies greater than 2 ha (20,000 m²) in area.
- 1.12. No lakes (standing water bodies of greater than 2 ha) have been identified that could potentially be affected by the Scheme, as such only pond habitats and their associated species assemblages are included within the baseline for standing water bodies.

Screening of aquatic features for further assessment

- 1.13. In determining features to be taken forward for baseline data collation and impact assessment professional judgement has been applied based on the details of the Scheme and known spatial and temporal impact pathways on aquatic habitats and their species.
- 1.14. Typical potential impact pathways which could (in the absence of mitigation) affect watercourses and ponds, include for example:
- Direct loss of watercourse extent or pond habitat due to being situated within the direct footprint of the Scheme, culverting requirements and/or channel diversions;
 - Shading effects resulting from the construction of or alteration to crossing structures;
 - Loss of riparian habitat due to construction alongside watercourses and/or construction of new crossing structures and drainage outfalls;
 - Alteration to surface and ground water hydro-morphology; and
 - General risks of pollution and sediment ingress associated with construction works.
- 1.15. Prior to baseline data collation and identification of survey requirements, a screening exercise has been undertaken of all of the identified aquatic features within the 150 m to ascertain those that could potential be affected by the Scheme elements. This has determined the aquatic features screened in or out of further assessment and ensures a proportionate effort is taken to provide a robust EcIA.
- 1.16. In summary, watercourses and standing water bodies are taken forward to assessment in instances where either temporary or permanent habitat losses or disturbance are likely to result from the Scheme and/or where changes in water quality and quantity are anticipated.
- 1.17. Only features potentially affected by the Scheme have been taken forward for baseline and impact assessment. A schedule of the aquatic features taken forward to the assessment is provided in Table 1-2.

Desk study

Data sources

- 1.18. Data sources used for desk study data collation of background records are listed below:
- Environment Agency biological survey records for fish, invertebrates, and macrophytes on the Environment Agency's Ecology and Fish Data Explorer website (<https://environment.data.gov.uk/ecology-fish/>).
 - Environment Agency Water Framework Directive (WFD) classification data on the Environment Agency's Catchment Data Explorer website (<https://environment.data.gov.uk/catchment-planning/>).

- Environment Agency England Non Native Species records 1965 to 2017 as provided on the National Biodiversity Network's website (NBN) (<https://registry.nbnatlas.org/public/show/dr827>).
- Statutory designated sites, Special Areas of Conservation (SACs), Wetlands of International Importance (Ramsar sites), Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNRs) and Local Nature Reserves (LNRs) that have associated aquatic habitats on the Multi-Agency Geographic Information for the Countryside (MAGIC) online map (<https://magic.defra.gov.uk/MagicMap.aspx>).
- Local records as requested from Hampshire Biodiversity Information Centre (HBIC) and Sussex Biodiversity Record Centre (SxBRC) as outlined in Chapter 9 Biodiversity in ES Volume 2.

Screening for field survey

- 1.19. Field survey requirements were determined in reference to background record availability and potential Scheme impacts. Surveys were undertaken only in the absence of existing baseline data or suitable proxies, ensuring that survey effort was proportionate to the requirement for robust ecological assessment. Existing baseline data (for example, proxy Environment Agency monitoring data) were reviewed to identify the validity of its use (spatially and temporally) in place of the requirement for additional Scheme specific survey.

Walkover survey

- 1.20. All watercourses and standing water bodies potentially affected by the Scheme were screened as requiring a walkover survey to provide habitat information to aid the identification of detailed survey requirements and inform the overall valuation of aquatic features.

River Habitat Survey

- 1.21. Whilst no specific screening criteria were applied to determine River Habitat Survey (RHS) requirement across the Scheme. Portsmouth Water commissioned a series of RHS. These data are considered to complement the walkover survey and are used to provide additional baseline information on physical habitat character.

Watercourse ecological survey

- 1.22. Watercourses were screened as requiring detailed ecological survey (namely aquatic invertebrate and fish survey) based on the following criteria:
- Watercourses exhibited suitable habitat for the detailed survey type based on walkover survey and RHS results, and where:
 - There were no suitable existing baseline ecological data on the watercourse, within 2 km of the Site; or
 - There were no relevant data from a suitable proxy site within the study area or from the same watercourse within 2 km of the Site.
- 1.23. In addition to the application of the screening criteria listed above, further requirements for detailed survey (namely aquatic invertebrate surveys) were determined in conjunction with the Environment Agency during meetings on the 5 March 2020 and 20 March 2020.

Pond survey

- 1.24. Standing water bodies were screened as requiring habitat survey (specifically Predictive SYstem for Multimetrics (PSYM) survey, which includes detailed ecological assessment of aquatic invertebrates and aquatic macrophytes) based on the following criteria:
- The water body is likely to be lost or affected by the Scheme, for example, through complete or partial habitat loss or a change in local hydrology that could affect pond flora and fauna; and
 - The water body is less than 5 ha in size, the maximum area for which PSYM can be applied; and
 - Its hydrological characteristics make it suitable for survey within the prescribed PSYM survey window.

Field survey methods

- 1.25. The status and results of surveys screened as being required are provided within the baseline section of this Technical Appendix. Where background records and/or nearby surveys have been used as proxies to inform on habitats and species characteristics, this has been stated.

Walkover survey

- 1.26. To assess the baseline conditions of the watercourses and standing water bodies potentially affected by the Scheme a walkover survey was undertaken on the 20 November 2019 by a suitably trained and experienced Atkins survey team. The team included an aquatic ecologist and two geomorphologists. This walkover survey was also used to inform the WFD compliance assessment for the Scheme and further details on both ecology and hydromorphology can be found in Appendix 15.1 WFD Assessment in ES Volume 4.
- 1.27. Watercourses and ponds identified as being potentially affected by the Scheme were visited at key points of Scheme interaction (i.e. within the reservoir footprint).
- 1.28. During the survey, representative georeferenced photographs were taken, and watercourse habitat characteristics were recorded broadly following habitat descriptors outlined in River Habitat Survey (RHS) methodology, as listed below:
- Substrates (e.g. sand/silt, gravel, pebble, cobble, boulders);
 - Vegetation type (e.g. submerged fine leaved, submerged broad leaved, marginal reeds);
 - Flow type (e.g. smooth, rippled, unbroken waves);
 - Approximate channel dimensions and water depths;
 - Presence and extent of channel and bank resectioning; and
 - Presence of any existing crossing structures, weirs or outfalls.
- 1.29. The aquatic ecology walkover survey was designed to assess the suitability of the watercourses and ponds for fish and other aquatic species.
- 1.30. This survey was also used to identify hydrological connections and delineate the watercourses into a series of reaches with different habitat typologies in order to aid valuation of features and assess potential extent of effects.
- 1.31. In addition to the walkover survey, Modular River Physical Survey (MoRPh) surveys were undertaken on the 26 June, 29 June and 2 July 2020. The results of the MoRPh surveys have been shared with the Environment Agency in advance of planning submission and are reported in Appendix A15.4 Biodiversity Net Gain for Rivers in ES Volume 4 and listed in context with the specific walkover survey outputs reported in this Technical Appendix.

River Habitat Survey

- 1.32. River Habitat Surveys (RHS) were carried out in 2008 to inform the ES for the Scheme. Appendix A of this report details the methodology and location of these surveys and provides a summary of outputs.

Aquatic invertebrate survey

- 1.33. Aquatic invertebrate surveys were undertaken by Arup in July and October 2008. Following the walkover survey and consultation with the Environment Agency on the 5 March 2020 and 20 March 2020, it was determined that further aquatic invertebrate surveys were required to inform the baseline. These surveys were undertaken in accordance with the Environment Agency's Monitoring Intermittent Streams index (MIS-index) survey method. This includes a modified three-minute kick sample to allow for assessment of ephemeral species during low flows. The samples were then preserved in 99% IDA (Industrial Denatured Alcohol) and sent to an accredited laboratory for analysis. The MIS-index survey methodology was sent to Portsmouth Water and Atkins by the Environment Agency on the 23 March 2020 and is provided in Appendix B of this report.
- 1.34. Following laboratory analysis, rare aquatic beetle taxa were independently verified by Garth Foster (nationally recognised expert taxonomist) of the of the Aquatic Coleoptera Conservation Trust.
- 1.35. No fish or pond surveys were screened as required based on the screening criteria listed in paragraphs 1.22 to 1.24 above. Therefore, no additional information on survey methodology or data processing has been provided for these within this Technical Appendix.

Survey limitations

- 1.36. Watercourse aquatic invertebrate surveys should ideally be undertaken in both Spring (March to May) and Autumn (September to November) survey periods, as recognised by the River Invertebrate Prediction and Classification System (RIVPACS) method, to account for the seasonality of aquatic assemblages. Due to the intermittent nature of the watercourses and the application of a survey method specially designed to sample for indicators of the habitat typology sampled, the Spring survey is deemed to provide suitable information on the range of species within the watercourse and for use in the assessment of habitat character.
- 1.37. Walkover surveys can be undertaken at any time of year; however, it is recognised that May to August is the most suitable period for recording observations of aquatic plants. However, given the intermittent nature of several of the watercourses visited, truly aquatic plant species are unlikely to persist within this habitat. No survey limitations were noted in regards to recording physical habitat characteristics, such as flow types, channel morphology and bed substrates. Given the availability of historical project information (namely 2008 RHS results) and wider environmental data for the Scheme (e.g. Phase 1 habitat survey), the walkover survey is considered to provide an appropriate level of information to inform the wider ecological baseline.

Field survey data processing methods

River Habitat Survey data

- 1.38. Following RHS Habitat Modification Scores (HMS) were calculated and Habitat Modification Classification (HMC) determined. The HMS provides a measure of artificial modification to the river channel morphology. To calculate the HMS for a survey site, points are allocated for the presence and extent of artificial features such as culverts/weirs and modifications caused by the re-profiling and reinforcement of banks.
- 1.39. Greater and more severe modifications result in a higher score. A HMC protocol has been developed which allocates the condition of the channel at a site to one of five modification classes, based on the total score (1 = near-natural; 5 = severely modified).
- 1.40. HMS are provided in the baseline section and Appendix A of this report.

Aquatic invertebrate survey data

- 1.41. In the laboratory, species/mixed level identification of aquatic invertebrates surveyed in April 2020 was undertaken in accordance with the Environment Agency Operational Instruction 024_08² with additional analysis to identify all taxa found, where possible to species level including terrestrial taxa as per the MIS-index analysis method (see Appendix B of this report). For each sample, the following biological metrics were calculated:

Whalley Hawkes Paisley Trigg (WHPT)

- The WHPT metric was formed by the statistical analysis of a large and comprehensive database of field samples, as an update to the Biological Monitoring Working Party (BMWP³) scoring system.
- Much like the former BMWP scoring system, WHPT was developed primarily as a means of assessing water quality and does not necessarily correlate intimately with conservation importance.
- The list of scoring taxa for WHPT is more extensive than the BMWP list, due both to the inclusion of additional taxa and splitting of some BMWP species aggregates. WHPT scoring utilises abundance data rather than just presence/absence as in BMWP.
- The metric is underpinned by sensitivity scores, based on tolerance to organic pollutants. Theoretically, a site with good water quality should result in a higher WHPT than a site with poor water quality.

² Environment Agency Operational Instruction 024_08 - Freshwater macro-invertebrate analysis of riverine samples (issued 02/10/2012).

³ Biological Monitoring Working Party (1978). Final report: assessment and presentation of the quality of rivers in Great Britain. Unpublished report, Department of the Environment, Water Data Unit.

- The number of scoring aquatic invertebrate taxa (NTAXA) is simply the number of scoring taxa recorded in the site sample and the ASPT is the WHPT divided by NTAXA.
- ASPT tends to be less influenced by seasonal community changes and the most appropriate index of the three by which to monitor a site over time. In general, ASPT scores above 5 represent invertebrate communities living in good water quality. Lower scores are indicative of invertebrate communities suffering from stress due to reduced water quality.
- In combination, the scores can also be used to infer watercourse condition in terms of habitat complexity.

Proportion of Sediment-sensitive Invertebrates⁴ (PSI)

- The PSI is based on the known ecological responses of different macro-invertebrate species or family groups to the accumulation of sediment on riverine substrata. This has been undertaken at a family level or species level.
- Those taxa that are known to benefit from, or that are largely unaffected by sedimentation, are given a high score, known as a Sediment Sensitivity Rating (SSR). Those taxa that are known to suffer from the accumulation of sediment are given a low SSR. The metric also depends on the relative abundance of different taxa and so is not just dependent on “presence-absence”, but also on the numbers of different taxa recorded.
- The PSI score describes the percentage of sediment-sensitive taxa present in a sample with high values indicating a greater proportion (percentage) of silt intolerant invertebrate species present within the macro-invertebrate community sampled i.e. the less a site is affected by silt the greater the PSI score. Scores range from 0 to 100 with categories from naturally sedimented/unsedimented to heavily sedimented.

Lotic invertebrate Index for Flow Evaluation⁵ (LIFE)

- This metric was developed as a means of assessing flow as a stressor on the aquatic invertebrate community. Invertebrate taxa are assigned to a flow group depending on their documented flow preferences (current velocity) ranging from I (Rapid) to VI (Drought Resistant). This has been undertaken at a family level or species level.
- The calculation of a community LIFE score is underpinned by flow scores. These are derived with reference to an abundance/flow group matrix such that both the abundance and flow preference of recorded taxa is taken into account. Abundance categories are defined by standard Environment Agency categories.
- LIFE score categories identify the community as having a low, moderate or high sensitivity to flow reduction. With a lower score indicating a community made up of proportionally more taxa with a preference for low flows.

Community Conservation Index⁶ (CCI)

- The CCI is used to assess community conservation value and highlights specific species of conservation importance based on the Joint Nature Conservation Committee (JNCC) threat categories (after Wallace, 1991⁷).
- Community score categories range from low (i.e. a site that supports only common species and/or a community of low taxon richness) to very high (a community potentially of national).

⁴ Extence, C.A., Chadd, R.P., England, J., Dunbar, M.J., Wood, P.J. and Taylor, E.D. (2013). The assessment of fine sediment accumulation in rivers using macro-invertebrate community response. *River Research and Applications*, 29, pp. 17-55.

⁵ Extence, C.A., Balbi, D.M. and Chadd, R.P. (1999). River flow indexing using British benthic macroinvertebrates: A framework for setting Hydroecological objectives. *Regulated Rivers: Research and Management* 15, pp. 543-574

⁶ Chadd, R.P. and Extence, C.A. (2004). The conservation of freshwater macroinvertebrate populations: a community-based classification Project. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 14, pp. 597-624.

⁷ Wallace, I.D. (1991). A review of the Trichoptera of Great Britain. *Research and Survey in Nature Conservation* No. 32. Nature Conservancy Council: Peterborough.

- Significance and may merit statutory protection) conservation value. It should be noted that the CCI does not directly align with nature conservation value.

1.42. Following identification, the invertebrate species list for each survey site was checked against known conservation designations using the sources below:

- Joint Nature-Conservation Committee (JNCC) Conservation Designations for UK Taxa⁸;
- Natural History Museum UK Species Data⁹; and
- National Biodiversity Network (NBN) Atlas¹⁰.

1.43. A full schedule and broad interpretation of biological metric scores and species designations are provided in the baseline section of this Technical Appendix.

Baseline conditions

1.44. This section details the aquatic ecological baseline of the Scheme collated from desk and field-based studies undertaken to inform the aquatic ecology assessment within the EcIA.

Aquatic features identified within the study area

1.45. Watercourses identified within the study area are detailed in Table 1-1 and shown on Figure 9.2 in ES Volume 3. In Table 1-1 watercourses are listed from north to south within the study area. These include three rivers which are classified as Main River for at least part of their length within the study area and six Ordinary Watercourses.

Table 1-1 - Watercourses identified within the study area

Watercourse(s)	Watercourse type	Location in relation to Site
Park Lane Stream	Ordinary watercourse upstream of the Warren (Ordnance Survey National Grid Reference (OSNGR) SU 70490 09029) and Main River downstream of the Warren.	Located outside of the Site. Flows to the west of the reservoir, approximately 100 m from the Site at its closest point.
Intermittent headwaters of Riders Lane Stream – composed of five unnamed tributaries of Riders Lane Stream (HS1-HS5)	Ordinary Watercourses	Five headwater streams (headwater streams 1-5 (HS1-HS5)). HS1, HS2 and HS3 are located upstream and within the reservoir footprint. HS4 and HS5 are located wholly within the reservoir footprint.
Riders Lane Stream	Main River downstream of its confluence with an unnamed tributary of Riders Lane Stream in Leigh Park (OSNGR SU 71745 08796). Classified as an Ordinary Watercourse upstream of confluence.	Located partially within the reservoir footprint, but predominantly downstream. Crossed by pipeline corridor.

⁸ JNCC (2020) Conservation designations for UK taxa [online] Available at:

<https://hub.jncc.gov.uk/assets/478f7160-967b-4366-acdf-8941fd33850b> [Accessed 13 May 2020].

⁹ Natural History Museum (2020) UK Species Data [online] Available at: <https://www.nhm.ac.uk/our-science/data.html> [Accessed 13 May 2020].

¹⁰ National Biodiversity Network (2020) NBN Atlas [online] Available at: <https://nbnatlas.org/> [Accessed 13 May 2020].

Watercourse(s)	Watercourse type	Location in relation to Site
Unnamed tributary of Riders Lane Stream (sometimes referred to as The Lake Stream within the ES)	Ordinary Watercourse	Crossed by pipeline corridor.
Hermitage Stream	Main river	Located downstream of the reservoir and crossed by pipeline corridor.

- 1.46. One standing water body was identified within the reservoir footprint. This pond is called Upper Lake and is located at OSNGR SU 71421 10030 within The Avenue. This pond is an online feature in direct hydrological connectivity with one of the intermittent headwaters of Riders Lane Stream (HS2). Leigh Lake (at OSNGR SU 71871 09157) a pond within Bell's Copse and several small ponds within Havant Thicket woodland and the western extent of Staunton Country Park are also present within the study area, but not within the reservoir footprint or pipeline corridor.

Aquatic features screened for further assessment

- 1.47. As described in paragraphs 1.13 to 1.17, given the nature of the Scheme design, not all watercourses and ponds situated within the study area are potentially affected by the Scheme. Therefore, the watercourses and ponds identified in Table 1-1 above and paragraph 1.46 were reviewed against details of the Scheme and known spatial and temporal impact pathways to identify those aquatic features for which an impact pathway exists.
- 1.48. Only aquatic features for which an impact pathway exists have been carried forward for baseline data collation, field survey and impact assessment.
- 1.49. Those watercourses and ponds screened into assessment are outlined in Table 1-2 along with a rationale for inclusion.

Table 1-2 - Aquatic features identified as requiring further assessment

Aquatic feature	Rationale for inclusion in impact assessment
Intermittent headwaters of Riders Lane Stream	Ordinary Watercourses screened into assessment given the expected partial or full loss of these watercourses within the reservoir footprint.
Riders Lane Stream	Main River screened into assessment due to being partially located within the reservoir and embankment footprint, and because the remaining watercourse is located downstream of the reservoir and compensation flow.
Unnamed tributary of Riders Lane Stream	Ordinary Watercourse screened into assessment given the potential for impacts associated with a proposed pipeline crossing.
Hermitage Stream	Main River screened into assessment due to being located downstream of the reservoir and compensation flow.
Upper Lake	Pond screened into assessment given the expected loss of this feature within the reservoir footprint.

- 1.50. Park Lane Stream was screened out of further assessment as no impact pathways have been identified to this features.

Background records

- 1.51. Table 1-3 outlines all available background records for the aquatic features taken forward to assessment within the study area.

Table 1-3 - Summary of background records available for aquatic features taken forward to assessment

Aquatic feature	Summary of background records
Intermittent headwaters of Riders Lane Stream	WFD status The five intermittent headwaters of Riders Lane Stream are situated within the headwaters of the Hermitage Stream WFD surface water body catchment (water body ID: GB107042016370). The Hermitage Stream is classified as a Heavily Modified Water Body (HMWB) with an overall status classification of moderate potential (2016). Further details of the WFD status for this water body are included against the Hermitage Stream aquatic feature. Environment Agency RHS data One Environment Agency RHS site (Site ID 23135) is situated on the central headwater (HS2) upstream of the reservoir footprint at OSNGR SU 71476 10450. One Environment Agency RHS survey record is available for this site for the 10 September 2008. This Habitat Modification Score of 960 and Habitat Modification Class (HMC) of 4 classifies the watercourse as significantly modified. The survey recorded a small channel with a bank top width of 0.5 m and bankfull width of 0.7 m. Water depths were shallow at 0.05 m and bed materials were recorded as unconsolidated. The survey recorded continuous riparian tree cover on both banks (which is consistent with the location of the watercourses within plantation woodland) and some bank and bed reinforcement and resectioning which contributed to the HMS. Environment Agency species data No available background record data are available for invertebrates, fish or macrophytes for any of the intermittent headwaters of Riders Lane Stream.
Riders Lane Stream	WFD status Situated within the Hermitage Stream WFD surface water body catchment (WFD water body ID: GB107042016370). Further details included against the Hermitage Stream aquatic feature. No other background record data available. However, background records for fish within the Hermitage Stream are considered to act as a suitable proxy for fish potentially present within Riders Lane Stream.
Unnamed tributary of Riders Lane Stream	Environment Agency RHS data RHS site (Site ID 23136) is situated on the unnamed tributary of Riders Lane Stream in Leigh Park at OSNGR SU 71758 09015. One Environment Agency RHS survey record is available for this site for the 26 August 2008. This HMS 710 and HMC of 4 classifies the watercourse as significantly modified. The survey recorded a small channel with a bank top width of 0.5 m and bankfull width of 2 m and wetted width of 0.02 m. Water depths were shallow at 0.05 m and bed materials were recorded as unconsolidated. The survey recorded semi-continuous riparian tree cover on the left bank and continuous on the right bank and some bank and bed reinforcement which contributed to the HMS. No other background record data available.

Aquatic feature	Summary of background records
Hermitage Stream	WFD status Hermitage Stream (water body ID: GB107042016370) is designated as a HMWB and, therefore, has an objective of achieving Good Ecological Potential (GEP). Its current overall classification as of 2016 is moderate. The biological quality elements are currently assessed as follows: • Fish: Poor • Invertebrates: Moderate • Macrophytes and phytobenthos combined: Not assessed Hydromorphological supporting elements are assessed as being able to support Good. It is assumed that the fish status has not fed into the overall status (following the standard one out all out (10ao) assessment procedure) based on professional judgement of the local Environment agency FRB team. The objective for the water body is to achieve GEP by 2027. The current reasons for not achieving good (RNAG) are: • Point source - misconnections in the Domestic General Public category responsible for Phosphate and invertebrates • Physical modification – barriers (sector under investigation) for fish, flood protection structures (urban and transport) for invertebrates, other (urban and transport, Local and Central Government) for mitigation measures assessment. Environment Agency RHS data No available background record data are available for RHS. Environment Agency fish data Three Environment Agency fish monitoring sites are situated on the Hermitage Stream within the background records study area. One site is situated upstream of potential impacts at Ramsdale Avenue (OSNGR SU 69937 08621; Site ID 43141). Data from one survey are available for this site from the 29 June 2012. This survey only recorded two species; bullhead (<i>Cottus gobio</i>) and European eel (<i>Anguilla anguilla</i>). With bullhead recorded in relatively high abundance (16 individuals per 100m² of channel based on a single electric fishing run) and European eel at much lower numbers (total of three individuals caught at survey). Site ID 28323 is situated just upstream of the confluence with Riders Lane Stream at OSNGR SU 70806 07781. Records are available for this site from surveys undertaken on 18 May 2007 and 29 June 2012. Similar to upstream, bullhead and European eel have both been recorded at this site, with the addition of three-spined stickleback (<i>Gasterosteus aculeatus</i>) in the 2012 survey. The third fish monitoring site (Site ID 43142) on Hermitage Stream is situated downstream of the confluence with Riders Lane Stream at OSNGR SU 71232 07107. Data from one survey are available for this site from the 29 June 2012. This survey also only recorded bullhead and European eel. With bullhead the more abundant species but still only observed in low density (three individuals per 100m² of channel based on a single electric fishing run). Environment Agency aquatic invertebrate data¹¹

¹¹ Notes on aquatic invertebrate biological metrics: BMWP NTAXA = Number of BMWP scoring taxa, BMWP = Biological Monitoring Working Party, ASPT = Average Score Per Taxon, family LIFE = Lotic-invertebrate Index for Flow Evaluation (family level), PSI(S) = Proportion of Sediment-sensitive Invertebrates (family level).

Aquatic feature	Summary of background records
	Two Environment Agency monitoring sites are situated on the Hermitage Stream within the study area. One site is situated upstream of the confluence with Riders Lane Stream at OSNGR SU 71000 07540 (Site ID 81176). For this site there have been 14 surveys between 2001 and 2018. The most recent aquatic invertebrate survey was on 1 October 2018 and returned the following biological metric scores: • BMWP NTAXA: 16 • BMWP: 78 • BMWP ASPT: 4.88 • WHPT NTAXA: 16 • WHPT: 69.4 • WHPT ASPT: 4.34 • Family LIFE: 6.14 • Family PSI: 18.18 (Heavily sedimented) The results are indicative of an invertebrate community of a heavily sedimented channel with moderate water quality and a low sensitivity to reduced flows. The second invertebrate monitoring site (Site ID 44272) is situated immediately downstream of the Nominal Tidal Limit (NTL) downstream of the reservoir near Bedhampton works at OSNGR SU 70530 06230. There have been 24 surveys between 1990 and 2001 at this site. Given the age of this data it has not been reported in detail as is not considered to provide a current baseline for the site. Environment Agency macrophyte data¹² One Environment Agency macrophyte monitoring site is situated on the Hermitage Stream within the study area. This site is located upstream of the confluence with Riders Lane Stream at OSNGR SU 71000 07540 (Site ID 81176) at the same point as an aquatic invertebrate monitoring site. Only one survey is available from 17 September 2012. The survey returned scores of: • RMNI: 7.7 • N RFG: 4 • RN A TAXA:5 • Observed Algae: 62.5% This survey identified a low taxon richness and is indicative of a macrophyte community indicative of nutrient enrichment. Environment Agency Non-Native Species data Five records for the non-native Jenkin's spire snail (<i>Potamopyrgus antipodarum</i>) have been identified on the Hermitage Stream in 2001. One record of Japanese Knotweed (<i>Fallopia japonica</i>) is present within the Hermitage Stream from 1995, upstream of the A3 motorway.
Upper Lake	WFD status As with the other aquatic features, Upper Lake is situated within the Hermitage Stream WFD surface water body catchment (water body ID: GB107042016370).

¹² Notes on aquatic macrophyte biological metrics: RMNI = River Macrophyte Nutrient Index, N RFG = Number of Functional Groups, RN A TAXA = Richness of Aquatic Taxa.

Aquatic feature	Summary of background records
	Ponds are a Core Non-Statutory component of Hampshire's Local Ecological Network, which has been designed to identify and establish coherent ecological networks within Hampshire. Additional ecological information for the Scheme Ecological vegetation surveys undertaken in 2018 and 2019 identified noteworthy vegetation at Upper Lake, including marsh pennywort, floating club-rush (<i>Eleogiton fluitans</i>), marsh St Johns-wort (<i>Hydrocotyle vulgaris</i>) and creeping forget-me-not (<i>Myosotis secunda</i>) (see the Vegetation Survey Report in Appendix A9.2 in ES Volume 4 for further details). No other background record data available.

Field survey

- 1.52. The surveys summarised within Table 1-4 were identified as necessary based on screening criteria outlined in the methodology section.
- 1.53. Table 1-4 includes information on the number and location of surveys undertaken on each watercourse.
- 1.54. Descriptions outlining the results of these surveys are provided in the remainder of this section and survey locations are shown on Figure 9.2 in ES Volume 3.

Table 1-4 - Summary of field survey results for aquatic features taken forward to assessment

Aquatic feature	Summary of field surveys
Intermittent headwaters of Riders Lane Stream	Walkover Survey The walkover survey on 20 November 2019 surveyed all five intermittent headwaters of Riders Lane Stream. A brief habitat description from this walkover survey is provided for each of the five headwater streams in paragraphs 1.58 to 1.65. River Habitat Survey Two RHS were undertaken in 2008 on the central headwater watercourse (HS2), one upstream of the reservoir and one within the reservoir footprint. Upstream of the reservoir the HMS was 495 indicating the watercourse is obviously modified. The survey within the reservoir site gave a HMS of 1350 indicating the channel at this location is severely modified. This score is driven by the presence of structures and extensive over-deepening and realignments. Detailed results from the RHS are provided in Appendix A of this report. Aquatic invertebrate survey Aquatic invertebrate surveys were undertaken within the RHS reaches in 2008. These data have been used to provide site context but have since been superseded by the aquatic invertebrate surveys undertaken in April 2020. Five aquatic invertebrate surveys were undertaken on the intermittent headwaters of Riders Lane Stream on 14 April 2020. These were at: - Site 1 (OSNGR SU 71494 10519) – Upstream of the reservoir on central tributary (HS2); - Site 2 (OSNGR SU 71194 09873) – On western tributary (HS1) in an area of open stream; - Site 3 (OSNGR SU 71473 09951) – On central tributary (HS2) in a wooded area downstream of Upper Lake; - Site 4 (OSNGR SU 71638 10008) – On eastern tributary (HS3) in an area of open stream; and

Aquatic feature	Summary of field surveys
	Site 5 (OSNGR SU 71451 09632) – On central tributary (HS2) in a wooded area. Fish survey Screened out of fish survey based on the intermittent nature of these streams being deemed unsuitable for fish survey methodology.
Riders Lane Stream	Walkover survey The walkover survey on 20 November 2019 surveyed the length of Riders Lane Stream from the reservoir to its confluence with Hermitage Stream. A habitat description from this walkover survey is provided in paragraphs 1.66 to 1.70 below. River Habitat Survey Two RHS were undertaken in 2008 on Riders Lane Stream downstream of the reservoir. These gave HMS of 550 to 1435 which indicate the watercourse is significantly to severely modified. Further details are provided in Appendix A of this report. Aquatic invertebrate survey Aquatic invertebrate surveys were undertaken within the RHS reaches in 2008. These data have been used to provide site context but have since been superseded by the aquatic invertebrate surveys undertaken in April 2020. Two invertebrate surveys were undertaken on Riders lane Stream on 14 April 2020. These were at: - Site 6 (OSNGR SU 71371 09075) – Immediately downstream of HTR footprint and compensation flow release; and - Site 7 (OSNGR SU 71721 108471) – within Great Copse downstream of the reservoir. Fish survey Screened out of survey given the availability of suitable Environment Agency fish survey proxy on the downstream Hermitage Stream.
Hermitage Stream	Walkover survey The walkover survey on 20 November 2019 surveyed Hermitage Stream between its Middle Park Way (OSNGR SU 70525 07977) and the Nominal Tidal Limit (NTL; OSNGR SU 70511 06237). A habitat description from this walkover survey is provided in paragraphs 1.71 to 1.74 below. Aquatic invertebrate survey One aquatic invertebrate survey was undertaken on Hermitage Stream on 14 April 2020. This was at: Site 8 (OSNGR SU 71000 107521) – downstream of the emergency discharge location. Fish survey Screened out of survey given the availability of suitable Environment Agency fish survey data for the Hermitage Stream.
Upper Lake	Walkover survey Walkover survey on 20 November 2019 recorded notes on habitat characteristics. A habitat description from this walkover survey is provided in paragraphs 1.75 to 1.81 below. Pond survey Screened out of survey due to the temporary nature of the water body making the pond unsuitable for survey within the prescribed PSYM survey window.

Walkover survey habitat descriptions

- 1.55. This section provides a habitat description for each of the aquatic features taken forward for assessment. Photographs are provided in a series of tables (Table 1-5 to
- 1.56.). Additional photographs are provided in the Appendix 15.1 WFD Assessment in ES Volume 4.
- 1.57. The walkover survey was undertaken prior to confirmation of the red line boundary for the Scheme. Only watercourses considered likely to be impacted by the Scheme at the time of survey were visited. One watercourse not surveyed during the walkover was subsequently screened into assessment (the unnamed tributary of Riders Lane Stream). A further survey was not feasible; therefore a precautionary approach has been applied in which the watercourse is considered to be of similar value and character to the intermittent headwaters of Riders Lane Stream given its proximity to these headwaters and location within the catchment. Observations of this watercourse by other disciplines have been taken into account during the assessment process.

Intermittent headwaters of Riders Lane Stream

- 1.58. The November 2019 walkover survey identified a network of small intermittent streams flowing in both defined channels and along low gradient flushes. Given their intermittent nature and headwater location upstream of an urbanised catchment (with several culvert structures downstream) these watercourses are considered sub-optimal for fish. Although small, species such as stickleback and bullhead have been observed to be present within the lower reaches.
- 1.59. Table 1-5 shows a series of photographs taken of the intermittent headwaters of Riders Lane Stream during the walkover survey on 20 November 2019.

Table 1-5 - Photographs of the intermittent headwaters of Riders Lane Stream



Photo 1: HS1 in Middle Clearing woodland (approximate OSNGR SU 71214 09687)



Photo 2: HS2 upstream of Upper Lake (approximate OSNGR SU 71400 10106).



Photo 3: HS2 looking upstream at outfall from Upper Lake (approximate OSNGR SU 71497 09956).



Photo 4: HS3 eastern tributary looking downstream (approximate OSNGR SU 71641 10011).



Photo 5: HS4 looking upstream from edge of The Avenue (approximate OSNGR SU 71694 09746).



Photo 6: looking upstream towards HS5 which is shown by the hedgerow on the right (approximate OSNGR SU 71439 09559).

- 1.60. **HS1:** This watercourse has been artificially straightened for much of its length. Upstream of the reservoir it flows through mature woodland and is heavily shaded which is likely to limit macrophyte growth. The woodland provides a source of woody debris and leaf litter to the channel giving some habitat diversity. Downstream, within the reservoir footprint the watercourse flows south through open grassland, with occasional riparian trees overhanging the channel, before entering another area of mature woodland (Photo 1). The channel is around 1 – 1.5 m wide, with water depths approximately 0.1 m at the time of survey. The channel lacks morphological diversity along much of its length.
- 1.61. **HS2:** HS2 is morphologically similar to HS1, with channel widths of approximately 1 - 1.5 m and variable bank heights of approximately 0.2 - 1 m. The watercourse has been straightened for much of its length and lacks morphological diversity. As with HS1 the upper reach of HS2 is situated within mature woodland before flowing south through a stretch of open grassland and heading back into an area of ancient woodland known as The Avenue (Photo 2). Within The Avenue, the watercourse flows into an online pond (Upper Lake) which provides a larger body of still water within the headwater system increasing habitat diversity. An outfall from Upper Lake (pipe approximately 0.4 m diameter) was discharging to the channel downstream during the survey (Photo 3). The majority of HS2 is slow flowing, with shallow water depths of approximately 0.1 m. Channel substrates were predominantly comprised of silt and gravels. Within the woodland, leaf litter input to the channel provides a source of organic material and has created a number of natural 'dam' features, which impounds water in places. Downstream of The Avenue the watercourse flows back into open grassland before converging with HS1.
- 1.62. **HS3:** HS3 also flows through mature woodland in its upper reach before flowing out into open grassland. This headwater stream is smaller than HS2 and HS1 and is more typical of a drainage ditch. HS3 flows south into The Avenue where it joins HS2. The width of the channel is approximately 1 m. During the time of the walkover survey the channel was dry for much of its length and where water was present there was no perceptible flow (Photo 4). As a result of this intermittent nature, the channel is vegetated with grasses and rushes throughout.
- 1.63. **HS4:** HS4 flows west across open grassland until it reaches The Avenue. Upstream of The Avenue the channel is very narrow (<0.5 m wide) and flows along a field boundary. Within The Avenue HS4 has been artificially diverted northwards to flow into HS2 and is culverted under a footpath. At the time of survey, this culvert was partially blocked by leaf litter and organic debris, impounding water upstream. The channel is wider at this location approximately 0.5 -1.0 m wide and 0.5 m deep, with variable water depths between approximately 0.1 and 0.3 m.
- 1.64. **HS5:** HS5 is the smallest of the headwater streams. It flows east from The Avenue into HS2 along a field boundary. As with HS4, it has features typical of a drainage ditch, following a straight path with limited morphological diversity. the channel is approximately 0.5 m wide and deep.
- 1.65. Within the context of the watercourse typology, headwater stream systems, the MoRPh condition assessment has identified them as ranging from fairly good to moderate condition. This aligns with the descriptors of the habitat condition described here.

Riders Lane Stream

- 1.66. Table 1-6 shows a series of photographs taken of Riders Lane Stream during the walkover survey on 20 November 2019.

Table 1-6 - Photographs of Riders Lane Stream



Photo 7: Riders Lane Stream downstream of the reservoir footprint with trash and debris dam present in channel (approximate OSNGR SU 71421 09023).



Photo 8: Riders Lane Stream in Great Copse (approximate OSNGR SU 71730 08511).



Photo 9: downstream of Great Copse (approximate OSNGR SU 71231 07932).



Photo 10: looking towards confluence of Riders Lane Stream and Hermitage Stream (approximate OSNGR SU 71016 07491)

- 1.67. **Riders Lane Stream from the reservoir to Great Copse:** Within this reach, Riders Lane Stream appears to have been artificially straightened. This upper section is relatively narrow, flowing through open grassland and lined with hedgerows which shade the channel. The watercourse then flows adjacent to a housing estate, however, despite the local urban land use the channel is situated within a continuous green corridor. The watercourse in this reach is approximately 2 - 3 m wide and has a mixture of flow types, chiefly smooth flow with occasional riffles and areas of no perceptible flow. A large box culvert conveys the watercourse under Middle Park Way after which it enters Great Copse woodland.
- 1.68. **Riders Lane Stream through Great Copse:** Within Great Copse, Riders Lane Stream (Photo 8) is more sinuous. It has riffle-run sequences and a more diverse range of flow types. Banks were typically steep and bare, noting the time of year was sub-optimal to make an assessment of channel vegetation. Bank erosion was present in places, thought to occur both from geomorphological processes and poaching of banks associated with public use. The woodland provides a source of woody debris to the watercourse which at points had partially blocked the channel providing deeper pool habitats. Within this reach the watercourse is approximately 2 - 3 m wide. The watercourse leaves Great Copse through a concrete pipe culvert approximately 1 m in diameter, which is considered likely to at least sometimes act as a barrier to some fish movement given the shallow depths observed within the pipe.

- 1.69. **Riders Lane Stream from Great Copse to confluence with the Hermitage Stream:** Downstream of Great Copse woodland to the confluence with Hermitage Stream, Riders Lane Stream flows through an urban area, in parts through residential gardens. As a result, the stream is largely modified and straightened, however, throughout the majority of its length the Riders lane Stream has an established riparian corridor providing a buffer between the river and the urban environment. Similar to upstream the channel is approximately 2 - 3 m wide within this reach.
- 1.70. Within the context of the watercourse typology, the MoRPh condition assessment has identified Riders Lane Stream as ranging from moderate to fairly poor condition. This aligns with the descriptors of the habitat condition described here.

Hermitage Stream

- 1.71. Table 1-7 shows two photographs taken of Hermitage Stream during the walkover survey on 20 November 2019.

Table 1-7 - Photographs of Hermitage Stream



Photo 11: immediately downstream of the confluence with Riders Lane Stream (OSNGR SU 71029 07447).



Photo 12: six-weir system on Hermitage Stream near to the NTL (approximate OSNGR SU 70648 06277).

- 1.72. **Hermitage Stream upstream of Riders Lane confluence to Middle Park Way:** Upstream of the confluence with Riders Lane Stream, Hermitage Stream has been straightened and reinforced with a concrete bed and banks. This reach has been restored through the partial removal of the concrete banks and the addition of wooden beams on the remaining concrete bed of the river to increase hydraulic diversity. The restoration has created localised increases in habitat and morphological diversity, as indicated by the presence of marginal macrophytes, a narrower channel and variation in flow. However, the watercourse is still constrained, and the concrete bed will act to limit aquatic invertebrate communities and fish habitat availability (particularly for benthic species, such as bullhead). The channel through this reach is approximately 3 - 4 m wide.
- 1.73. **Hermitage Stream downstream of confluence with Riders Lane Stream to the six weir system:** Downstream of its confluence with Riders Lane Stream, the Hermitage Stream is modified by a concrete channel with artificial beds and banks. The watercourse has a six-weir system marking the start of the tidal limit. It largely flows through urban land uses and the concrete channel acts to constrain both habitat and ecology. The channel through this reach is approximately 9 - 10 m wide.
- 1.74. Within the context of the watercourse typology, the MoRPh condition assessment has identified Hermitage Stream as ranging from poor to fairly poor condition. This aligns with the descriptors of the habitat condition described here.

Upper Lake (pond)

- 1.75.
- 1.76. shows photographs taken of Upper Lake during the walkover survey on 20 November 2019.

Table 1-8 - Photographs of Upper Lake



Photo 13: looking south west across the pond towards the embankment (approximate OSNGR SU 71471 09984).



Photo 14: Looking upstream from pond outfall to HS2 (approximate OSNGR SU 71471 09984).



Photo 15: Photo of Upper Lake showing the extent of the summer drying taken during an additional site visit in summer 2020 (approximate OSNGR SU 71471 09984).

- 1.77. Upper Lake pond (approximately 0.65 ha in size) is located in the woodland setting of The Avenue. It is an artificial feature, impounded by a man-made embankment along its southern margin from which flow can exit via a piped outfall. It is fed from the north by an intermittent stream (HS2).
- 1.78. Within The Avenue, the pond is situated in a small clearing resulting in a mixture of open and shaded habitat. In less shaded areas it is fringed by marginal macrophytes (rushes and sedges).
- 1.79. At the time of survey, the open water habitat was characterised by the presence of large accumulations of leaf litter and woody material. It was shallow throughout, with young saplings and small stands of emergent macrophytes established within the main body of the pond.
- 1.80. Ecological vegetation surveys undertaken in 2018 and 2019 identified a range of plants within and around Upper Lake, including common marginal species such as bulrush (*Typha latifolia*) and branched bur-reed (*Sparganium erectum*) as well as less common species including marsh pennywort, floating club-rush, marsh St Johns-wort and creeping forget-me-not (as previously listed in Table 1-3).
- 1.81. The pond has been observed to retreat in size over the summer season, and largely dry out. Although, in 2018 it was noted to retain a very shallow amount of water throughout the summer. This indicates that the pond may be important for providing some smaller perennial pools of water which are likely to be of value to the resilience of the invertebrate communities present.

Aquatic invertebrate survey results

- 1.82. Eight aquatic invertebrate surveys were undertaken on the 14 April 2020 at the locations shown on Figure 9.2 in ES Volume 3. Detailed survey data are provided in Appendix C of this report.

Intermittent headwaters of Riders Lane Stream

- 1.83. Five aquatic invertebrate surveys were undertaken on the intermittent headwaters of Riders Lane Stream as summarised in Table 1-9.

Table 1-9 - Aquatic invertebrate survey results for the intermittent headwaters of Riders Lane Stream

Aquatic invertebrate Survey Site	Watercourse	Location (OSNGR)	Summary results (including biological metrics)
1	HS2	SU 71494 10519	Total NTAXA: 15 WHPT NTAXA: 7 WHPT ASPT: 4.76 Family LIFE: 6 Species LIFE: 6 CCI: 25.67 (very high conservation value) Species PSI: 10 (heavily sedimented) Family PSI: 23.08 (sedimented) Notable taxa: <i>Ilybius chalconatus</i> (CS: 7)
2	HS1	SU 71194 09873	Total NTAXA: 41 WHPT NTAXA: 21 WHPT ASPT: 5.68 Family LIFE: 6.65 Species LIFE: 6.74 CCI: 18.9 (high conservation value) Species PSI: 36.67 (sedimented) Family PSI: 48.65 (moderately sedimented) Notable taxa: <i>Niphargus aquilex</i> (CS: 6) <i>Ochthebius pusillus</i> (CS: 7 and Nationally Scarce) <i>Limnephilus bipunctatus</i> (CS: 5 and Nationally Scarce)
3	HS2	SU 71473 09951	Total NTAXA: 24 WHPT NTAXA: 13 WHPT ASPT: 4.7 Family LIFE: 5.6 Species LIFE: 7.17 CCI: 23 (very high conservation value) Species PSI: 23.33 (sedimented) Family PSI: 20.83 (sedimented) Notable taxa: <i>Ochthebius marinus</i> (CS: 7 and Nationally Notable)

Aquatic invertebrate Survey Site	Watercourse	Location (OSNGR)	Summary results (including biological metrics)
			<i>Hydraena testacea</i> (CS: 7 and Nationally Notable)
4	HS3	SU 71638 10008	Total NTAXA: 18 WHPT NTAXA: 11 WHPT ASPT: 5.49 Family LIFE: 6 Species LIFE: 6.89 CCI: 6 (moderate conservation value) Species PSI: 24 (sedimented) Family PSI: 29.41 (sedimented) Notable taxa: None recorded
5	HS2	SU 71451 09632	Total NTAXA: 22 WHPT NTAXA: 15 WHPT ASPT: 5.22 Family LIFE: 6.36 Species LIFE: 7 CCI: 18.38 (high conservation value) Species PSI: 30.56 (sedimented) Family PSI: 31.25 (sedimented) Notable taxa: <i>Hydrochus angustatus</i> (CS:8 and Nationally Scarce)

- 1.84. Aquatic invertebrate sampling conducted at five sites on the intermittent headwaters of Riders Lane Stream yielded a total of 68 aquatic invertebrate taxa. Within the context of the intermittent nature of the stream systems, taxon richness across these headwaters is relatively high and consistent between sites 1, 3, 4 and 5. Taxon richness at Site 2, which is situated in open grassland on HS1, is notably higher than the other sampling locations. During the survey, it was observed that some sections of the headwater streams (including Site 2) appeared to be hydrologically connected to groundwater as evidenced by upwelling and the clarity of water observed. At Site 2 a spring is considered likely to provide a more consistent supply of higher alkalinity water at this location and as such is thought to be the reason for the higher taxon richness recorded here.
- 1.85. This assumption is supported by the presence of species typically associated with groundwater upwelling, namely *Niphargus aquilex* (recorded at Site 2 on HS1). *Niphargus* species typically occur in wells, interstitial gravels and other subterranean habitats in southern England and Wales¹³. *Niphargus aquilex* is likely to be widely distributed in groundwater, however its presence is notable as it is liable to be found where groundwater reaches the surface (e.g. springs)¹⁴, which is a relatively unique habitat feature within the context of the regional geology of the site. In addition, there are a number of aquatic invertebrate taxa, which within the regional context, may be indicative of cooler groundwater inputs e.g. the presence of *Nemourid* stonefly. Moreover, the relative diversity and abundance in crustaceans within Site 2 compared with Sites 1, 3, 4 and 5 could indicate higher alkalinity as would be expected from groundwater inputs in this location.

¹³ Hypogean Crustacea Recording Scheme (2020) *Niphargus aquilex* [online] Available at: <https://hcrs.brc.ac.uk/species/niphargus-aquilex> [Accessed 18 August 2020].

¹⁴ Gledhill, T., Sutcliffe, D.W. and Williams, W.D. (1993) British freshwater Crustacea Malacostraca: a key with ecological notes. Freshwater Biological Association, Scientific Publication No. 52.

- 1.86. The WHPT ASPT scores indicate that the communities within these watercourses are not obviously suffering stress from poor water quality although the PSI scores indicate that these watercourses have moderately sedimented to sedimented beds. LIFE scores indicate that the communities in these watercourse exhibit a low to moderate sensitivity to reduced flows. Both the PSI and LIFE scores are likely to be in part driven by the intermittent nature of these systems and the presence of a number of species associated with lentic conditions.
- 1.87. Seven regionally notable or rarer taxa were recorded (as identified by the Conservation Scores ascribed by the CCI and various designations as outlined on the Natural History Museum UK species database¹⁵, JNCC conservation designation spreadsheet¹⁶ and the NBN website¹⁷).
- 1.88. Of these, there are two Nationally Scarce¹⁸ beetles (*Hydrochus angustatus* and *Ochthebius pusillus*) and one Nationally Scarce cased-caddisfly (*Limnephilus bipunctatus*) recognised by the JNCC¹⁹. These were recorded at survey Site 2 and Site 5 on the western and central headwater streams (HS1 and HS2).
- 1.89. The Copper Diver beetle (*Ilybius chalconatus*) recorded at Site 1 on the central headwater stream (HS2) and the beetles *Ochthebius marinus* and *Hydraena testacea* recorded at Site 3 (also on HS2) are listed as being a Nationally Notable species on the Natural History Museum's UK species database. The Nationally Notable designation has been superseded by the Nationally Scarce designation. In the absence of an updated status it is assumed that these species are also Nationally Scarce.

Riders Lane Stream

- 1.90. Two aquatic invertebrate surveys were undertaken on Riders Lane Stream as summarised in Table 1-10.

Table 1-10 - Aquatic invertebrate survey results for Riders Lane Stream

Aquatic invertebrate Survey Site	Location (OSNGR)	Summary results (including biological metrics)
6	SU 71371 09075	Total NTAXA: 26 WHPT NTAXA: 16 WHPT ASPT: 5.45 Family LIFE: 6.67 Species LIFE: 6.91 CCI: 4.13 (low conservation value) Species PSI: 38.24 (sedimented) Family PSI: 41.38 (moderately sedimented) Notable taxa: No regionally notable or rarer species recorded.
7	SU 71721 108471	Total NTAXA: 23 WHPT NTAXA: 17 WHPT ASPT: 4.62

¹⁵ Natural History Museum (2020) UK Species Data [online] Available at: <https://www.nhm.ac.uk/our-science/data.html> [Accessed 13 May 2020].

¹⁶ JNCC (2020) Conservation designations for UK taxa [online] Available at: <https://hub.jncc.gov.uk/assets/478f7160-967b-4366-acdf-8941fd33850b> [Accessed 13 May 2020].

¹⁷ National Biodiversity Network (2020) NBN Atlas [online] Available at: <https://nbnatlas.org/> [Accessed 13 May 2020].

¹⁸ Nationally Scarce are those species occurring in 16-100 hectads in Great Britain.

¹⁹ As identified on the JNCC Conservation designations for UK taxa spreadsheet which identifies these species as Nationally Scarce based on the following sources: A review of the status of the caddis flies (Trichoptera) of Great Britain (Wallace, 2016), and A review of the scarce and threatened Coleoptera of Great Britain Part (3)- Water beetles of Great Britain (Foster, 2010).

Aquatic invertebrate Survey Site	Location (OSNGR)	Summary results (including biological metrics)
		Family LIFE: 6.69 Species LIFE: 6.7 CCI: 4 (low conservation value) Species PSI: 35.14 (sedimented) Family PSI: 40 (sedimented) Notable taxa: No regionally notable or rarer species recorded.

- 1.91. Aquatic invertebrate sampling on Riders lane Stream yielded a total of 36 taxa. Taxon richness is generally moderate, and consistent between the two sites.
- 1.92. The WHPT ASPT scores indicate that the communities within Riders Lane Stream are not obviously suffering stress from poor water quality although the PSI score indicates that this watercourse bed is moderately sedimented to sedimented. LIFE scores indicate that the communities in these streams exhibit a moderate sensitivity to reduced flows.
- 1.93. The conservation value assigned to the assemblage is low, and in contrast to its headwater systems no notable taxa were recorded.

Hermitage Stream

- 1.94. One aquatic invertebrate survey was undertaken on Hermitage Stream as summarised in Table 1-11.

Table 1-11 - Aquatic invertebrate survey results for Hermitage Stream

Aquatic invertebrate Survey Site	Location (OSNGR)	Summary results (including biological metrics)
8	SU 71000 107521	Total NTAXA: 42 WHPT NTAXA: 29 WHPT ASPT: 4.84 Family LIFE: 6.65 Species LIFE: 6.84 CCI: 7.27 (moderate conservation value) Species PSI: 37.5 (sedimented) Family PSI: 32.56 (sedimented) Notable taxa: No regionally notable or rarer species recorded.

- 1.95. Aquatic invertebrate sampling on Hermitage Stream yielded a total of 42 taxa.
- 1.96. The WHPT ASPT score indicates that the community within Hermitage Stream is not obviously suffering stress from poor water quality although the PSI score indicates that the watercourse bed is sedimented. LIFE scores indicate that the community in this watercourse exhibits a moderate sensitivity to reduced flows.
- 1.97. No notable taxa were recorded, and the moderate conservation value is a function of a community identified has having moderate taxon richness.

Nature conservation valuation

- 1.98. The general approach to defining the importance of aquatic ecological receptors follows that of CIEEM (2018²⁰). Habitats and associated species assessed within the EclA have been assigned levels of importance for nature conservation based on the criteria set out in Table 1-12.
- 1.99. The rarity, ability to resist or recover from environmental change, and uniqueness of an ecological feature, function/role within an ecosystem, and level of legal protection or designation afforded to a given ecological feature are all factors considered in determining its importance.

Table 1-12 - Importance criteria for aquatic receptors

Importance	Criteria
International	Habitats and species essential for the maintenance of: Internationally designated areas (for example River SACs) or undesignated areas that meet the criteria for designation; and/or Viable populations of species of international conservation concern (for example Critically Endangered, Endangered, or Vulnerable species under International Union for Conservation of Nature (IUCN) criteria, as recognised by the JNCC²¹).
National	Habitats and species essential for the maintenance of: - Nationally designated areas (for example, statutory designated sites such as River SSSIs) or undesignated areas that meet the criteria for designation; and/or - Habitats of principal importance in England²²; and/or Viable populations of species of national conservation concern (including certain species of principal importance in England²³, for example, those that are Near Threatened under IUCN criteria and/or Nationally Rare in the UK, as recognised by JNCC).
Regional	Habitats and species essential for the maintenance of: - Local Nature Reserves (LNRs); and/or - Ecologically important features in Natural England National Character Area²⁴; and/or Viable populations of species of regional conservation concern (for example, aquatic invertebrates/aquatic macrophytes that are Nationally Scarce as recognised by JNCC).
County	Habitats and species essential for the maintenance of: Local sites (for example, Local Wildlife Sites (LWS), County Wildlife Sites (CWS) and Biological Notification Sites (BNS)) or watercourse/pond habitats that meet the appropriate selection criteria; and/or

²⁰ CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.1. Chartered Institute of Ecology and Environmental Management, Winchester. [online] Available at: <https://cieem.net/resource/guidelines-for-ecological-impact-assessment-ecia/> [Accessed 13 May 2020].

²¹ JNCC (2020) Conservation designations for UK taxa [online] Available at: <https://hub.jncc.gov.uk/assets/478f7160-967b-4366-acdf-8941fd33850b> [Accessed 13 May 2020].

²² Natural England (2008) List of habitats of principal importance [online] Available at: <https://webarchive.nationalarchives.gov.uk/20140605093420/http://www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/habsandspeciesimportance.aspx> [Accessed 13 May 2020].

²³ Natural England (2010) List of habitats of principal importance [online] Available at: <https://webarchive.nationalarchives.gov.uk/20140605093420/http://www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/habsandspeciesimportance.aspx> [Accessed 13 May 2020].

²⁴ Natural England (2014) National Character Area profiles. [online] Available at: <https://www.gov.uk/government/publications/national-character-area-profiles-data-for-local-decision-making> [Accessed 13 May 2020].

Importance	Criteria
	Viable populations of species of conservation interest within the County (for example, fish or aquatic invertebrate species of principal importance including Regionally Notable aquatic invertebrates (as identified under the CCI).
Local	Habitats and species essential for the maintenance of: Local biodiversity interest (for example, a watercourse or pond that supports a range of aquatic species and provides local habitat connectivity); and/or Viable populations of species typical of the feature.
Site	Habitats and species essential for the maintenance of: Biodiversity interest at the site level (for example a heavily modified and managed drainage channel or small pond).
Negligible	For example, areas of hardstanding and amenity grassland.

1.100. Nature conservation values ascribed to each of the aquatic features taken forward for assessment are provided in Chapter 9 Biodiversity in ES Volume 2.

Appendix A.

River Habitat Survey data (collected and reported by Arup in 2008/2009)

- A.1. Five RHS were undertaken in 2008 by Arup. The location of these RHS are shown on Figure A1 and listed below.
- A.2. RHS were undertaken in five locations:
- Riders Lane Stream – Great Copse;
 - Riders Lane Stream – North of Great Copse;
 - Havant Thicket Plantation;
 - Reservoir Site; and
 - Park Lane Stream.
- A.3. The results from the Park Lane Stream survey are not outlined here given no impact pathways were identified to this watercourse associated with the preliminary design for the Scheme.
- A.4. The RHS standard methodology was used to collect RHS data²⁵. A survey reach is 500 m in length with bank and channel features recorded at 10 spot-checks, spaced every 50 m. At each of the spot-check locations, physical features (e.g. flow type, substrate type, and channel / bank modifications), land use and channel vegetation types are recorded. Along the 500 m reach additional characteristics are recorded, i.e. land use, bank profile, extent of trees, extent of channel features (e.g. riffles, pools, bars), channel dimensions (at a representative point along the 500m stretch), features of special interest and evidence of recent management.
- A.5. Once the data was captured in an Excel spreadsheet, the morphological variability / degradation and habitat diversity and quality was calculated using the Habitat Quality Assessment (HQA) and Habitat Modification Score (HMS) indices. The HQA index incorporates a variety of measures to assess habitat quality, e.g. the number of different flow types, channel substrate and deposition features. The HMS index quantifies the extent and impact of anthropogenic modifications such as bank reinforcement, channel re-sectioning, culverts and the number of weirs.
- A.6. HMS can be interpreted using the following thresholds:
- 0-16 Pristine;
 - 17-199 Predominantly Unmodified;
 - 200-499 Obviously Modified;
 - 500-1399 Significantly Modified; and
 - > 1400 Severely Modified
- A.7. The HMS and HQA scores for the surveys are provided in Table A1.

²⁵ Methodology outlined in: Environment Agency (2003). River Habitat Survey in Britain and Ireland. Field Survey Guidance Manual

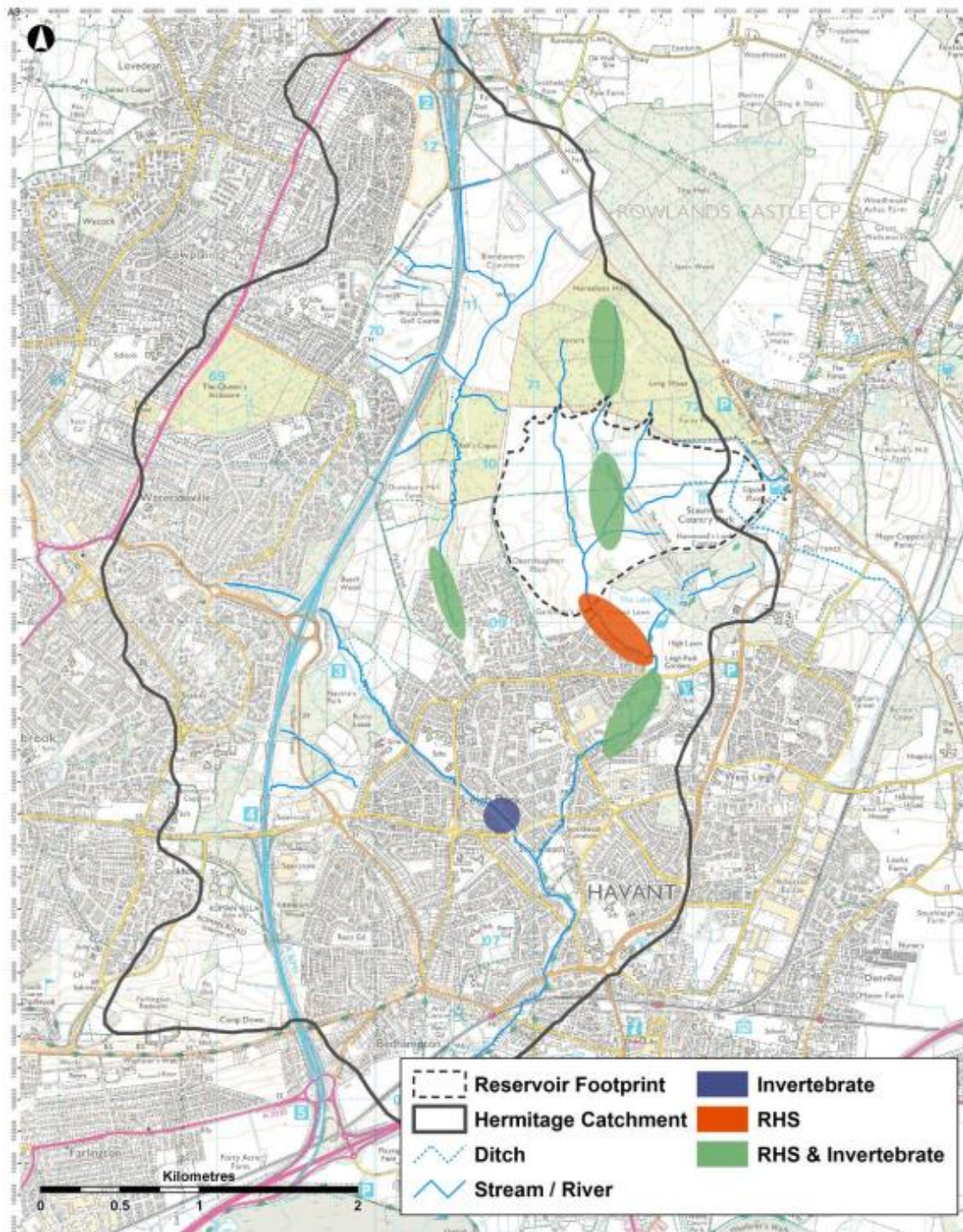


Figure A1: location map of sample sites for Arup 2008 RHS and invertebrate surveys

Table A1: HMS and HQA scores and summary of artificial features

Location ²⁶	Survey Date	HMS	HQA	Artificial features
Riders Lane Stream - Great Copse (OSNGR SU 71675 08409)	22 July 2008	1435	65	1 major bridge 2 major culverts 1 minor bridge Over-deepened for >33% of the reach
Riders Lane Stream – North of Great Copse (OSNGR SU 71492 08926)	10 October 2008	550	72	2 intermediate deflectors / groynes / croys 2 intermediate outfalls / intakes
Havant Thicket Plantation (OSNGR SU 71504 10701)	26 July 2008	495	58	1 intermediate bridge 2 major culverts Weir / dam impoundment for > 33% of the reach
Reservoir Site (The Avenue) (OSNGR SU 71529 09782)	24 July 2008	1350	65	1 major bridge 2 major culverts Realigned and over-deepened for >33% of the reach

²⁶ Grid references are for the central spot check of each RHS (spot check 6).

Appendix B.

MIS-index survey methodology

Macro-invertebrate Survey and Analysis Method

Ephemeral Streams 2018 Pilot

Introduction

This document outlines the method to use when surveying invertebrates for the ephemeral streams pilot in 2018. The surveys will be carried out based on the MIS-INDEX method adopted by Dave Leeming

Sampling Method

Follow the Environment Agency's standard Operational Instruction for surveying macro-invertebrates in freshwater ([442 09 Surveying freshwater macro-invertebrates](#)) with the exception of the following alterations:

1. **Survey area**

Include the marginal silty/sedimented areas and splash zone in the sample area. This can either be sampled by splashing the sample up the bank and catching the water in the net. To sample silty/muddy marginal areas, put a footprint in the mud and catch the water pooled into the print in the net.

2. **Photographs**

Take a photograph of the survey area, clearly recording where the picture is taken.

3. **Video**

Take an approx. 15 second video clip of the survey site, clearly recording where the video is taken.

Samples will be collected in Spring (if possible), Summer and Autumn. Send site photos and videos to [Libby Greenway](#) once completed. Enter the collect sample details onto Biosys. Record the sample as collected using the 'OTHER: Any other method – provide details in comments' method, in the comments tab make a note the sample was collected using the MIS-INDEX method. Record the driver as Local Water Resources (LOC_WR).

Analysis Method

Follow the Environment Agency's standard Operational Instruction for analysing macro-invertebrates in freshwater ([Sample analysis - Freshwater macro-invertebrates](#)) with the exception of the following alterations:

1. Analyse all taxa found, where possible, to species level. This includes *Pisidium* and terrestrial taxa.
2. Where identification is not possible, place the specimens in a vial and send to the relevant invertebrate specialist for identification (shown in the table below).
3. Record the sample analysis data on Biosys. Where the species is unknown in Biosys enter the information in the comments tab.

Appendix C.

Aquatic invertebrate biological metric data

Site Description	Sample Method	Sample Date	Total number of taxa in sample	Family LIFE	Species LIFE	CCI	Species PSI	Species PSI Interpretation	Family PSI	Family PSI Interpretation	WHPT ASPT	WHPT NTAXA
Site 1	MI-Index	14 April 2020	15	6	6	25.67	10.00	Heavily Sedimented	23.08	Sedimented	4.76	7
Site 2	MI-Index	14 April 2020	41	6.65	6.74	18.9	36.67	Sedimented	48.65	Moderately Sedimented	5.68	21
Site 3	MI-Index	14 April 2020	24	5.6	7.17	23	23.33	Sedimented	20.83	Sedimented	4.7	13
Site 4	MI-Index	14 April 2020	18	6	6.89	6	24.00	Sedimented	29.41	Sedimented	5.49	11
Site 5	MI-Index	14 April 2020	22	6.36	7	18.38	30.56	Sedimented	31.25	Sedimented	5.22	15
Site 6	MI-Index	14 April 2020	26	6.67	6.91	4.13	38.24	Sedimented	41.38	Moderately Sedimented	5.45	16
Site 7	MI-Index	14 April 2020	23	6.69	6.7	4	35.14	Sedimented	40.00	Sedimented	4.62	17
Site 8	MI-Index	14 April 2020	42	6.65	6.84	7.27	37.50	Sedimented	32.56	Sedimented	4.84	29

April 2020 invertebrate species list

Taxa ID	Havant Thicket Site 1	Havant Thicket Site 2	Havant Thicket Site 3	Havant Thicket Site 4	Havant Thicket Site 5	Havant Thicket Site 6	Havant Thicket Site 7	Havant Thicket Site 8
Hydra sp.		3			1			
Tricladida								1
Polycelis nigra/tenuis			2					3
Dendrocoelum lacteum		1					1	3
Nematoda			2	1	2	1		
Potamopyrgus antipodarum							92	72
Galba truncatula								1
Radix balthica							4	5
Bathymphalus contortus								7
Hippeutis complanatus								2
Ancylus fluviatilis								1
Acroloxus lacustris								4
Pisidium sp.		53	641	8	13	10	171	73
Oligochaeta	76	6	330	2	14	44	10	18
Glossiphonia complanata							2	1
Erpobdellidae								1
Erpobdella octoculata								1
Hydracarina		1				3	34	114
Oribatei	67	1	2					
Ostracoda			4	1				

Taxa ID	Havant Thicket Site 1	Havant Thicket Site 2	Havant Thicket Site 3	Havant Thicket Site 4	Havant Thicket Site 5	Havant Thicket Site 6	Havant Thicket Site 7	Havant Thicket Site 8
Asellidae							2	
Asellus aquaticus						28	6	77
Proasellus meridianus		8	7		475			
Crangonyx pseudogracilis/floridanus			382		129	2		
Gammaridae					1			
Gammarus sp.		38				9	11	8
Gammarus pulex		22			16			166
Gammarus pulex/fossarum		211				3	103	241
Niphargus aquilex		2						
Collembola	3	1						
Baetidae							1	
Baetis rhodani		1					7	176
Baetis atlanticus						1		
Baetis atlanticus/rhodani							19	206
Leptophlebiidae								5
Habrophlebia fusca		20			28	222	221	84
Caenidae								2
Caenis luctuosa/macrura								25
Nemouridae						1		
Amphinemura sp.		3			4	1		
Amphinemura sulcicollis		56			1	3	9	1

Taxa ID	Havant Thicket Site 1	Havant Thicket Site 2	Havant Thicket Site 3	Havant Thicket Site 4	Havant Thicket Site 5	Havant Thicket Site 6	Havant Thicket Site 7	Havant Thicket Site 8
Nemoura sp.	26	14	4					
Nemoura cambrica/erratica		51	123	25		4		
Nemoura avicularis	273	17			25			
Nemoura cinerea	9		90	95		7		
Isoperla grammatica		2			3	2		
Calopteryx splendens								1
Libellulidae		2						
Velia sp.		7					1	
Notonecta sp.			1					
Dytiscidae	2	1						
Hydrovatus sp.	1							
Hydroporus angustatus				1				
Hydroporus discretus		2						
Hydroporus gyllenhalii				1				
Hydroporus memnonius		3						
Hydroporus tessellatus		2		4				
Agabus sp.		1		2	1			
Agabus bipustulatus		1						
Ilybius/Agabus sp.	1							
Ilybius sp.				2				
Ilybius chalconatus	1							
Gyrinus substriatus						3		

Taxa ID	Havant Thicket Site 1	Havant Thicket Site 2	Havant Thicket Site 3	Havant Thicket Site 4	Havant Thicket Site 5	Havant Thicket Site 6	Havant Thicket Site 7	Havant Thicket Site 8
Hydrochus angustatus					1			
Helophorus grandis		1						
Helophorus flavipes/obscurus	1			1		1		
Helophorus obscurus		5						
Anacaena limbata		1						
Ochthebius marinus			2					
Ochthebius pusillus		1						
Hydraena testacea			2					
Elodes sp.		1						
Odeles marginata						1		
Dryops sp.					1			
Elmis aenea								2
Limnius volckmari								2
Chrysomelidae		1			11			
Curculionidae	2							
Trichoptera						1		
Hydroptila sp.								3
Lype sp.							1	1
Tinodes waeneri								3
Limnephilidae		41	2		30	32	10	3
Halesus sp.			1					
Halesus digitatus			1					

Taxa ID	Havant Thicket Site 1	Havant Thicket Site 2	Havant Thicket Site 3	Havant Thicket Site 4	Havant Thicket Site 5	Havant Thicket Site 6	Havant Thicket Site 7	Havant Thicket Site 8
Micropterna sequax						1		
Chaetopteryx villosa			2	4				
Chaetopteryx villosa/Halesus sp.			1					
Limnephilus bipunctatus		3						
Limnephilus lunatus		13			3	6	49	6
Beraea pullata		3						
Mystacides azurea								45
Lepidoptera			1					
Pilaria sp.	1			2				
Ormosia sp.			1					
Psychodidae						1	3	2
Ceratopogonidae		30	42	2	14	19	45	2
Simuliidae	6	2	1	81	1			6
Chironomidae	201	501	1187	91	1190	178	325	1014
Stratiomyidae								1
Hemerodrominae				1				
Chelifera sp.								1



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