

A46 Newark Bypass

TR010065/APP/6.3

6.3 Environmental Statement Appendix 8.8 Aquatic Ecology Technical Report

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A46 Newark Bypass

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ENVIRONMENTAL STATEMENT

APPENDIX 8.8 AQUATIC ECOLOGY TECHNICAL REPORT

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1 Introduction

1.1 Background and scope of works

- 1.1.1 As part of the A46 Newark Bypass Scheme (the Scheme), baseline aquatic ecology surveys were undertaken to inform the biodiversity assessment reported in Chapter 8 (Biodiversity) of the Environmental Statement (ES) **(TR010065/APP/6.1)**.
- 1.1.2 Chapter 2 (The Scheme) of the ES **(TR010065/APP/6.1)** provides the background and a description of the Scheme. The information described in this appendix provides a baseline of aquatic ecology used to inform the Environmental Impact Assessment (EIA) for the Scheme.
- 1.1.3 This appendix reports on the surveys for aquatic ecology undertaken in 2022 and 2023. All waterbodies within the Order Limits plus a buffer of 250 meters were surveyed. In addition, an aquatic desk study encompassing the Order Limits plus 2 kilometers was undertaken.
- 1.1.4 For ponds within the Order Limits, Predictive System for Multimetrics (PSYM) surveys were deemed an appropriate survey technique, as this methodology provides a comprehensive analysis of both macrophyte and macroinvertebrate taxa and pond biotic integrity. For ponds outside of the Order Limits, Rapid pond technique was employed to provide an overview of pond integrity based on macroinvertebrate taxa.
- 1.1.5 Riverine waterbodies within the Order Limits plus 250 metre buffer were assessed using macroinvertebrate surveys, employing sampling methodology appropriate to running water. This macroinvertebrate sampling methodology was also used for the assessment of linear ditches; however different biotic indices were used in analysis as appropriate for these habitat types.
- 1.1.6 All suitable habitats, except those for which land access permission was not available, were surveyed in accordance with the methods given in Section 3 of this appendix.
- 1.1.7 This appendix includes:
- Relevant legislation
 - Methods for desk and field-based assessments
 - Limitations to the surveys undertaken and any assumptions made as a result of incomplete data
 - Desk study results
 - Survey results
 - A summary of desk study and field survey results

2 Legislation, policy and licences

2.1 Legislation

- 2.1.1 This assessment has been undertaken within the context of the following relevant legislative instruments and planning policies:
- The Wildlife and Countryside Act 1981 (as amended)¹ affords specific protection to flora listed on Schedule 8. In addition, under Schedule 9, it is an offence to cause to grow or establish in the wild a number of aquatic plants and animals considered non-native.
 - The Conservation of Habitats and Species Regulations 2017 (as amended)² provide for the designation and protection of 'European sites', and the protection of European protected species.
 - The Natural Environment and Rural Communities (NERC) Act 2006,³ which places the duty on every local authority to conserve biodiversity. Section 40 refers to the restoration and enhancement of populations and habitats, whilst Section 41 (S41) lists species and habitats of principal importance for the conservation of biodiversity in England.
 - Under the Invasive Alien Species (Enforcement and Permitting) Order 2019,⁴ it may be an offence to release, cause to escape, plant, or grow species of animal or plant 'not ordinarily resident in' and 'not a regular visitor to Great Britain in a wild state', or otherwise listed in Schedule 2.

2.2 Policy framework

- 2.2.1 National policies relevant to biodiversity are not provided here. These are evaluated in Chapter 8 (Biodiversity) of the ES **(TR010065/APP/6.1)**.
- 2.2.2 The Nottinghamshire Species and Habitats of Conservation Concern 2016⁵ contains a list of species and habitats of conservation concern for the local area.

¹ HMSO, The Wildlife & Countryside Act, 1981. <https://www.legislation.gov.uk/ukpga/1985/59/contents>.

² HMSO, The Conservation of Habitats and Species Regulations, 2017. <https://www.legislation.gov.uk/uksi/2017/1012/contents>. <https://www.legislation.gov.uk/uksi/2017/1012/contents>.

³ HMSO, The Natural Environment and Rural Communities (NERC) Act, 2006. <https://www.legislation.gov.uk/ukpga/2006/16/contents>. <https://www.legislation.gov.uk/ukpga/2006/16/contents>.

⁴ HMSO, The Invasive Alien Species (Enforcement and Permitting) Order, 2019. <https://www.legislation.gov.uk/uksi/2019/527/contents>. <https://www.legislation.gov.uk/uksi/2019/527/contents>.

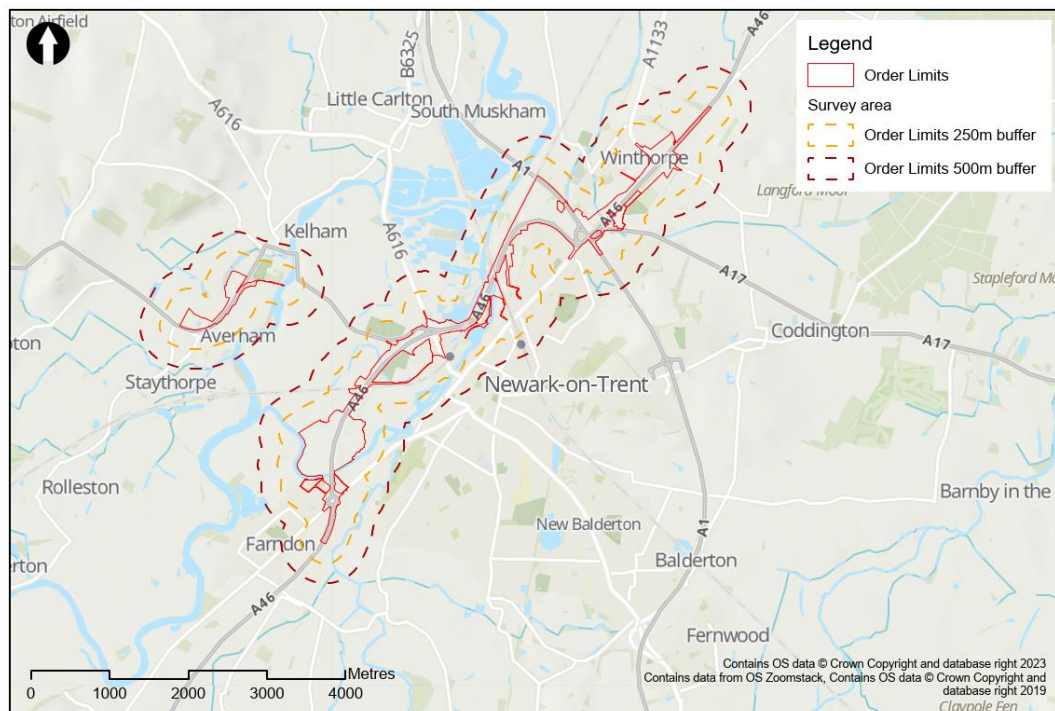
⁵ Nottinghamshire Biodiversity Action Group (2022). Species and habitats of conservation concern. [online] Available at: [\[REDACTED\]](#) (Last accessed 7 December 2022).

3 Methodology

3.1 Survey area

3.1.1 All aquatic surveys were conducted within a 250 metre boundary of the Order Limits, hereafter referred to as the 'survey area', which can be seen in Figure 3-1 below. The Order Limits include the main alignment area associated with the A46 improvements, and the Kelham and Averham Floodplain Compensation Area (FCA) to the north-west. The Order Limits have been amended as the project design has developed. Some surveyed habitats now fall outside the survey area associated with the current Order Limits; however, the results have been included within this report for completeness. Similarly, some habitats previously located in the Order Limits may now be within the 250 metre buffer.

Figure 3-1: Survey area



Source: Mott MacDonald, 2023

3.1.2 As outlined below in Section 3.3 to 3.6, aquatic surveys were conducted on all ponds, ditches and riverine waterbodies present within 250 metres of the Order Limits during May 2022 to June 2023.

3.2 Desk study

- 3.2.1 Open-source macroinvertebrate, macrophyte and fish data for the last 10 years (2013 to 2022 inclusive) was obtained for the desk study using the Environment Agency (EA) Ecology and Fish Data Explorer,⁶ the National Biodiversity Network (NBN) Atlas⁷ online records system and Nottinghamshire Biological and Geological Record Centre (NBGRC). This search was undertaken within the Order Limits plus a 2 kilometre buffer.
- 3.2.2 An additional search for migratory fish species was also undertaken using the same sources but within a 10 kilometre buffer of the Order Limits in order to identify species which may utilise watercourses within the Order Limits.
- 3.2.3 Biological records derived from the desk study were screened for the presence of protected, notable and non-native aquatic and riparian species. All records are up to date as of 24/01/2023.

3.3 Predictive System for Multimetrics surveys

Survey scoping and design

- 3.3.1 To assess the biological quality of ponds within the Order Limits, all seven ponds within this area were scoped in for assessment using Predictive System for Multimetrics (PSYM) methodology⁸. Due to alterations to the Order Limits some survey sites are no longer present within the 250 metre buffer but have been included within this report for completeness.
- 3.3.2 In line with this guidance, surveys were completed during July 2022 and June 2023 (listed in Table 3-1). A map of pond sites is shown in Appendix A Map A-1 (Aquatic pond sites) of this report.

Table 3-1: PSYM pond survey information

Pond ID	National Grid reference (NGR)	Location	Survey date
P1	SK 79289 54796	Within Order Limits	27/07/2022
P2	SK 80430 55999	Within Order Limits	26/07/2022

⁶ Environment Agency (2023). EA Ecology & Fish Data Explorer. [online] Available at: <https://environment.data.gov.uk/ecology.explorer> (Last accessed 25 January 2023).

⁷ National Biodiversity Network (2023). NBN Atlas, [online] Available at: [REDACTED] Last accessed 25 January 2023).

⁸ Pond Action (2002). A guide to monitoring the ecological quality of ponds and canals using PSYM. [online] Available at: [REDACTED] (Last accessed 25 November 2022).

Pond ID	National Grid reference (NGR)	Location	Survey date
P3	SK 79998 54811	Within 250m buffer	27/07/2022
P4	SK 78472 53925	Within Order Limits	N/A
P5	SK 78338 53812	Within 250m buffer	N/A
P6	SK 79382 54705	Within Order Limits	26/07/2022
P7	SK 79292 54559	Within Order Limits	27/07/2022
P15	SK 76408 54759	Within Order Limits	15/06/2023

3.3.3 Ponds P4 and P5 were not visited due to access constraints.

Guidance documents

3.3.4 The following guidance has been considered in survey design and execution:

- A guide to monitoring the ecology quality of ponds and canals using PSYM (Pond Action, 2002)⁸.

3.3.5 Any deviation from standard industry practice is noted in Section 3.9.

Survey methodology

3.3.6 PSYM surveys require the assessment of macroinvertebrate and macrophyte species present, as well as the collection and collation of supporting environmental and geographical information.

3.3.7 Each macroinvertebrate survey consisted of a 3-minute sweep net sample, with time divided equally between the mesohabitats present. If necessary, stony or sandy substrates were lightly 'kick-sampled' to disturb and capture macroinvertebrates.

3.3.8 A further 1-minute manual search was undertaken during each survey, comprising a visual search for surface-dwelling invertebrates, and a physical search of any large objects which could be accessed such as stones and woody debris.

3.3.9 The assessment requires recording of all macrophyte species present within and on the banks of each pond. Macrophytes were surveyed by walking or wading the entire perimeter of the dry and shallow water areas making note of all emergent, floating-leaved and submerged macrophytes present. Deeper water areas were sampled either using a pond net or by grapnel thrown from shallow water.

3.3.10 Environmental and geographical information was collected by observation or measurement in the field, including: grid reference, photographs, inflow presence/absence, pH, shade (% overhanging), grazing (% of pond edge), emergent plant cover (%) and substrate

composition. In addition, maps were used to determine pond area (m²), altitude, and base geology and to check inflow presence or absence.

Sample processing

- 3.3.11 Macroinvertebrate samples were stored at 1-3°C until preservation later that day in industrial methylated spirit (IMS).
- 3.3.12 In the laboratory, the macroinvertebrate samples were analysed to River Invertebrate Prediction and Classification System (RIVPACS) Taxonomic Level 1 (TL1 – Biological Monitoring Working Party (BMWP) family level).⁹ This level of taxonomic resolution enables calculation of biological indices required for PSYM.

Data analysis

- 3.3.13 In accordance with the guidance⁸ and where possible, the following indices were calculated from the PSYM pond survey results:
- Number of submerged and emergent plant species (SM) – the total number of both submerged and emergent plant taxa present in the survey (aquatic plant taxa sensitive to degradation).
 - Trophic ranking score (TRS) – a measure of the average trophic rank for the pond, calculated by summing aquatic plant species' scores (based on tolerance to nutrients) at a site and dividing by the number of taxa present.
 - Uncommon species index (U) – number of plant species with a defined rarity score of 2 or more (a status of local, nationally scarce, or Red Data Book).
 - Average score per taxon (ASPT) – an average score of pollution sensitivity, calculated by summing the BMWP scores of aquatic invertebrate taxa in the sample, and dividing by the number of taxa present.
 - Odonata and Megaloptera families (OM) – total number of dragonfly (Odonata) and alderfly (Megaloptera) families noted at the site.
 - Coleoptera families (C) – number of freshwater beetle (Coleoptera) families present at the site, a metric sensitive to bank quality and water quality.
- 3.3.14 For the above indices, Environmental Quality Indicator (EQI) scores were calculated by generation of expected scores (through submission of data to the Freshwater Habitats Trust), and comparison of these with the observed data. The EQI is calculated as a ratio of

⁹ Davy-Bowker, J., Arnott, S., Close, R., Dobson, M., Dunbar, M., Jofre, G., Morton, D., Murphy, J., Wareham, W., Smith, S. and Gordon, V. (2010). Further development of river classification tool. Final report, SNIFFER project WFD100.

the observed to the expected score. These scores are then combined into an Index of Biotic Integrity (IBI), which gives an overall indication of the ecological quality of the pond – categorised as Very Poor, Poor, Medium or Good (where Good indicates that a pond is a priority pond for conservation purposes).

3.4 Rapid pond surveys

Survey scoping and design

- 3.4.1 To assess the biological quality of ponds outside the Order Limits but within a 250 metre buffer, the Rapid pond survey method¹⁰ was used. This methodology involves the recording of high-level macroinvertebrate groups.
- 3.4.2 Surveys were completed in July 2022 and June 2023 (listed in Table 3-2). A map of pond sites is shown in Appendix A Map A-1 (Aquatic pond sites) of this report. Due to alterations to the Order Limits some survey sites are no longer present within the 250 metre buffer but have been included within this report for completeness.

Table 3-2: Rapid pond survey information

Pond ID	NGR	Location	Date
P8	SK 79060 54780	Within 250m buffer	27/07/2022
P9	SK 79697 54877	Within 250m buffer	26/07/2022
P10	SK 79472 54940	Within 250m buffer	26/07/2022
P11	SK 79631 55009	Within 250m buffer	26/07/2022
P12	SK 78570 53239	Within 250m buffer	N/A
P13	SK 78601 53381	Within 250m buffer	N/A
P14	SK 81076 56362	Within 250m buffer	27/07/2022
P16	SK 76838 55445	Within 250m buffer	15/06/2023
P17	SK 76996 55659	Within 250m buffer	15/06/2023

- 3.4.3 Ponds P12 and P13 were not visited due to access restrictions.

Guidance documents

- 3.4.4 The following guidance has been considered in survey design and execution:
- The Big Pond Dip invertebrate survey method¹⁰ – for survey methodology and analysis criteria

¹⁰ Pond Conservation (2010). The development of the Big Pond Dip invertebrate survey method [online] Available at: [\[redacted\]](#) (Last accessed 7 December 2022).

- A guide to the methods of the National Pond Survey¹¹ – for standardised sampling technique.
- A guide to monitoring the ecology quality of ponds and canals using PSYM⁸ – for standardised sampling technique.

3.4.5 Any deviation from the standard described methodology is noted in Section 3.9.

Survey methodology

3.4.6 Rapid pond survey methodology aims to provide an indication of biological quality, based on the presence of macroinvertebrate taxonomic groups¹⁰. These groups are listed below in Table 3-3.

3.4.7 To ensure consistency of sampling effort, a standard 3-minute pond sampling technique was employed at each pond^{8,10}.

3.4.8 Macroinvertebrates were sampled with a standard pond net. Within each pond a number of samples were collected to represent the range of habitats present. Sample collection typically involved 15 to 60 seconds of active sampling within each different mesohabitat within a pond to give a 3-minute total. An additional 1-minute was then spent examining additional habitats (such as the water surface, on vegetation, and under stones and logs) to capture any species which may have been missed during net sampling.

3.4.9 Upon collection, individual samples were examined in the field in a white tray until the analyst was sufficiently confident in the identification of all taxa present to the required level.

3.4.10 Any relevant environmental site information was recorded, including weather conditions. A photograph of each pond was taken.

Data analysis

3.4.11 As described in the Rapid methodology¹⁰, an overall Rapid score was calculated for each pond by summing the individual invertebrate taxon scores of those taxa found during sampling, as shown in Table 3-3 below.

Table 3-3: Rapid pond survey invertebrate scores

Taxa group	Invertebrate taxon score
Caddis larvae	10
Alderfly larvae	10

¹¹ Pond Action (1998). A guide to the methods of the National Pond Survey.[online] Available at: [REDACTED] (Last accessed 7 December 2022).online] Available at: [REDACTED] (Last accessed 7 December 2022).

Taxa group	Invertebrate taxon score
Dragonfly larvae	10
Damselfly larvae	10
Mayfly larvae	5
Water beetles (adult and larvae)	5
Water bugs (excluding pond skaters)	5
Freshwater shrimps	5
Pond skaters (adults or nymphs)	5
Water slaters	1
Water snails	1
Worms, fly larvae and leeches	1

3.4.12 The biological quality of each pond was interpreted from the overall Rapid scores calculated, using the thresholds shown in Table 3-4 below, taken from the Rapid methodology¹⁰.

Table 3-4: Quality score thresholds used in the Rapid pond assessments

Quality band	Score
Low quality	0-17
Moderate quality	18-34
Good quality	35-51
Excellent quality	52-68

3.5 Riverine macroinvertebrate surveys

Survey scoping and design

3.5.1 Sites chosen for survey were selected to allow for an assessment of baseline ecological conditions of all riverine waterbodies within the survey area. Due to alterations to the Order Limits some survey sites are no longer present within the 250 metre buffer but have been included within this report for completeness.

3.5.2 Full details of survey sites are shown in Table 3-5. A map of riverine sites is shown in Appendix A Map A-2 (Aquatic ditch and riverine survey locations) of this report. Samples were collected in recognised RIVPACS spring (March to May inclusive) and autumn (September to November inclusive) seasons (EU-STAR, 2004¹²).

¹² EU-STAR (2004). UK Invertebrate sampling and analysis procedure for STAR project, RIVPACS macroinvertebrate sampling protocol. [online] [redacted] [Last accessed 30 November 2022].

Table 3-5: Riverine invertebrate survey information

Site ID	Waterbody	Location	NGR	Spring sampling date	Autumn sampling date
R1	River Trent	Within Order Limits	SK 77994 52838	N/A	22/11/2022
R2	Slough Dyke	Within Order Limits	SK 81528 56078	26/05/2022	21/11/2022
R3	River Devon	Outside 250m buffer	SK 78442 52209	26/05/2022	21/11/2022
R4	River Trent	Within Order Limits	SK 80142 55195	26/05/2022	22/11/2022
R5	River Trent	Within 250m buffer	SK 80192 56152	26/05/2022	22/11/2022
R6	River Trent	Outside 250m buffer	SK 77634 55559	N/A	N/A
R7	River Trent	Within 250m buffer	SK 77396 54990	N/A	N/A
R8	River Trent	Outside 250m buffer	SK 77009 54591	N/A	N/A
R9	River Trent	Within 250m buffer	SK 77536 55303	N/A	N/A

3.5.3 Sites R6, R7, R8 and R9 could not be visited due to access restrictions. Site R1 was accessible in autumn 2022 only.

Guidance documents

3.5.4 The following guidance was considered when planning and undertaking riverine macroinvertebrate surveys and taxonomic analysis:

- Best practice guidance for the undertaking of aquatic macroinvertebrate surveys and assessment is provided in British Standards (BS) EN ISO 10870:201213
- The Environment Agency’s standard macroinvertebrate sampling and analysis manual – BT00114 and standard RIVPACS procedures⁹

3.5.5 Macroinvertebrate data analysis of spring and autumn data using the River Invertebrate Classification Tool (RICT¹⁵) will be informed by the

¹³ European Committee for Standardization (2014). BS EN 14184: 2014: Water quality. Guidance for the surveying of aquatic macrophytes in running waters: Brussels: CEN (2014).

¹⁴ Murray-Bligh, J.A.D (1999). Procedure for collecting and analysing macro-invertebrate samples. Quality management systems for environmental monitoring: Biological techniques BT001. Version 2.0. Bristol: Environment Agency.

¹⁵ River Invertebrate Classification Tool (RICT). [online] Available at: [REDACTED] [Last accessed 7 December 2022].

Water Framework Directive – United Kingdom Technical Advisory Group (WFD-UKTAG) guidance¹⁶.

Survey methodology

- 3.5.6 Macroinvertebrate sampling consisted of 3-minutes of sampling using a pond net, and a 1-minute manual search to record invertebrates from any distinct habitats (such as those organisms attached to vegetation, submerged objects such as cobbles and woody debris, or surface-dwelling taxa). Where site conditions allowed, surveys were undertaken by kick-sampling to collect invertebrates. If kick-sampling was not possible due to sediment and depth then a sweep-sampling technique was used, whereby the net is moved through the water whilst the substrate is disturbed in order to capture invertebrates from a number of micro-habitats (EU-STAR, 2004).
- 3.5.7 Environmental data for the sampling area, banks and surrounding area was collected. This data included the environmental variables (watercourse width, depth, substrate composition) required for subsequent prediction and data analysis (EU-STAR, 2004¹²).
- 3.5.8 Samples were stored at 1-3°C until preservation later that day in IMS, before being sent to a laboratory for taxonomic analysis.

Sample processing

- 3.5.9 In the laboratory, the macroinvertebrate samples were analysed to RIVPACS Taxonomic Level 5 (TL5)⁹. Within this framework, specimens are identified to the highest taxonomic level possible given their life stage and condition, with exceptions where this would require disproportionate effort (eg aquatic worms, family Oligochaeta). This level of taxonomic resolution enables calculation of biological indices (as described in 3.5.10) and allows the detection of Invasive and Non-Native Species (INNS) and species of conservation importance. The abundance of all taxa present within the sample was also recorded.

Data analysis

- 3.5.10 Macroinvertebrate results were used to calculate the following biological indices in order to characterise the assemblages, and to evaluate the baseline condition of the macroinvertebrate community in the riverine waterbodies within the survey area:

¹⁶ WFD-UKTAG (2014). UKTAG River assessment method. Benthic invertebrate fauna. Invertebrates (General degradation): Whalley, Hawkes, Paisley & Trigg (WHPT) metric in River Invertebrate Classification Tool (RICT). Stirling: Water Framework Directive UK Technical Advisory Group.

- Whalley, Hawkes, Paisley and Trigg Average Score Per Taxon (WHPT ASPT¹⁶) – the average score for all scoring species in the WHPT index for the sample, a metric used to assess the condition of the river and likely impact of organic pollution
- WHPT Number of Taxa (WHPT NTAXA¹⁶) – the number of taxa which score within the WHPT system for a sample, which may be affected by additional factors such as habitat disturbance
- The Lotic Invertebrate Index Flow Evaluation (LIFE) index¹⁷ – a metric used to indicate whether a riverine macroinvertebrate community is affected by changes in flow
- Proportion of Sediment-sensitive Invertebrates (PSI) index¹⁸ – a metric used to indicate whether a survey site’s riverine macroinvertebrate community is affected by deposition of fine sediment
- Community Conservation Index (CCI)¹⁹ – a metric that acts as a score of conservation value of freshwater habitats, based on the rarity of species found in a sample and the diversity of the assemblage

3.5.11 Any protected, notable species or non-native species identified within the samples were noted.

River Invertebrate Classification Tool

3.5.12 In order to provide contextual analysis of these indices, the RICT was used. This tool is an online interface which uses the RIVPACS IV model to predict the expected invertebrate community for river sites on a seasonal basis. This tool requires ‘variant’ and ‘invariant’ environmental variables in order to predict the macroinvertebrate assemblage. Variant variables include channel width, channel depth, and substrate composition within the sampling area, and were collected during field sampling. Invariant variables include site altitude, slope, ‘discharge category,’ distance from source, and alkalinity.

3.5.13 Slope and distance from source were calculated using the online source UK Grid Reference Finder.²⁰ Altitude was taken from the online source England Topographic Map.²¹

¹⁷ Extence, C, Balbi, D. M., and Chadd, R. (1999). River flow indexing using British benthic macroinvertebrates: A framework for setting hydroecological objectives. *Regulated Rivers Research & Management*. 15 (6), pp.545-574.

¹⁸ Extence, C. A., Chadd, R. P., England, J., Dunbar, M. J., Wood, P. J. and Taylor, E. D. (2011). The assessment of fine sediment accumulation in rivers using macro-invertebrate community response. *River Research and Applications* 2013. 29 (1): pp.17-55.

¹⁹ Chadd, R., and Extence, C. (2004). The conservation of freshwater macroinvertebrate populations: a community-based classification scheme. *Aquatic Conservation: Marine and Freshwater Ecosystems*. 14, pp.597-624.

²⁰ UK Grid Reference Finder. (2011). Available at: <<https://gridreferencefinder.com/>> [Accessed 27/03/2023]

²¹ Topographic-Map. *England topographic map*. (n.d) Available at: [REDACTED] [Accessed 27/03/2023]

WFD status

- 3.5.14 Following WFD-UKTAG (2014) guidance and using RICT, WHPT ASPT and WHPT NTAXA values were processed to provide an indicative Waste Framework Directive (WFD) status for each site.
- 3.5.15 RICT compares observed and expected WHPT ASPT and WHPT NTAXA scores to produce an Ecological Quality Ratio (EQR) value for each index. Spring and autumn EQR values are averaged for each index when a single classification is required for the year. For this analysis, a bias ratio of 1.68 was used. The EQR values for each index are then equated to a WFD class based on the boundaries shown in Table 3-6 below. The lowest of these classes is subsequently reported as the WFD status for the site.

Table 3-6: EQR class boundaries

Class Boundary	WHPT NTAXA EQR	WHPT ASPT EQR
High/Good	0.80	0.97
Good/Moderate	0.68	0.86
Moderate/poor	0.56	0.72
Poor/bad	0.47	0.53

- 3.5.16 Where two seasons of data were available, a combined spring and autumn WFD classification was produced. Where only one season of data was available, an indicative WFD classification for the season was produced following the same process.
- 3.5.17 For rivers, the indicative WFD classifications were used in order to infer the condition of the macroinvertebrate communities present. These classes are designed to reflect the degree to which biological communities have been degraded as a result of human activity and were interpreted as per the descriptions in Table 3-7 below.

Table 3-7: Descriptions of WFD classifications

WFD status	Description
High	Near natural conditions
Good	Slight change from natural conditions as a result of human activity
Moderate	Moderate change from natural conditions as a result of human activity
Poor	Major change from natural conditions as a result of human activity
Bad	Severe change from natural conditions as a result of human activity

3.6 Ditch macroinvertebrate surveys

Survey scoping and design

- 3.6.1 All ditches within the survey area were scoped in for assessment. Due to alterations to the Order Limits some survey sites are no longer present within the 250 metre buffer but have been included within this report for completeness.
- 3.6.2 Full details of survey sites are shown in Table 3-8. A map of ditch sites is shown in Appendix A Map A-2 (Aquatic ditch and riverine survey locations) of this report.
- 3.6.3 Ditches within the main alignment (D1 to D7) were sampled during May 2022; this is within the optimal period for ditch macroinvertebrate sampling (considered to be the last week in April to early June, with a less optimal period extending to mid-October).²² Due to the addition of the Kelham and Averham FCA to the Order Limits at a later date, ditches within the Kelham and Averham FCA (D8 to D20) were sampled within a sub-optimal period of early December 2022, though seasonal effects may have been somewhat offset by mild weather at the time of sampling.

Table 3-8: Ditch invertebrate survey information

Site ID	Area within Scheme	Location	NGR	Spring date	Autumn date
D1	A1	Within Order Limits	SK 81177 55843	26/05/2022	21/11/2022
D2	Old Trent Dyke	Within 250m buffer	SK 78743 54132	26/05/2022	21/11/2022
D3	A46	Within Order Limits	SK 78206 53377	N/A	22/11/2022
D4	Old Trent Dyke	Within 250m buffer	SK 77957 53589	N/A	22/11/2022
D5	A46	Within Order Limits	SK 78110 53244	N/A	22/11/2022
D6	Farndon Fields	Within 250m buffer	SK 78125 52148	26/05/2022	21/11/2022
D7	A46	Within Order Limits	SK 77999 53200	N/A	22/11/2022
D8	Kelham and Averham FCA	Outside 250m buffer	SK 77462 55616	No longer within Order Limits or 250m buffer – not collected	06/12/2022
D9	Kelham and Averham FCA	Outside 250m buffer	SK 77288 55835	No longer within Order Limits or 250m buffer – not collected	N/A

²² Buglife (2013). A manual for the survey and evaluation of the aquatic plant and invertebrate assemblages of grazing marsh ditch systems. Version 6. [online] Available at [redacted] [Last accessed 7 December 2022].

Site ID	Area within Scheme	Location	NGR	Spring date	Autumn date
D10	Kelham and Averham FCA	Within 250m buffer	SK 76837 55470	No longer within Order Limits or 250m buffer – not collected	N/A
D11	Kelham and Averham FCA	Outside 250m buffer	SK 76101 55329	No longer within Order Limits or 250m buffer – not collected	05/12/2022
D12	Kelham and Averham FCA	Outside 250m buffer	SK 76183 55456	No longer within Order Limits or 250m buffer – not collected	05/12/2022
D13	Kelham and Averham FCA	Outside 250m buffer	SK 76681 55778	No longer within Order Limits or 250m buffer – not collected	N/A
D14	Kelham and Averham FCA	Outside 250m buffer	SK 76749 56063	No longer within Order Limits or 250m buffer – not collected	N/A
D15	Kelham and Averham FCA	Outside 250m buffer	SK 76145 55801	No longer within Order Limits or 250m buffer – not collected	N/A
D16	Kelham and Averham FCA	Outside 250m buffer	SK 75945 55549	No longer within Order Limits or 250m buffer – not collected	N/A
D17	Kelham and Averham FCA	Outside 250m buffer	SK 75774 55841	No longer within Order Limits or 250m buffer – not collected	05/12/2022
D18	Kelham and Averham FCA	Outside 250m buffer	SK 75546 55692	No longer within Order Limits or 250m buffer – not collected	05/12/2022
D19	Kelham and Averham FCA	Outside 250m buffer	SK 75590 55818	No longer within Order Limits or 250m buffer – not collected	05/12/2022
D20	Kelham and Averham FCA	Within Order Limits	SK 77102 55282	N/A	N/A
D21	Kelham and Averham FCA	Within Order Limits	SK 76751 55136	N/A	N/A
D22	Kelham and Averham FCA	Within 250m buffer	SK 76672 54764	N/A	N/A
D23	Kelham and Averham FCA	Within 250m buffer	SK 76614 54574	N/A	N/A

3.6.4 Within the main alignment area D3, D4, D5 and D7 were not visited during spring due to access issues.

3.6.5 Within the flood compensation area, sites D9, D10, D13, D14, D15, D16, D20, D21, D22 and D23 were not visited in autumn due to access issues.

3.6.6 Due to changes in the Order Limits, spring surveys originally planned for Spring 2023 on D8, D9, D10, D11, D12, D13, D14, D15, D16, D17, D18 and D19 were not undertaken as they no longer fall within the Order Limits or 250m buffer.

3.6.7 D20, D21, D22 and D23 were not visited in spring due to access issues.

Guidance documents

- 3.6.8 The following documents were considered when planning and undertaking ditch macroinvertebrate surveys:
- Best practice guidance for the undertaking of aquatic macroinvertebrate surveys and assessment is provided in BS EN ISO 10870:2012¹³
 - Macroinvertebrate sampling and taxonomic analysis was taken in accordance Environment Agency's standard macroinvertebrate sampling and analysis manual – BT001¹⁴ and standard RIVPACS procedures (EU-STAR, 2004)¹²

Survey methodology

- 3.6.9 Macroinvertebrate sampling consisted of 3-minutes of sampling using a pond net, and a 1-minute manual search to record invertebrates from any distinct habitats (such as those organisms attached to vegetation, submerged objects such as cobbles and woody debris, or surface-dwelling taxa). Due to the prevalence of soft, sinking substrate, sampling was undertaken through a sweep-sampling technique from the bank, whereby the net is moved through the water whilst the substrate is disturbed in order to capture invertebrates from a number of micro-habitats (EU-STAR, 2004).¹²
- 3.6.10 Environmental data for the sampling area, banks and surrounding area was collected. This data included watercourse width, depth, and substrate composition.
- 3.6.11 Samples were kept at 1-3°C until preservation later that day in IMS, before being sent to a laboratory for taxonomic analysis.

Sample processing

- 3.6.12 In the laboratory, macroinvertebrate samples were analysed to RIVPACS Taxonomic Level 5 (TL5)⁹. Within this framework, specimens are identified to the highest taxonomic level possible given their life stage and condition, with exceptions where this would require disproportionate effort. This level of taxonomic resolution enables calculation of biological indices and allows the detection of INNS and species of conservation importance. The abundance of all taxa present within the sample was also recorded.

Data analysis

- 3.6.13 To summarise the macroinvertebrate assemblage, and to evaluate the baseline condition of the macroinvertebrate communities, the resulting datasets were used to calculate the following biological

indices (as also described in 3.5.10). Other commonly used macroinvertebrate indices such as LIFE and PSI were not included for ditches, as they were not considered useful for these artificial habitats, which are typically characterised by fine substrate (usually silt and/or clay) and slow or negligible flow velocities:

- WHPT ASPT
- WHPT NTAXA
- CCI

3.6.14 Any protected, notable or non-native species identified within samples were highlighted.

3.7 Biosecurity considerations

3.7.1 Biosecurity measures were implemented to prevent the spread of diseases and INNS between the sites visited for surveys. Substrate (for example silt or sand) and plant fragments were removed from survey equipment and personal protective equipment (including waders) between visits to different survey locations. Additionally, all equipment was washed using Virkon® disinfectant between surveys, in accordance with the manufacturer's guidance.

3.8 Quality assurance

3.8.1 All surveys and assessments were undertaken in accordance with the prescribed methodologies.

3.8.2 All surveys were led by appropriately trained surveyors.

3.8.3 Laboratory analysis of macroinvertebrate samples was subject to a quality assurance process involving re-processing of a proportion of samples by an experienced analyst.

3.9 Constraints, limitations and assumptions

3.9.1 It should be noted that the lack of detection of certain protected or notable species does not preclude their presence on a site. There is always the risk of protected or rare species being overlooked, either owing to the timing of a survey, sampling variability, natural variability, or the scarcity of species at a site.

3.9.2 Specific constraints and limitations associated with aquatic ecology surveys are summarised in Table 3-9 below.

Table 3-9: List of survey site constraints

Survey type	Site ID	Constraint	Limitation
PSYM	P3	Insufficient water levels	Invertebrate sample could not be collected.
	P6		
	P7		
PSYM	P4	Site could not be accessed	Data could not be obtained for these ponds.
	P5		
Rapid ponds	P8	Insufficient water levels	Invertebrate sample could not be collected.
	P11		
Rapid ponds	P12	Site could not be accessed	Data could not be obtained for these ponds.
	P13		
Riverine macro-invertebrates	R1	Site could not be accessed in spring	Data could not be obtained for these sites.
	R6	Site could not be accessed in spring or autumn	Data could not be obtained for these sites.
	R7		
	R8		
R9	Site could not be accessed in spring	Data could not be obtained for these sites.	
Ditch macro-invertebrates	D3	Site could not be accessed in spring	Data could not be obtained for these ditches.
	D4		
	D5		
	D7		
Ditch macro-invertebrates	D8	Sub-optimal sampling period (December 2022)	Faunal diversity may appear lower during winter months and therefore conservation value may be underestimated, though seasonal effects may have been somewhat offset by mild conditions at the time of survey.
	D11		
	D12		
	D17		
	D18		
Ditch macro-invertebrates	D9	Site could not be accessed in autumn.	Data could not be obtained for these ditches
	D10		
	D13		
	D14		
	D15		
	D16		
	D20		
Ditch macro-invertebrates	D21	Site could not be accessed in spring	Data could not be obtained for these ditches.
	D22		
	D23		

Predictive System for Multimetrics surveys

3.9.3 For three of the five ponds surveyed (see Table 3-9) water levels were not sufficient to collect a macroinvertebrate sample, and therefore only the macrophyte assessment component of the survey could be undertaken. Therefore, a complete calculation of biological integrity for these three ponds could not be calculated, and assessment was limited to the production of scores for macrophyte indices.

- 3.9.4 Access issues prevented ponds P4 and P5 from being visited and therefore these ponds were not assessed.

Rapid pond surveys

- 3.9.5 Two of the six ponds surveyed had insufficient water levels (see Table 3-9) and therefore it was not possible to undertake invertebrate sampling.
- 3.9.6 P12 and P13 could not be accessed due to access restrictions and therefore these surveys could not be completed.

Riverine macroinvertebrate surveys

- 3.9.7 Access issues prevented surveys from being undertaken on the River Trent adjacent to the Kelham and Averham FCA (see Table 3-9 – sites R6, R7, R8 and R9). Site R1 could also not be visited due to health and safety issues preventing access, therefore the survey could not be completed.

Ditch macroinvertebrate surveys

- 3.9.8 Due to changes to the Order Limits, ditches within the proposed Kelham and Averham FCA were sampled during December 2022, which is a sub-optimal sampling period.²² As such, the range and diversity of species identified may have been limited. However, notably mild temperatures at the time of sampling may have offset a proportion of any seasonal effects.
- 3.9.9 Ditches D9, D10, D13, D14, D15, D16 and D20 could not be accessed and therefore surveys could not be undertaken in Autumn 2022 (see Table 3-9).
- 3.9.10 D21, D22 and D23 could not be accessed due to access restrictions and therefore these surveys could not be completed.
- 3.9.11 Due to changes in the Order limits, spring surveys originally planned for Spring 2023 on D8, D9, D10, D11, D12, D13, D14, D15, D16, D17, D18 and D19 were not undertaken as they no longer fall within the 250 metre survey buffer.

4 Results

4.1 Desk study

4.1.1 The search returned records of four protected species within the study area. This comprised of four fish records: barbel *Barbus barbus*, bullhead *Cottus gobio*, spined loach *Cobitis taenia* and European eel *Anguilla anguilla*. Details of the location of these records and presence within the Order Limits are shown within Table 4-1.

4.1.2 Records within a 10 kilometre buffer of the Order Limits also indicate the presence of the following migratory fish:

- Brown/sea trout *Salmo trutta* (unknown if these records represent migratory sea trout or resident freshwater brown trout)
- Flounder *Platichthys flesus*
- Glass eels, elvers and eels (all freshwater life stages of European eel)
- Given the connectivity of the River Trent to upstream waterbodies and habitats, additional migratory fish species may also pass through the Order Limits during their migration. Salmon *Salmo salar* are noted upstream in the River Dove²³ and therefore use the River Trent as a migratory route. River lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* are noted downstream as a qualifying feature of the Humber Estuary Special Area of Conservation (SAC),²⁴ and therefore may migrate up the River Trent.

4.1.3 The desk study additionally indicated the presence of the following 16 native fish species within the Order Limits, associated with the River Trent:

- Ten-spined stickleback *Pungitius pungitius*
- Three-spined stickleback *Gasterosteus aculeatus*
- Bleak *Alburnus alburnus*
- Chub *Squalius cephalus*
- Common/bronze bream *Abramis brama*
- Dace *Leuciscus leuciscus*
- Gudgeon *Gobio gobio*
- Minnow *Phoxinus phoxinus*
- Perch *Perca fluviatilis*
- Pike *Esox lucius*
- Roach *Rutilus rutilus*

²³ Trent River Trust (2023). Dove. [online] Available at [REDACTED] [Accessed 31/03/2023].

²⁴ Joint Nature Conservation Committee (n.d). Humber estuary. [online] Available at: [REDACTED] [Accessed 31/03/2023].

- Rudd *Scardinius erythrophthalmus*
- Ruffe *Gymnocephalus cernuus*
- Silver bream *Blicca bjoerkna*
- Stone loach *Barbatula barbatula*
- Tench *Tinca tinca*

4.1.4 Species associated with a moderate flow (such as chub) and those associated with a slow flow (such as tench) were identified in the desk study. This range of species highlights the high diversity of species and habitat preferences in the fish community. The most abundant species recorded were minnow, roach and dace. Overall, desk study records indicate that there is a diverse fish community in the River Trent within the Order Limits, with species typical of an eastern lowland river. In particular, populations of silver bream are highly concentrated in rivers in the east of England.

4.1.5 Full details of protected species found within this desk study are found in Appendix B (Notable species recorded within the study area) of this report.

Table 4-1: Protected species recorded within 2km buffer

Species	Taxa group	Status	Waterbodies	Recorded within DOL
Barbel <i>Barbus barbus</i>	Fish	Habitat Directive A5 ²⁵ Habitat Regulations Schedule 4 ²⁶	River Trent-Kelham channel River Trent	No
Bullhead <i>Cottus gobio</i>	Fish	Habitat Directive A2 ²⁷	River Trent Car Dyke River Trent-Kelham channel River Devon Pingley Dyke Middle Beck	No
Spined loach <i>Cobitis taenia</i>	Fish	Bern A3 ²⁸ Habitat Directive A2 NERC S.41 ²⁹	Car Dyke River Trent- Kelham channel River Trent- Farndon Marina River Devon	No

²⁵ Habitats and Species Directive Appendix 5: Animal and plant species of Community interest whose taking in the wild and exploitation may be subject to management measures.

²⁶ The Conservation of Habitats and Species Regulations 2017 Schedule 4 Animals which may not be captured or killed in certain ways.

²⁷ Habitats and Species Directive: Appendix 2 – non-priority species: animal and plant species of European Community interest whose conservation requires the designation of Special Areas of Conservation.

²⁸ Bern Convention (Appendix 3): special protection through 'appropriate and necessary legislative and administrative measures' of the listed wild fauna species.

²⁹ Species of Principle Importance listed within the 2006 Natural Environment and Rural Communities (NERC) Act.

Species	Taxa group	Status	Waterbodies	Recorded within DOL
European eel <i>Anguilla anguilla</i>	Fish	OSPAR ³⁰ IUCN Red list- Critically Endangered ³¹	River Trent Rundell Dyke River Devon River Trent- Kelham channel Un-named stream (SK 79060 57430) The Fleet	No

4.1.6 The desk search returned records of 24 non-native species within the Order Limits plus a 2 kilometre buffer which consisted of six plants, five fish and 13 macroinvertebrates. Details of the location of these records and presence within the Order Limits are shown within Table 4-2.

4.1.7 Full details of these records are shown in Appendix B (Notable species recorded within the study area) of this report.

Table 4-2: INNS recorded within 2km buffer

Species	Taxa group	Status	Waterbodies	Recorded within OL
Asian clam <i>Corbicula fluminea</i>	Invertebrate	UKTAG – High impact ³²	River Trent River Trent- Kelham channel	No
Bladder snail <i>Physella acuta</i>	Invertebrate	UKTAG – Unknown impact	River Trent River Devon	No
Bloody red mysid <i>Hemimysis anomala</i>	Invertebrate	UKTAG – High impact	River Trent	No
Caspian mud shrimp <i>Chelicorophium curvispinum</i>	Invertebrate	UKTAG – Unknown impact	River Trent River Trent-Kelham channel	No
Demon shrimp <i>Dikerogammarus haemobaphes</i>	Invertebrate	UKTAG – High impact	River Trent River Trent-Kelham channel	No
Flatworm <i>Dugesia tigrina</i>	Invertebrate	Non-native (impact not assessed)	River Trent	No

³⁰ Convention designed to protect the marine environment in the north-east Atlantic.

³¹ Listed in The International Union for Conservation of Nature's Red List of Threatened Species.

³² WFD-UKTAG listed INNS, categorised as High/Medium/Low/Unknown Impact (WFD-UKTAG, 2021).

Species	Taxa group	Status	Waterbodies	Recorded within OL
Himalayan balsam <i>Impatiens glandulifera</i>	Plant	UKTAG- High impact WACA 1981 Schedule ³³ EU species of special concern ³⁴ IAS Order 2019 Schedule 235	River Trent River Trent- Kelham channel River Greet Rundell Dyke Adjacent to A46 Un-named waterbody (SK 755 527 to SK 760 530) River Devon Old Trent Dyke Un-named waterbody (SK 790 590 to SK 800 610) Slough Dyke SK 78300 54700 to SK 79100 54600 Stayhope road Middle Beck Newark on Trent Lakes adjacent to River Trent The Fleet	Yes
Jenkin's spire shell <i>Potamopyrgus antipodarum</i>	Invertebrate	UKTAG – Moderate impact	River Trent Pingley Dyke River Devon River Trent- Kelham channel Slough Dyke	No
Northern River/Florida crangonyctid <i>Crangonyx pseudogracilis/floridanus</i>	Invertebrate	UKTAG – Low impact/not assessed	River Trent Car Dyke River Devon Middle Beck River Trent- Kelham channel Beck Dyke Slough Dyke	No
Polychaete worm <i>Hypania invalida</i>	Invertebrate	UKTAG – Unknown impact	River Trent	No
Zander <i>Sander lucioperca</i>	Fish	UKTAG – Moderate impact WACA 1981 Schedule 9	River Trent River Trent- Farndon Marina	No
Nuttall's pondweed <i>Elodea nuttallii</i>	Plant	UKTAG – High impact EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch. 2	River Trent Middle Beck	No
Least duckweed <i>Lemna minuta</i>	Plant	UKTAG – Moderate impact	Middle Beck	No

³³ Listed on Schedule 9 of the Wildlife and Countryside Act 1981.

³⁴ Invasive Non-Native Species (Amendment etc.) (EU Exit) Regulations 2019 – listed as an 'invasive alien species of union concern'.

³⁵ Listed on Schedule 2 of the Invasive Alien Species (Enforcement and Permitting) Order 2019.

Species	Taxa group	Status	Waterbodies	Recorded within OL
Sweet Flag <i>Acorus calamus</i>	Plant	UKTAG – Low impact	River Trent Old Trent Dyke River Trent Kelham channel	Yes
Common carp <i>Cyprinus carpio</i>	Fish	UKTAG – High impact	Kingfisher pond Hall's pond	No
Goldfish <i>Carassius auratus</i>	Fish	UKTAG – High impact	Hall's pond	No
Sturgeon <i>Acipenser</i> sp.	Fish	UKTAG – Unknown impact	River Trent (NGR SK8057)	Exact location unknown
Wels catfish <i>Silurus glanis</i>	Fish	UKTAG – Low impact	River Trent (NGR SK8057)	Exact location unknown
New Zealand pygmyweed <i>Crassula helmsii</i>	Plant	UKTAG – High impact	Un-named watercourse (SK 80900 53500) Lakes adjacent to River Trent Un-named stream (SK 80900 535000)	No
Signal crayfish <i>Pacifastacus leniusculus</i>	Invertebrate	UKTAG – High impact WACA 1981 Sch. 9 EU species of special concern IAS Order 2019 Sch. 2	Pingley Dyke	No
Zebra mussel <i>Dreissena polymorpha</i>	Invertebrate	UKTAG – High impact	River Trent- Farndon Marina River Trent	No
Sideswimmer <i>Gammarus tigrinus</i>	Invertebrate	UKTAG – Unknown impact	Slough Dyke	No
Chinese mitten crab <i>Eriocheir sinensis</i>	Invertebrate	UKTAG – High impact WACA 1981 Sch. 9 EU species of special concern IAS Order 2019 Sch. 2	River Trent Un-named lake (SK 80900 53500) Lakes adjacent to River Trent (SK 79600 56600)	No
Japanese knotweed <i>Fallopia japonica</i>	Plant	UKTAG – High impact WACA 1981 Schedule 9	River Trent River Trent Farndon Marina Un-named locations (SK 80500 53700, SK 70430 52720, SK 80500 53700)	No

4.2 Predictive System for Multimetrics surveys

4.2.1 Environmental data collected is shown in Table 4-3.

Table 4-3: Environmental data collected for Predictive system for Multimetrics pond surveys

Environmental variable	P1	P2	P3	P6	P7	P15
Altitude (m)	9	15	15	14	10	13
Base geology	Clay (67-100%)	Clay (67-100%)	Clay (67-100%)	Other (67-100%)	Clay (67-100%)	Sand, gravel cobble (67-100%)
Area (m ²)	50	250	Dry – not recorded	Dry – not recorded	Dry – not recorded	150
pH	7.75	7.18	Dry – not recorded	Dry – not recorded	Dry – not recorded	7.65
Shade (% overhanging)	5	5	5	0	0	5
Grazing (% of pond edge)	95	0	100	0	100	0
Inflow	Absent	Absent	Absent	Absent	Absent	Absent
Emergent plant cover (%)	25	90	75	0	80	3

4.2.2 Of the six ponds identified for Predictive System for Multimetrics (PSYM) surveys, three could not be fully surveyed, as water levels were too low to undertake macroinvertebrate sampling (see Table 3-9). Full analysis was therefore only available for P1, P2 and P15, and for these three sites the Environmental Quality Indicator (EQIs) could be calculated. Results are shown in Table 4-4.

Table 4-4: PSYM summary results for the six surveyed pond sites

Index	P1	P2	P3	P6	P7	P15
SM	8 (EQI 0.6)	9 (EQI 0.5)	12	3	4	3.0 (EQI 0.2)
U	1 (EQI 0.5)	0 (EQI 0.0)	1	0	0	1.0 (EQI 0.4)
TRS	8.95 (EQI 1.07)	8.60 (EQI 1.17)	8.3	8.75	8.75	8.35 (EQI 1.00)
ASPT	4.07 (EQI 0.80)	4.79 (EQI 0.85)	N/A	N/A	N/A	4.60 (EQI 0.92)
OM	1 (EQI 0.29)	2 (EQI 0.79)	N/A	N/A	N/A	2.00 (EQI 0.72)
C	4 (EQI 1.07)	4 (EQI 1.18)	N/A	N/A	N/A	2.00 (EQI 0.55)
IBI (%)	61	56	N/A	N/A	N/A	61

Index	P1	P2	P3	P6	P7	P15
PSYM quality category	Moderate	Moderate	N/A	N/A	N/A	Moderate
Priority Pond	No	No	N/A	N/A	N/A	No

- 4.2.3 All three ponds were given a PSYM quality category of Moderate; therefore, none were classed as a Priority Pond. Due to insufficient water levels, a quality category or priority rating could not be given to ponds P3, P6, and P7.
- 4.2.4 For pond P1, the macroinvertebrate Average Score per taxon (ASPT) score was 4.07, with an Environmental Quality Indicator (EQI) ratio of 0.80. Therefore, the ASPT was lower than expected and the results indicate that the macroinvertebrate community may be limited by water quality. Six water beetle families were identified, including one notable species designated as Nationally Scarce – *Noterus crassicornis*. However, the Odonata and Megaloptera (OM) families EQI was 0.29, suggesting a lack of habitat for Odonata and Megaloptera families. Eight submerged and marginal plant species were recorded (including one uncommon species) resulting in an EQI of 0.6. Full details are included in Appendix C (Predictive System for Multimetrics Survey Data) of this report. The trophic ranking score EQI was calculated as 1.07, suggesting that the plant community is not limited by nutrient impact. The calculated Index of Biotic Integrity was 61% (Moderate quality), therefore based on the data this site is not considered a Priority Pond. Overall, the data suggest that the pond may be impacted by a lack of habitat, possibly through overgrazing, and that the water quality may be a limiting factor for macroinvertebrates.
- 4.2.5 P2 had a macroinvertebrate ASPT of 4.79, with an EQI of 0.85. Eight water beetle families were identified, and one Invasive and Non-Native Species (INNS) was recorded – the Northern River/Florida Crangonyctid, *Crangonyx pseudogracilis/floridanus*. Nine submerged and marginal macrophyte taxa were recorded (see Appendix C (Predictive System for Multimetrics Survey Data) of this report), resulting in an EQI of 0.5 **Error! Reference source not found.** The trophic ranking score was 8.6 with an EQI of 1.17. No uncommon plant species were recorded. Therefore, the macrophytes data show a lower than expected number of species, indicating that habitat availability may be a limiting factor. The overall Index of Biotic Integrity (IBI) was calculated as 56% (Moderate quality), and therefore the site is not considered a Priority Pond.
- 4.2.6 P3 was dry at the time of survey. The pH and total area values could not be recorded, and the macroinvertebrates sample could not be collected. A total of 12 submerged and marginal plant species were

recorded, including one uncommon species (full details are shown in Appendix C (Predictive System for Multimetrics Survey Data) of this report).

- 4.2.7 For P6, the water level was too shallow at the time of survey to collect environmental data and a macroinvertebrate survey could not be collected. Three submerged and marginal plant species were recorded, which is considered low (full details are shown in Appendix C (Predictive System for Multimetrics Survey Data) of this report) and suggests a habitat or low water availability pressure. No uncommon plant species were recorded.
- 4.2.8 P7 was also dry at the time of survey. Therefore, environmental data could not be collected and the macroinvertebrate survey was also not possible. Four submerged and marginal plant taxa were recorded (full details are shown in Appendix C (Predictive System for Multimetrics Survey Data) of this report), suggesting a pressure from low water levels or habitat disturbance. No uncommon plant species were recorded.
- 4.2.9 P15 had a macroinvertebrate ASPT of 4.6 with an EQI of 0.92. The macroinvertebrate assemblage sampled included two water beetle families (Dytiscidae/Noteridae and Haliplidae) and two Odonata and Megaloptera families (Libellulidae and Sialidae). No protected or notable species were recorded, however the INNS Northern River/Florida crangonyctid and Jenkin's spire shell *Potamopyrgus antipodarum* were identified. Three submerged and marginal plant species were recorded (including one uncommon species) resulting in an EQI of 0.2. Numbers of emergent, submerged and uncommon macrophytes were significantly lower than expected. The trophic ranking score EQI was calculated as 1.00, indicating that the plant community is not limited by nutrient impact. The calculated Index of Biotic Integrity was 61% (Moderate quality), therefore, based on the data this site is not considered a Priority Pond.

4.3 Rapid pond surveys

- 4.3.1 Of the nine ponds visited for Rapid surveys, only five surveys could be completed as the remaining ponds were dry. Full details of taxa groups recorded within the Rapid pond surveys are found in Appendix D (Rapid Pond Survey Data) of this report.
- 4.3.2 P8 was dry but was dominated by reedmace *Typha latifolia*, indicating that the pond holds water during part of the year.
- 4.3.3 P9 was a large pond with limited marginal vegetation and substantial amounts of pondweed *Potamogeton* sp. and invasive non-native waterweed (*Elodea* sp.). The invasive non-native demon shrimp *Dikerogammarus haemobaphes* were both recorded in this pond. P9

- scored 48, with macroinvertebrates from 10 of the 12 groups recorded. This equates to Good quality.
- 4.3.4 P10 was a large pond with stands of reedmace and reed canary-grass *Phalaris arundinacea*. The notable species screech beetle was recorded at this site. The site scored 58, and macroinvertebrates from all taxa groups except for alderfly larvae were recorded. Therefore, the pond is considered Excellent quality.
- 4.3.5 P11 was dry but dominated by wetland plants species – including reedmace, gypsywort *Lycopus europaeus* and rush *Juncus* sp..
- 4.3.6 P14 was a lined, ornamental pond with filamentous algae present. P14 scored 48, with only two taxon groups not recorded in the survey. Overall, the pond is therefore considered Good quality.
- 4.3.7 P16 was heavily shaded with 100% silt substrate. P16 scored 18 with 6 out of 12 macroinvertebrate groups recorded including snails, shrimp, beetles and water slaters which are was. Overall P16 which is considered Moderate quality.
- 4.3.8 P17 was a large pond with steep banks. All macroinvertebrate groups were recorded at this site resulting in the maximum score of 68, therefore this pond is considered to be Excellent quality.
- 4.3.9 The final scores of the Rapid pond surveys are presented below in Table 4-5.

Table 4-5: Rapid pond survey results summary

Pond number	Overall score	Score interpretation
P8 (pond dry)	N/A	N/A
P9	48	Good quality
P10	58	Excellent quality
P11 (pond dry)	N/A	N/A
P14	48	Good quality
P16	18	Moderate quality
P17	68	Excellent quality

- 4.3.10 Full results from each pond are shown in Appendix D (Rapid Pond Survey Data) of this report.
- 4.3.11 High-scoring taxa groups were recorded at P9, P10, P14 and P17 indicating all are of a high biological quality, suggesting little pollution is present. P10 and P17 fall into the ‘Excellent quality’ category, while both P9 and P14 fall into the ‘Good quality’ category. P16 is considered lower quality and did not contain any high sensitivity groups.

4.4 Riverine macroinvertebrate surveys

- 4.4.1 The observed scores for WHPT, LIFE, PSI and CCI and macroinvertebrate biotic indices with indicative WFD status for the five riverine water bodies surveyed are shown below in Table 4-6 and Table 4-7.

Table 4-6: Biotic indices from riverine watercourses surveyed

Site number	R1		R2		R3		R4		R5	
Season	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	
WHPT NTAXA	12	24	10	32	19	21	14	9	5	
WHPT ASPT	3.84	4.27	3.20	4.66	4.58	4.13	4.21	3.29	3.20	
LIFE (species)	6.75	6.45	5.57	6.13	6.47	6.20	6.08	6.50	5.00	
PSI (species)	25.00 (Sedimented)	33.93 (Sedimented)	5.26 (Heavily sedimented)	7.04 (Heavily sedimented)	13.89 (Heavily sedimented)	7.69 (Heavily sedimented)	10.34 (Heavily sedimented)	11.11 (Heavily sedimented)	40.00 (Sedimented)	
CCI	4.50 (Low)	6.14 (Moderate)	1.00 (Low)	9.09 (Moderate)	3.86 (Low)	7.69 (Moderate)	4.50 (Low)	4.20 (Low)	1.00 (Low)	

Table 4-7: Macroinvertebrate WHPT EQR scores for each sample location and waterbody and corresponding WFD status

Site number	R1	R2		R3		R4		R5	
Season	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
WHPT NTAXA EQR	0.475	0.991	0.464	1.243	0.899	0.761	0.586	0.361	0.237
WHPT ASPT EQR	0.810	0.813	0.652	1.120	1.107	0.870	0.854	0.746	1.048
Overall WHPT NTAXA EQR	N/A	0.728		1.071		0.673		0.300	
Overall WHPT ASPT EQR	N/A	0.733		1.113		0.862		0.898	

Site number	R1	R2	R3	R4	R5
WFD status	Bad	Moderate	High	Moderate	Bad

- 4.4.2 Data from R1 could be collected in autumn only therefore a partial RICT classification was performed. The overall indicative WFD status of this site was classified as Bad, indicating the macroinvertebrate community is experiencing severe changes as a result of human activity. The Whalley, Hawkes, Paisley and Trigg Average Score Per Taxon (WHPT NTAXA) EQR and WHPT Average Score Per Taxon (ASPT) EQR was classed as Poor (EQR of 0.475) and Moderate (EQR of 0.810). The taxa recorded at this site was relatively limited in diversity and included one caddis species *Tinodes waeneri* and one mayfly species *Cloeon dipterum*. The PSI and CCI score for R1 indicate the watercourse is sedimented with a Low conservation value. The Lotic Invertebrate Index Flow Evaluation (LIFE) scores indicate the macroinvertebrate communities within the site area are associated with moderate flow. No protected and notable species were recorded at this site. Four INNS were recorded at this site including Northern River/Florida Crangonyctid , Caspian mud shrimp , bladder snail and Jenkin's spire shell.
- 4.4.3 A full classification of the spring and autumn data collected at R2 gave an indicative Water Framework Directive (WFD) status of Moderate, indicating the macroinvertebrate community is experiencing moderate change as a result of human activity. The combined WHPT NTAXA EQR and WHPT ASPT EQR for spring and autumn were 0.728 (Good) and 0.733 (Moderate) respectively. There was a diversity of taxa recorded at this site which included caddisfly families *Glossosomatidae*, *Leptoceridae*, *Limnephilidae* and *Psychomyiidae* and mayfly families *Baetidae* and *Caenidae*. The PSI score and CCI score for R2 indicate the survey area is sedimented to heavily sedimented with a Moderate to Low conservation value. The LIFE scores indicate the macroinvertebrate communities within the site area are associated with moderate flow. No protected or notable species were recorded at this site. Three INNS were recorded at this site including Northern River/Florida Crangonyctid, bladder snail and Jenkin's spire shell.
- 4.4.4 A full classification of the spring and autumn data collected at R3 resulted in an indicative WFD status of High, indicating the macroinvertebrate community is at near natural conditions. The combined WHPT NTAXA EQR and WHPT ASPT EQR for spring and autumn were 1.071 (High) and 1.113 (High) respectively. The site was inhabited by a diverse range of taxa which require good water quality and included records of caddisfly families *Limnephilidae*, *Psychomyiidae*, *Hydroptilidae*, *Leptoceridae* and *Polycentropodidae*, mayfly families *Caenidae* and *Baetidae*, damselfly families *Coenagrionidae* and *Calopterygidae* and the dragonfly *Brachytron pratense*. The biological indices for R3 indicate the survey area is heavily sedimented with a Moderate to Low conservation value. The LIFE scores indicate the macroinvertebrate communities within the site area are associated with moderate flow. No protected and notable

species were recorded at this site. Three INNS species were recorded at this site including Northern River/Florida Crangonyctid, bladder snail and Jenkin's spire shell.

- 4.4.5 A full classification of the spring and autumn data collected at R4 resulted in an indicative WFD status of Moderate, indicating the macroinvertebrate community is experiencing moderate change as a result of human activity. The combined WHPT NTAXA EQR and WHPT ASPT EQR for spring and autumn were 0.673 (Moderate) and 0.862 (Moderate) respectively. The taxa recorded at this site was diverse and included species from the caddis families *Leptoceridae* and *Limnephilidae* and mayfly families *Baetidae*. Other high value species such as the river limpet *Acroloxus lacustris* and the snail *Galba truncatula* were also recorded. The PSI score and CCI score for R4 indicate the watercourse is heavily sedimented and of a Moderate to Low conservation value. The LIFE scores indicate the macroinvertebrate communities within the site area are associated with moderate flow. No protected and notable species were recorded at this site. Seven INNS were recorded at this site including Northern River/Florida Crangonyctid, Caspian mud shrimp, demon shrimp, Asian clam *Corbicula fluminea* and bladder snails *Physella acuta* and *Physa fontinalis*.
- 4.4.6 A full classification of the spring and autumn data collected at R5 resulted in an indicative WFD status of Bad, indicating that the macroinvertebrate community is experiencing severe changes as a result of human activity. The combined WHPT NTAXA EQR and WHPT ASPT EQR for spring and autumn were 0.300 (Bad) and 0.898 (Good) respectively. The diversity of taxa recorded at this site was low and included the damselfly *Calopteryx splendens*. The PSI score and CCI score for R5 indicate the survey area is heavily sedimented to sedimented with a Low conservation value. The LIFE scores indicate the macroinvertebrate communities within the site area are associated with moderate flow. No protected and notable species were recorded at this site. Two INNS were recorded at this site including demon shrimp and Asian clam.

4.5 Ditch macroinvertebrate surveys

- 4.5.1 No protected or notable species were found during the surveys; however, the non-native Northern River/Florida Crangonyctid was identified from the survey. The biotic indices for the three spring samples and seven samples collected from ditches within the survey area along the main alignment are shown below in Table 4-8. The biotic indices for the surveys undertaken at ditches within the Kelham and Averham FCA survey area are shown in Table 4-9.

- 4.5.2 Spring surveys within the Kelham and Averham FCA survey area which were originally planned for May 2023 were not undertaken due to either land access constraints or their removal from the survey area due to changes in the Order Limits.

Table 4-8: Biotic indices from ditch surveys undertaken along the main alignment

Index	D1		D2		D3	D4	D5	D6		D7
Sampling season	Spring	Autumn	Spring	Autumn	Autumn	Autumn	Autumn	Spring	Autumn	Autumn
WHPT NTAXA	13	21	21	20	12	13	13	6	17	13
WHPT ASPT	3.15	4.30	4.62	4.36	3.68	3.76	4.30	3.43	3.98	3.76
CCI	4.13 (Low)	3.75 (Low)	7.50 (Moderate)	4.50 (Low)	4.20 (Low)	4.50 (Low)	5.00 (Low)	1.00 (Low)	3.75 (Low)	6.00 (Moderate)

Table 4-9: Biotic indices from ditch surveys undertaken at the Kelham and Averham FCA

Index	D8	D11	D12	D17	D18	D19
Sampling season	Winter (sub-optimal)	Winter (sub-optimal)	Winter (sub-optimal)	Winter (sub-optimal)	Winter (sub-optimal)	Winter (sub-optimal)
WHPT NTAXA	9	10	5	8	9	9
WHPT ASPT	3.74	3.72	3.06	3.96	4.08	4.63
CCI	10.50 (Fairly high)	18.67 (High)	3.75 (Low)	9.00 (Moderate)	5.00 (Low)	1.00 (Low)

- 4.5.3 At D1, a total of 13 to 21 scoring taxa were present, with an ASPT of 3.15 to 4.15. The CCI score indicates the macroinvertebrate community is of a Low conservation value during spring and autumn.
- 4.5.4 The D2 survey resulted in a total of 21 to 20 scoring taxa present, with an ASPT of 4.62 to 4.36, the highest of all ditch sites surveyed. The CCI score indicates a Moderate conservation value to Low conservation value in spring and autumn.
- 4.5.5 D3 was surveyed in autumn only. A total of 12 scoring taxa were present, with an ASPT of 3.68. The CCI score indicates the macroinvertebrate community is of a Low conservation value.
- 4.5.6 D4 was surveyed in autumn only. A total of 13 scoring taxa were present, with an ASPT of 3.76. The CCI score indicates the macroinvertebrate community is of a Low conservation value.
- 4.5.7 D5 was surveyed in autumn only. A total of 13 scoring taxa were present, with an ASPT of 4.30. The CCI score indicates the macroinvertebrate community is of a Low conservation value.
- 4.5.8 D6 showed only six scoring taxa present in spring and 17 scoring taxa in autumn. The ASPT ranged from 3.43 to 3.98. The CCI score equates to a Low conservation value.
- 4.5.9 D7 was surveyed in autumn only. A total of 13 scoring taxa were present, with an ASPT of 3.76. The CCI score indicates the macroinvertebrate community is of Moderate conservation value.
- 4.5.10 D8, a total of nine scoring taxa were present, with an ASPT of 3.74. The results indicate a Moderate conservation value.
- 4.5.11 A total of 10 scoring taxa were present at D11, with an ASPT of 3.72. The CCI score was the highest of all sites, giving the site a High conservation value. This indicates despite similar environmental pressures to other ditch sites, D11 is of higher conservation value which is likely driven by the presence of a combination of less common taxa.
- 4.5.12 At D12, only five scoring taxa were present, the lowest of all ditch sites surveyed. The ASPT was 3.06. The CCI score translates to a Low conservation value.
- 4.5.13 A total of eight scoring taxa were present at D17, with an ASPT of 3.96. The CCI score equates to a Moderate conservation value.
- 4.5.14 A total of nine scoring taxa were present at D18, with an ASPT of 4.08. The CCI score indicates the macroinvertebrate community is of a Low conservation value.
- 4.5.15 The D19 survey resulted in nine scoring taxa present, with an ASPT of 4.63. The CCI resulted in the site being assigned a Low conservation value.

5 Summary and conclusions

5.1.1 Key results from the desk study are as follows:

- Four protected fish species, barbel, bullhead, spined loach and European eel could be present within the site or a 250 metre buffer
- Records of 24 non-native aquatic and riparian species were identified in the study area, including the High impact species Asian clam, bloody red mysid, demon shrimp, signal crayfish, zebra mussel, Chinese mitten crab, common carp, goldfish, New Zealand pygmyweed, Himalayan balsam, Japanese knotweed and Nuttall's pondweed
- A total of 16 additional native fish were recorded indicating there is a diverse fish community
- An expanded desk search highlighted the potential presence of several migratory fish such as sea trout and European eel, which may also pass through the River Trent within the Order Limits

5.1.2 The results of the PSYM surveys are summarised as follows:

- Full analysis of P3, P6 and P7 was not possible due to low water levels limiting macroinvertebrate sampling. The TRS scores do not suggest high nutrient levels, however P6 and P7 both had a low number of species observed, suggesting a habitat pressure or pressure from low water levels.
- The data for P1 suggest that the macroinvertebrate and macrophyte communities may be limited by habitat availability, and additionally the macroinvertebrate community may be affected by water quality. One notable species – the water beetle *Noterus crassicornis* – was recorded. The overall Index of Biotic Integrity (IBI) score was 61% (Moderate quality).
- At P2, one INNS was recorded, the Northern River/Florida Crangonyctid. The macrophyte Environmental Quality Indicator (EQIs) indicate habitat availability may be a limiting factor. The overall IBI was 56% (Moderate quality).
- At P15 the overall IBI was 61% (Moderate quality). Two INNS were recorded, the Northern River/Florida Crangonyctid and Jenkin's spire shell. The number of macrophytes recorded at this pond were significantly lower than expected.

5.1.3 The results of the Rapid pond assessments indicate:

- P9 and P11 are likely ephemeral in nature, as despite being dry at the time of survey they were dominated by wetland plants
- In P9 the notable species screech beetle was recorded, in addition to the INNS waterweed and demon shrimp.

- Ponds P10 and P17 had the highest scoring macroinvertebrate taxa groups and falls into the 'Excellent quality' category
- Ponds P9 and P14 scored highly and fall into the 'Good quality' category
- P16 was of lower quality and was considered to be of 'Moderate quality'

5.1.4 Surveys of the riverine watercourses show that:

- River Invertebrate Classification Tool (RICT) analysis of these sites indicated that R1 and R5 were Bad Water Framework Directive (WFD) status indicating that the macroinvertebrate communities were severely impacted by human activities and were not in a natural state. R2 and R4 were Moderate WFD status, indicating there was moderate pressure on the macroinvertebrate communities. R3 was High WFD status which suggests this site is in a near natural condition.
- All sites are indicated as being sedimented to heavily sedimented with a Moderate to Low conservation value. Lotic Invertebrate Index Flow Evaluation (LIFE) scores indicate all macroinvertebrate communities within the survey area are associated with moderate flow.
- The Community Conservation Index (CCI) indicated that all sites were of a Moderate to Low conservation value and no high scoring or protected taxa were recorded in any sample.
- INNS were detected at every site and included Northern River/Florida Crangonyctid, Caspian mud shrimp, bladder snail, Jenkins spire shell, demon shrimp and Asian clam.

5.1.5 The analysis of the ditch macroinvertebrate surveys undertaken within the main alignment show that:

- The WHPT NTAXA scores ranged from 21 to 6 in spring and 21 to 13 in autumn, with D2 scoring the highest overall. The ASPT ranged from 3.15 to 4.62 in spring and 3.68 to 4.36, with D2 again scoring the highest overall.
- The low WHPT NTAXA and WHPT values for D6 suggests an environmental pressure at the time of sampling.
- The conservation values for the sites were Moderate (D2) or Low (D1 and D6) in spring and Moderate (D7) or Low (D1 to D6) in autumn.

5.1.6 The analysis of the ditch macroinvertebrate surveys within the Kelham and Averham FCA show:

- The WHPT NTAXA scores ranged from 5 to 10, with D11 scoring the highest and D12 scoring the lowest. The ASPT ranged from 4.63 to 3.06, with D19 scoring the highest and D12 scoring the lowest.

- The WHPT NTAXA and WHPT values were similar across all sites, indicating an influence of pollution and nutrient enrichment associated with this type of habitat (slow-flowing waterbodies).
- Ditches D12, D18 and D19 had a Low conservation value, whilst D17 had a Moderate conservation value.

5.1.7 D8 had a Fairly High conservation value and D11 had a High conservation value.

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A. Appendix: Maps

Map A-1: Aquatic pond sites

Map A-2: Aquatic ditch and riverine survey locations

B. Appendix: Notable species recorded within the study area

B.1.0.1 The complete records for protected, notable and INNS found within the desk study are show below in Table B-1 and Table B-2, respectively.

Appendix Table B-1: Notable species recorded within the study area

Species name	Taxon group	Data source	Location	Latest record	Designation
Barbel <i>Barbus barbus</i>	Fish	EA	SK 78799 56261 River Trent – Kelham channel	09/10/2018	Habitat Directive A5 ²⁵ Habitat Regulations Schedule 4 ²⁶
		EA	SK 80021 55543 River Trent	23/05/2016	
		EA	SK 79339 53791 River Trent	22/09/2016	
		NBN ³⁶	SK 79877 58954 River Trent	11/10/2018	
		NBN ³⁶	SK 79117 56187 River Trent – Kelham channel	22/09/2016	
		NBN ³⁶	SK 79887 58592 River Trent	22/09/2014	
		NBGRC	SK 80240 56330 River Trent – Kelham channel	2007-2013	
		NBGRC	SK 79160 53610 River Trent	2007-2013	
Bullhead <i>Cottus gobio</i>	Fish	EA	SK 79339 53791 River Trent	22/09/2016	Habitat Directive A2 ²⁷
		EA	SK 78180 50887 Car Dyke	08/05/2013	
		NBN ³⁶	SK 78900 56200 River Trent – Kelham channel	06/11/2014	
		EA	SK 78644 51047 River Devon	03/11/2016	
		NBN ³⁶	SK 76000 54200 Pingley Dyke	13/03/2015	
		NBN ³⁶	SK 78686 51511 Middle Beck	22/05/2013	
		NBGRC	SK 78100 50800 Car Dyke	08/05/2013	

³⁶ Environment Agency (2023). Protected and Invasive Species Records Collected Through Environment Agency Survey 1995 - 2021. Occurrence dataset on the NBN Atlas

Species name	Taxon group	Data source	Location	Latest record	Designation
		NBGRC	SK 78600 51500 Middle Beck	22/05/2013	
		NBGRC	SK 78600 51000 River Devon	17/10/2013	
		NBGRC	SK 79300 53700 River Trent	23/09/2014	
		NBGRC	SK 79100 53610 River Trent	2007-2013	
		NBGRC	SK 80240 56330 River Trent – Kelham channel	2007-2013	
Spined loach <i>Cobitis taenia</i>	Fish	EA	SK 78180 50887 Car Dyke	08/05/2013	Bern A3 ²⁸ Habitat Directive A2 NERC S.41 ²⁹
		EA	SK 78799 56261 River Trent – Kelham channel	22/09/2016	
		EA	SK 77018 52307 River Trent - Farndon Marina	08/10/2015	
		NBN ³⁶	SK 79117 56187 River Trent – Kelham channel	22/09/2016	
		NBN ³⁶	SK 78644 51047 River Devon	20/05/2016	
		NBGRC	SK 77000 52300 River Trent - Farndon Marina	08/10/2015	
		NBGRC	SK 78100 50800 Car Dyke	08/05/2013	
		NBGRC	SK 78700 56200 River Trent – Kelham channel	23/09/2014	
European eel <i>Anguilla anguilla</i>	Fish	EA	SK 79339 53791 River Trent	22/09/2016	OSPAR ³⁰ IUCN Red list- Critically Endangered ³¹ NERC S.41
		NBGRC	SK 75020 52420 Rundell Dyke	25/08/2015	
		NBGRC	SK 78120 51600 River Devon	17/08/2010	
		NBGRC	SK 79300 53700 River Trent	18/09/2013	
		NBGRC	SK 79060 57430 un-named stream	31/10/2016	
		NBGRC	SK 80240 56330 River Trent – Kelham channel	2007-2013	
		NBGRC	SK 82000 58740 The Fleet	28/08/2018	
		NBGRC	SK 81530 57410 The Fleet	30/08/2018	
		NBGRC	SK 82000 58740 The Fleet	28/08/2018	
		NBGRC	SK 82000 58740 The Fleet	28/08/2018	

Species name	Taxon group	Data source	Location	Latest record	Designation
		NBGRC	SK 81530 57410 The Fleet	30/08/2018	

Appendix Table B-2: INNS recorded within the study area

Species name	Taxon group	Data source(s)	NGR	Latest record	Designation
Asian clam <i>Corbicula fluminea</i>	Invertebrate	EA	SK 80481 56712 River Trent	18/10/2022	UKTAG – High impact ³²
		EA	SK 78900 56200 River Trent – Kelham channel	06/11/2014	
		NBN ³⁷	SK 79117 56187 River Trent - Kelham channel	22/09/2016	
Bladder snail <i>Physella acuta</i>	Invertebrate	EA	SK 80481 56712 River Trent	23/05/2019	UKTAG – Unknown impact
		EA	SK 78644 51047 River Devon	20/05/2016	
Bloody red mysid <i>Hemimysis anomala</i>	Invertebrate	EA	SK 80481 56712 River Trent	31/10/2014	UKTAG – High impact
Caspian mud shrimp <i>Chelicorophium curvispinum</i>	Invertebrate	EA	SK 80481 56712 River Trent	18/10/2022	UKTAG – Unknown impact
		EA	SK 78900 56200 River Trent- Kelham channel	03/04/2017	
		EA	SK 75811 50871 River Trent	27/05/2022	
Demon shrimp <i>Dikerogammarus haemobaphes</i>	Invertebrate	EA	SK 80481 56712 River Trent	18/10/2022	UKTAG – High impact
		EA	SK 75811 50871 River Trent	27/05/2022	
		EA	SK 78900	03/04/2017	

³⁷ Environment Agency (2016). Protected and Invasive Species Records Collected Through Environment Agency Survey 1995 - 2021. Occurrence dataset on the NBN Atlas

Species name	Taxon group	Data source(s)	NGR	Latest record	Designation
			56200 River Trent – Kelham channel		
Flatworm <i>Dugesia tigrina</i>	Invertebrate	EA	SK 80481 56712 River Trent	18/10/2022	Non-native (impact not assessed)
Himalayan balsam <i>Impatiens glandulifera</i>	Macrophyte	EA	SK 75811 50871 River Trent	05/09/2022	UKTAG- High impact WACA 1981 Schedule 9 ³³ EU species of special concern ³⁴ IAS Order 2019 Schedule 2 ³⁵
			SK 78900 56200 River Trent – Kelham channel	21/07/2014	
		NBN ³⁸	SK 756 536 to SK 749 531 Rundell Dyke	18/07/2017	
			SK 780 520 A46	04/08/2015	
			SK 755 527 to SK 760 530 Un-named waterbody	19/09/2015	
			SK 790 530 River Devon	24/08/2017	
			SK 783 547, SK 791 553, SK 790 540 Old Trent Dyke	07/08/2017	
			SK 807 539 River Devon	28/07/2017	
			SK 790 590 Un-named waterbody	19/09/2015	
			SK 815 571 Slough Dyke	10/08/2017	
EA	SK 78900 56200 River Trent- Kelham channel	21/07/2014			

³⁸ Environment Agency (2015-2017). Protected and Invasive Species Records Collected Through Environment Agency Survey 1995 - 2021. Occurrence dataset on the NBN Atlas

Species name	Taxon group	Data source(s)	NGR	Latest record	Designation
		EA	SK 80481 56712 River Trent	07/10/2013	
		NBGRC	SK 75000 50800 to SK 80000 59000 River Trent	06/09/2017	
			SK 78300 54700 to SK 79100 54600	06/09/2017	
			SK 75500 52700, SK 75300 53400 Stayhope Road	24/08/2017	
			SK 78000 53900 Old Trent Dyke	10/08/2017	
			SK 79000 53000 River Devon	24/08/2017	
			SK 80000 51000 Middle Beck	28/07/2014	
			SK 80700 53900 Newark on Trent	06/09/2017	
			SK 80000 57000 Lakes adjacent to River Trent	12/08/2017	
			SK 81500 57100 The Fleet	12/08/2017	
			NBN ³⁶	SK 80500 53700 Un-named location	06/10/2013
		NBN ³⁶	SK 70430 52720 Un-named location	18/07/2017	
		NBN ³⁶	SK 77018 52307 River Trent - Farndon Marina	11/09/2014	
		NBGRC	SK79800 54300 River Trent	11/01/2018	

Species name	Taxon group	Data source(s)	NGR	Latest record	Designation
		NBGRG	SK 80500 53700 Un-named location	06/10/2013	
Jenkin's spire shell <i>Potamopyrgus antipodarum</i>	Invertebrate	EA	SK 80481 56712 River Trent	18/10/2022	UKTAG – Moderate impact
		EA	SK 75811 50871 River Trent	27/05/2022	
		EA	SK 76000 54200 Pingley Dyke	26/10/2015	
		EA	SK 75183 50890 River Trent	08/10/2014	
		EA	SK 78644 51047 River Devon	03/11/2016	
		EA	SK 78900 56200 River Trent – Kelham channel	03/04/2017	
		NBN ³⁶	SK 82000 59000 Slough Dyke	26/10/2015	
Northern River/Florida crangonyctid <i>Crangonyx pseudogracilis/floridanus</i>	Invertebrate	EA	SK 75811 50871 River Trent	27/05/2022	UKTAG – Unknown impact
		EA	SK 78183 50890 Car Dyke	08/10/2014	
		EA	SK 78644 51047 River Devon	22/05/2013	
		EA	SK 78686 51511 Middle Beck	22/05/2013	
		EA	SK 78900 56200 River Trent – Kelham channel	03/04/2017	
		EA	SK 80481 56712 River Trent	21/11/2018	
		NBN ³⁶	SK 78100 50800 Car Dyke	08/10/2014	
		NBN ³⁶	SK 73581 52424 Beck Dyke	09/04/2015	

Species name	Taxon group	Data source(s)	NGR	Latest record	Designation
		NBN ³⁶	SK 82003 59005 Slough Dyke	28/05/2015	
Polychaete worm <i>Hypania invalida</i>	Invertebrate	EA	SK 80481 56712 River Trent	18/10/2022	UKTAG – Unknown impact
		EA	SK 75811 50871 River Trent	27/05/2022	
Zander <i>Sander luciperca</i>	Fish	EA	SK 80021 55543 River Trent	23/05/2016	UKTAG – Moderate impact WACA 1981 Schedule 9
		EA	SK 77018 52307 River Trent - Farndon Marina	20/09/2016	
Nuttall's pondweed <i>Elodea nuttallii</i>	Macrophyte	EA	SK 75811 50871 River Trent	05/09/2022	UKTAG – High impact EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch. 2
		EA	SK 78686 51511 Middle Beck	23/08/2016	
Least duckweed <i>Lemna minuta</i>	Macrophyte	EA	SK 78686 51511 Middle Beck	23/08/2016	UKTAG – Moderate impact
Sweet Flag <i>Acorus calamus</i>	Macrophyte	EA	SK 75811 50871 River Trent	05/09/2022	UKTAG – Low impact
		EA	SK 78500 53200 Old Trent Dyke	21/07/2014	
		EA	SK 78900 56200 River Trent – Kelham channel	21/07/2014	
Common carp <i>Cyprinus carpio</i>	Fish	EA	SK 79490 56655 Kingfisher	27/11/2014	UKTAG – High impact
		EA	SK 80539 51394 Hall's Pond	27/11/2014	

Species name	Taxon group	Data source(s)	NGR	Latest record	Designation
Goldfish <i>Carassius auratus</i>	Fish	EA	SK 80539 51394 Hall's Pond	20/11/2014	UKTAG – High impact
Sturgeon <i>Acipenser sp.</i>	Fish	NBGRC	SK8057 River Trent	15/07/2013	UKTAG – Unknown impact
Wels catfish <i>Silurus glanis</i>	Fish	NBGRC	SK8057 River Trent	15/07/2019	UKTAG – Low impact
New Zealand pygmyweed <i>Crassula helmsii</i>	Macrophyte	NBN ³⁸	SK 80900 53500 un-named water course	24/06/2014	UKTAG – High impact
		NBGRC	SK 78900 56400 Lakes adjacent to River Trent	21/08/2015	
		NBGRC	SK 79600 56600 Lakes adjacent to River Trent	21/08/2015	
		NBGRC	SK 80900 53500 Un-named stream	24/06/2014	
Signal crayfish <i>Pacifastacus leniusculus</i>	Invertebrate	NBN ³⁸	SK 76000 54200 Pingley Dyke	23/08/2016	UKTAG – High impact WACA 1981 Sch. 9 EU species of special concern IAS Order 2019 Sch. 2
Zebra mussel <i>Dreissena polymorpha</i>	Invertebrate	NBN ³⁸	SK 77018 52307 River Trent - Farndon Marina	22/09/2016	UKTAG – High impact
		NBGRC	SK 76000 51000 River Trent	16/12/2021	
Sideswimmer <i>Gammarus tigrinus</i>	Invertebrate	NBN ³⁸	SK 81200 56900 Slough Dyke	14/11/2016	UKTAG – Unknown impact
Chinese mitten crab <i>Eriocheir sinensis</i>	Invertebrate	NBGRC	SK 79200 56200 River Trent	10/09/2021	UKTAG – High impact WACA 1981 Sch. 9 EU species of special concern IAS Order 2019
		NBGRC	SK 80700 57800 River Trent	01/09/2021	

Species name	Taxon group	Data source(s)	NGR	Latest record	Designation
					Sch. 2
		NBGRC	SK 79600 56600 Lakes adjacent to River Trent	21/08/2015	
		NBGRC	SK 80900 53500 Un-named lake	24/06/2014	
Japanese knotweed <i>Reynoutria japonica</i>	Macrophyte	NBN ³⁹	SK 80500 53700 un- named location	06/10/2013	UKTAG – High impact WACA 1981 Schedule 9
		NBN ⁴⁰	SK 70430 52720 un- named location	18/07/2017	
		NBN ³⁶	SK 77018 52307 Farndon Marina (River Trent)	11/09/2014	
		NBGRC	SK79800 54300 River Trent	11/01/2018	
		NBGRC	SK 80500 53700 un- named location	06/10/2013	

³⁹ Records provided by Botanical Society of Britain and Ireland and Biological Records Centre [Accessed 24/01/2023]

⁴⁰ Records provided by Nottinghamshire Non-Native Invasive Species Dataset, accessed through NBN Atlas website. [Accessed 24/01/2023]

C. Appendix: Predictive System for Multimetrics Survey Data

C.1.0.1 The complete macrophyte and macroinvertebrate results for PSYM surveys are show below in Table C-1 and Table C-2, respectively.

Appendix Table C-1: Macrophytes recorded in PSYM surveys

Species	Taxa group	P1	P2	P3	P6	P7	P15
Bittersweet <i>Solanum dulcamara</i>	Emergent plant	✓					
Branched bur-reed <i>Sparganium erectum</i>	Emergent plant		✓	✓			
Bulrush <i>Typha latifolia</i>	Emergent plant		✓	✓		✓	
Canadian waterweed <i>Elodea canadensis</i>	Submerged plant	✓					
Common club rush <i>Schoenoplectus lacustris</i>	Emergent plant			✓			✓
Common duckweed <i>Lemna minor</i>	Floating leaved pant	✓	✓		✓		
Cuckooflower <i>Cardamine pratensis</i>	Emergent plant			✓			
Fennel pondweed <i>Stuckenia pectinata</i>	Submerged plant	✓					
Floating sweet-grass <i>Glyceria fluitans</i>	Emergent plant	✓		✓		✓	
Fool's water cress <i>Apium nodiflorum</i>	Emergent plant			✓			
Great willowherb <i>Epilobium hirsutum</i>	Emergent plant		✓	✓	✓		✓
Greater pond sedge <i>Carex riparia</i>	Emergent plant		✓	✓			
Gypsywort <i>Lycopus europaeus</i>	Emergent plant			✓	✓		✓
Intermediate water-starwort <i>Callitriche hamulata</i>	Submerged plant	✓					

Species	Taxa group	P1	P2	P3	P6	P7	P15
Ivy-leaved duckweed <i>Lemna trisulca</i>	Floating leaved plant	✓					
Marsh cinquefoil <i>Potentilla palustris</i>	Emergent plant		✓	✓			
Amphibious bistort <i>Persicaria amphibia</i>	Marginal plant						✓
Purple loosestrife <i>Lythrum salicaria</i>	Emergent plant		✓				
Reed canary-grass <i>Phalaris arundinacea</i>	Emergent plant				✓		
Ridged hornwort <i>Ceratophyllum demersum</i>	Submerged plant	✓					
Soft rush <i>Juncus effusus</i>	Emergent plant			✓		✓	
Water soldier <i>Stratiotes aloides</i>	Submerged plant		✓				
Water- starwort <i>Callitriche</i> spp.	Submerged plant	✓	✓	✓			
Water-plantain <i>Alisma plantago-aquatica</i>	Emergent plant	✓				✓	
Yellow iris <i>Iris pseudacorus</i>	Emergent plant		✓				

Appendix Table C-2: Macroinvertebrate abundance recorded in PSYM surveys

Species	P1	P2	P15
<i>Crangonyx pseudogracilis/floridanus</i> agg.		2	15
<i>Acilius sulcatus</i>	1		
<i>Agabus bipustulatus</i>	5		
<i>Agabus</i> sp.		1	
<i>Colymbetes fuscus</i>	15		
Dytiscidae		7	25
<i>Hydroporus angustatus</i>		2	
<i>Hydroporus figuratus</i>	4		
<i>Hydroporus palustris</i>	10	1	
<i>Hygrotus inequalis</i>	1	1	
<i>Hygrotus</i> sp.		1	
<i>Hyphydrus ovatus</i>	1	1	
<i>Laccophilus minutus</i>		1	1
<i>Gyrinus substriatus</i>	1		
<i>Haliphus lineatocollis</i>	2		1

Species	P1	P2	P15
<i>Haliphus ruficollis</i>		1	
<i>Haliphus ruficollis</i> group	3	3	
<i>Haliphus</i> sp.	2	1	
<i>Helophorus minutus</i>	1	1	
<i>Helophorus</i> sp.	1		
<i>Hydraena riparia/rufipes/britteni</i>		1	
<i>Cercyon sternalis</i>		1	
<i>Enochrus testaceus</i>		3	
<i>Hydrobius fuscipes/rottenbergii/subrotundus</i> agg.	3		
Hydrophilidae		18	1
<i>Hygrobia hermanni</i>		1	
<i>Noterus clavicornis</i>		1	
<i>Noterus crassicornis</i>	1		
<i>Contacyphon</i> sp.		1	
Ceratopogonidae	1	2	
Chironomidae		200	
<i>Chironomini</i>	15	520	433
<i>Anopheles</i> sp.	1		
Culicidae		672	
<i>Dixella</i> sp.		2	
<i>Setacera</i> sp.		138	
<i>Limonia</i> sp.		2	
Sciomyzidae		2	
<i>Cloeon dipterum</i>	9	108	
<i>Acroloxus lacustris</i>		1	
<i>Ampullaceana balthica</i>	251	320	
<i>Stagnicola palustris/fuscus/corvus</i> agg.	28		
<i>Physella acuta/heterostropha</i>		125	
<i>Anisus leucostoma</i>	2		
<i>Planorbis planorbis</i>	529		
Corixidae		25	34
<i>Hesperocorixa linnaei</i>		246	
<i>Hesperocorixa sahlbergi</i>	20	66	1
Gerridae		10	
<i>Gerris lacustris</i>	3		
<i>Gerris odontogaster</i>		2	
<i>Ilyocoris cimicoides</i>		64	
<i>Nepa cinerea</i>		2	
<i>Notonecta glauca</i>	5	2	
<i>Notonecta maculata</i>	1		
<i>Plea minutissima</i>		2	7
<i>Asellus aquaticus</i>		136	450

Species	P1	P2	P15
<i>Proasellus meridianus</i>	1		
<i>Aeshna mixta</i>		2	
Coenagrionidae	2	330	
<i>Enallagma cyathigerum</i>		1	
Oligochaeta	1		
<i>Callicorixa praeusta</i>			1
<i>Callicorixa wollastoni</i>			2
Chaoboridae			2
<i>Dytiscus sp.</i>			1
<i>Hygrotus impressopunctatus</i>			3
Libellulidae			1
Lumbricidae			1
Lymnaeidae			1
<i>Musculium lacustre</i>			6
Notonectidae			6
Ostracoda			2
<i>Paracorixa concinna</i>			1
<i>Potamopyrgus antipodarum</i>			1
<i>Sialis lutaria</i>			24
<i>Sympetrum sanguineum</i>			1
Tanypodinae			114
Tanytarsini			23
<i>Triaenodes bicolor</i>			1

D. Appendix: Rapid Pond Survey Data

D.1.0.1 The complete Rapid pond survey results for Pond 21, Pond 22, and Pond 27 are shown below in Table D-1 below.

Appendix Table D-1: Rapid pond survey results

Invertebrate group	P9 score	P10 score	P14 score	P16 score	P17 score
Caddis larvae	10	10	0 (absent)	0 (absent)	10
Alderfly larvae	0 (absent)	0 (absent)	0 (absent)	0 (absent)	10
Dragonfly larvae	0 (absent)	10	10	0 (absent)	10
Damselfly larvae	10	10	10	0 (absent)	10
Water beetles (adult and larvae)	5	5	5	5	5
Water bugs (excluding pond skaters)	5	5	5	5	5
Pond skaters (adults or nymphs)	5	5	5	0 (absent)	5
Mayfly larvae	5	5	5	0 (absent)	5
Freshwater shrimps	5	5	5	5	5
Water slaters	1	1	1	1	1
Water snails	1	1	1	1	1
Worms, fly larvae, leeches	1	1	1	1	1
Total	48 (Good quality)	58 (Excellent quality)	48 (Good quality)	18 (Moderate quality)	68 (Excellent quality)