# Norwich Western Link

# Environmental Statement

# Chapter 10: Biodiversity

# Appendix 10.12: Aquatic Ecology Survey Report 2022

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# Contents

## Tables

**Figures**

# Foreword

WSP UK Ltd. (WSP) has been commissioned by Norfolk County Council (NCC 'the Applicant') to undertake an aquatic ecology assessment in relation to the proposed Norwich Western Link Road (hereafter referred to as the 'Proposed Scheme'). The Proposed Scheme is a highway scheme linking the A1270 Broadland Northway from its junction with the A1067 Fakenham Road to the A47 trunk road near Honingham.

The Proposed Scheme will interact with multiple watercourses, including the River Wensum and its flood plain, which will be crossed by means of a viaduct. In addition, at least six other structures are proposed to cross minor roads and to provide habitat connectivity (e.g., bat highways). The Scheme will include ancillary works such as provision for non-motorised users, necessary realignment of the local road network, including the stopping-up of some minor roads, and the provision of environmental mitigation measures.

This report describes the findings of a desk study and aquatic ecology surveys carried out on the River Wensum, the Wensum floodplain ditch network and Foxburrow Stream, to describe the aquatic ecology baseline condition of these watercourses. Surveys assessed the macrophyte community, aquatic macroinvertebrate and fish populations. Survey locations were identified in the desk study as having the potential to be affected by the Proposed Scheme. These locations (hereafter referred to as the 'Survey Area'), were chosen because of their hydrological connectivity, proximity to or crossing by the Proposed Scheme's route.

The aquatic macroinvertebrate surveys involved three three-minute kick and two bankside-sweep sampling surveys within the Survey Area. Red-legged moss beetle Hydraena rufipes was identified in the Wensum floodplain ditches. The beetle has a Notable conservation status and is scarce in Great Britain. A representative assessment of the River Wensum indicated a diverse macrophyte community was present at the survey location. The River Wensum macrophyte community was dominated by clasping-leaved pondweed Potamogeton perfoliatus. A representative assessment of the Foxburrow stream indicated a simple macrophyte community at the survey location, dominated by fool's watercress Apium nodiflorum. The fish surveys on the River Wensum found no notable or protected species. However,

brook/river lamprey ammocetes were caught on the Wensum floodplain ditches. Brook lamprey Lampetra planeri are an Annex II qualifying feature of the River Wensum SAC. No fish were caught on the Foxburrow Stream within the Survey Area.

The baseline condition will inform further assessments, such as the Water Framework Directive Assessment (WFDa), the Environmental Statement (ES), the Outline Construction Environmental Management Plan (OCEMP) and the final Construction Environmental Management Plan (CEMP).

# 1 Introduction

## 1.1 Project Background

1.1.1 The Norwich Western Link Road (NWL) is a highway scheme linking the A1270 Broadland Northway from its junction with the A1067 Fakenham Road to the A47 trunk road near Honingham.

1.1.2 The NWL, hereafter referred to as the Proposed Scheme, will comprise:

- Dualling the A1067 Fakenham Road westwards from its existing junction with the A1270 to a new roundabout located approximately 400m to the northwest.
- Construction of a new roundabout.
- Constructing a dual carriageway link from the new roundabout to a new junction with the A47 near Honingham.

1.1.3 As part of a separate planned scheme, Highways England proposes to realign and dual the A47 from the existing roundabout at Easton to join the existing dual carriageway section at North Tuddenham. This scheme was consented in August 2022 and National Highways will construct the Honingham junction, with the Proposed Scheme as per section 1.1.2, connecting to the north-eastern side of that junction.

1.1.4 The Scheme will cross the River Wensum and its floodplain by means of a viaduct. The Scheme will also cross four minor roads by means of overpass or underpass bridges. The Scheme will include ancillary works such as provision for non-motorised users, necessary realignment of the local road network and the provision of environmental mitigation measures.

## 1.2 Ecological Background

1.2.1 This report presents the results of the aquatic ecology survey programme of the River Wensum and Foxburrow stream completed in 2022. Baseline surveys of the River Wensum and floodplain were completed in 2020.

Additional surveys, which included a River Habitat Survey (RHS) and macrophyte survey on Foxburrow stream, were completed in 2021 (WSP UK Ltd., 2021a). Due to changes to the alignment and the age of some of the data, all survey types except RHS were repeated in 2022. RHS was replaced with a River Condition Assessment (RCA). RCA surveys were conducted to inform Biodiversity Net Gain assessments specific to rivers and streams, as part of the Biodiversity Metric 3.1, and the Water Framework Directive Assessment. An updated aquatic ecology desk study for the preferred route option is included in this report.

1.2.2 Aquatic ecology surveys were recommended based on identification of habitats with the potential to support notable and protected species groups that may be impacted by the Proposed Scheme both directly and indirectly. These habitats were originally identified following a Phase 1 Habitat Survey and the associated desk study (WSP UK Ltd., 2018).

1.2.3 The River Wensum's floodplain contains several ordinary watercourses (hereafter referred to as "ditches") connected to the main river that are to be crossed by the Proposed Scheme. Aquatic ecology surveys of these watercourses were repeated to inform the Biodiversity Chapter of the Environmental Statement and to inform additional assessments such as the Water Framework Directive Assessment (WFDa).

1.2.4 A culvert crossing of Foxburrow Stream, a tributary of the River Tud, is also proposed. Aquatic ecology surveys of this watercourse were also repeated to inform the impact assessment for the Biodiversity Chapter of the Environmental Statement and to inform additional assessments such as the WFDa.

## 1.3 Brief and Objectives

1.3.1 WSP UK Ltd was commissioned by NCC to complete an updated desk study and repeat programme of aquatic ecology surveys to fulfil the following objectives:

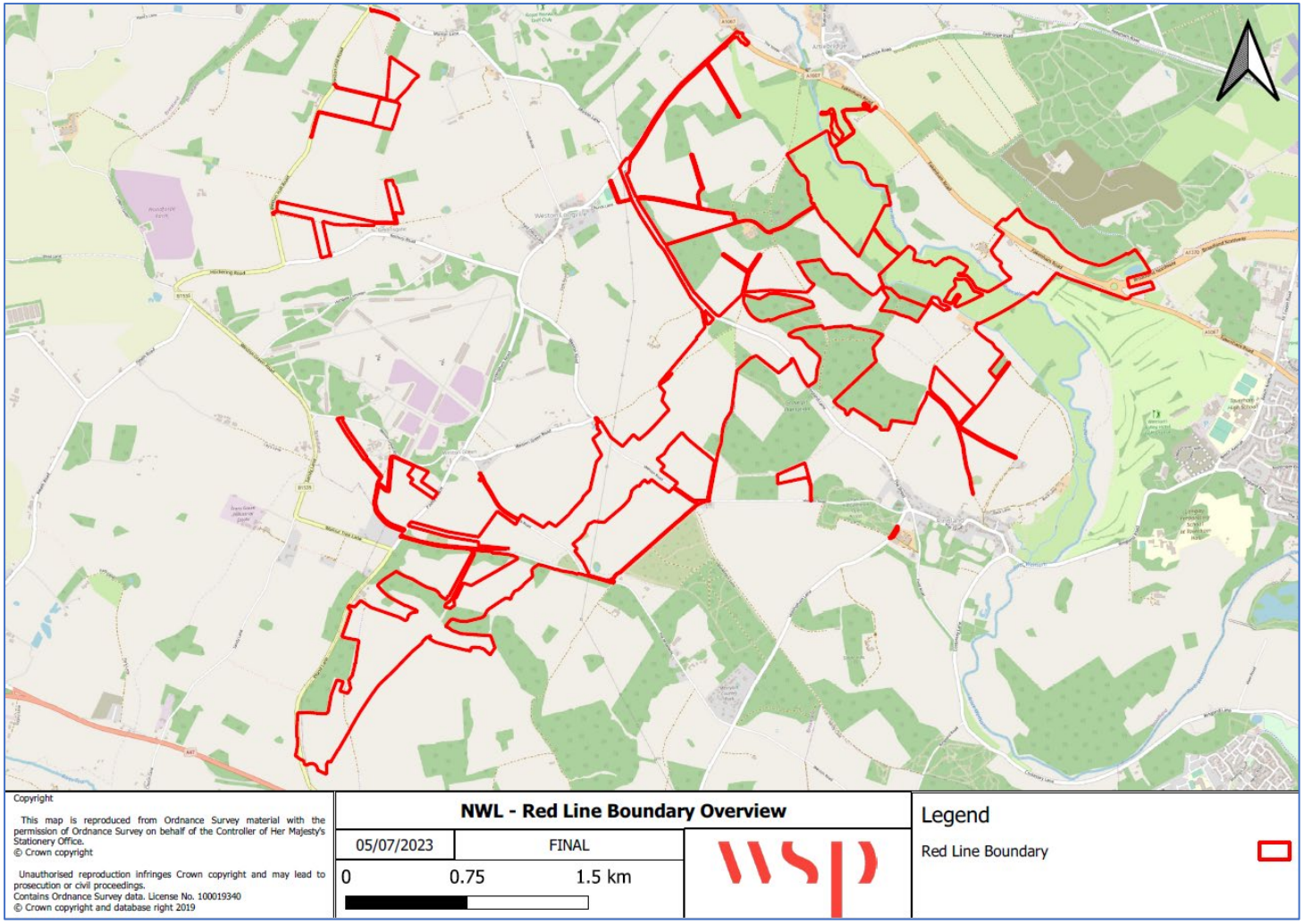
- To determine the presence/likely absence of protected and/or notable species in an updated study area informed by the refined alignment; and
- To present the findings of the surveys in a baseline report.

1.3.2 The findings of the desk study and surveys will be used to inform the impact assessment and the proposed mitigation for aquatic ecology, which are to be presented within the Biodiversity Chapter of the Environmental Statement (ES) for the Proposed Scheme and additional assessments such as the WFDa.

## 1.4 Survey Area

1.4.1 The ‘Survey Area’, as it is referred to hereafter, includes the locations at which aquatic surveys were completed, and is shown in Figure 3-1, Figure 3-2 and Figure 3-3. The Survey Area includes the location of the proposed viaduct where it crosses the River Wensum and hydrologically connected watercourses within its floodplain, as well as the culvert crossing point of Foxburrow Stream.

**Figure 1-1 Map displaying the Proposed Scheme Red Line Boundary**



# 2 Relevant Legislation

## 2.1 Legal Compliance

2.1.1 Watercourses of plain to montane levels with Ranunculion fluitantis and Callitricho-Batrachion vegetation are an Annex I habitat and a primary reason for the designation of the River Wensum as a Special Area of Conservation (SAC) (JNCC, 2019a) under The Conservation of Habitats and Species Regulations 2017 (HMSO, 2019a).

2.1.2 Such habitats are designated as Sites of Community Importance (SCIs) and included in the Natura 2000 network (now referred to as National Network Sites following the UK's exit from the European Union) (DEFRA, 2021). These sites must be managed in accordance with the ecological needs of the features that characterise them.

2.1.3 The River Wensum is designated as a Site of Special Scientific Interest (SSSI), as specified under the Wildlife and Countryside Act (WCA) (as amended) 1981 (HMSO, 1981). The purpose of this SSSI designation is to safeguard the diversity and geographic range of habitats, species, geological and physiographic features. Public bodies have a statutory duty to take reasonable steps, consistent with the proper exercise of its functions, to further the conservation and enhancement of the special scientific interest of SSSIs.

2.1.4 The Natural Environment and Rural Communities (NERC) Act 2006 reinforces the duty upon all public authorities, including planning authorities, to have regard for the conservation of biodiversity when discharging their duties. Whilst not yet in force, the Environment Act 2021 proposes that this duty should be supplemented to also have regard to the enhancement of biodiversity. The NERC Act refines the definition of biodiversity conservation, stating that it includes restoring or enhancing a population or habitat. Section 41 of the NERC Act requires the Secretary of State to list habitats and species of principal importance (HPIs and SPIs) for the conservation of biodiversity in

England. The habitats and species listed in accordance with Section 41 largely replicate those listed on the UK Biodiversity Action Plan (BAP) which occur in England.

2.1.5 The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater, and for all waterbodies (unless artificial or heavily modified) to achieve "good" ecological status by [2027]. This is a retained EU law following the United Kingdom's exit from the EU, in line with The Floods and Water (Amendment etc.) (EU Exit) Regulations 2019 (HMSO, 2019b).

2.1.6 Ecological Status is expressed in terms of five classes (High, Good, Moderate, Poor or Bad) (HMSO, 2015). These classes are based on specific criteria and boundaries defined against biological, physico-chemical and hydromorphological quality elements. Biological assessment uses numeric measures of communities of aquatic plants and animals, including fish. The overall Ecological Status of a water body is determined by its poorest quality element. For example, a water body's chemical and physico-chemical quality elements might be classed as 'Good' but the biological element classed as 'Moderate Status'. In this case it would be classed overall as 'Moderate Ecological Status'. To achieve the overall aim of Good surface water status, the Directive requires that surface waters be of at least Good Ecological Status and Good Chemical Status. To achieve High Status, the Directive requires that the hydromorphological quality elements are also in place. When considering the impact of a development or activity on a waterbody it is a regulatory requirement under the WFD to assess if it will cause or contribute to a deterioration in status or jeopardise the waterbody achieving Good status by 2027.

# 3 Methods

## 3.1 Desk Study

3.1.1 A desk study was undertaken in October 2022 to update information from previous reports (WSP UK Ltd., 2018; 2020; 2021a; 2021b; 2021c) used to inform route options for the Proposed Scheme. The desk study was conducted to review relevant existing ecological baseline information available in the public domain, to obtain information held by relevant third parties and confirm the Survey Area. For the purpose of the desk study exercise, records were collated from various radii, based on hydrologically connectivity to the Survey Area. This approach is consistent with current good practice guidance published by CIEEM (2017).

Designated Nature Conservation Sites

3.1.2 Freely downloadable datasets (available from Natural England) were consulted for information regarding the presence of statutory designated sites within 2km of the Survey Area. This search was extended to 10km for Natura 2000 sites (Special Areas of Conservation (SAC) and Special Protection Areas (SPA)) of European importance and internationally designated Ramsar sites).

Water Framework Directive

3.1.3 The current Water Framework Directive (WFD) status for the catchment within which the Site is located was obtained from the Environment Agency's Catchment Data Explorer website (Environment Agency, 2022a).

Environment Agency Records

3.1.4 A search of the Environment Agency's Ecology and Fish Data Explorer was completed to identify any existing aquatic ecology survey data relevant to the Proposed Scheme (Environment Agency, 2022b).

## 3.2 Aquatic Macroinvertebrate Survey

Field Survey and Processing

3.2.1 Aquatic macroinvertebrate surveys were undertaken on 25 May 2022 (spring) and repeated on 09 September 2022 (autumn).

3.2.2 Five locations for aquatic macroinvertebrate surveys were chosen based on the Proposed Scheme's footprint and hydrological connectivity. The two locations on the Wensum are located upstream and downstream of the viaduct crossing. The locations on Ditch C and Foxburrow stream are crossed by the route, and the location on Ditch B is in close proximity to the route. The sampling site grid references are provided in Table 3-1. Sample locations are shown in Figure 3-1.

**Table 3-1 Aquatic macroinvertebrate sampling locations and National Grid References**

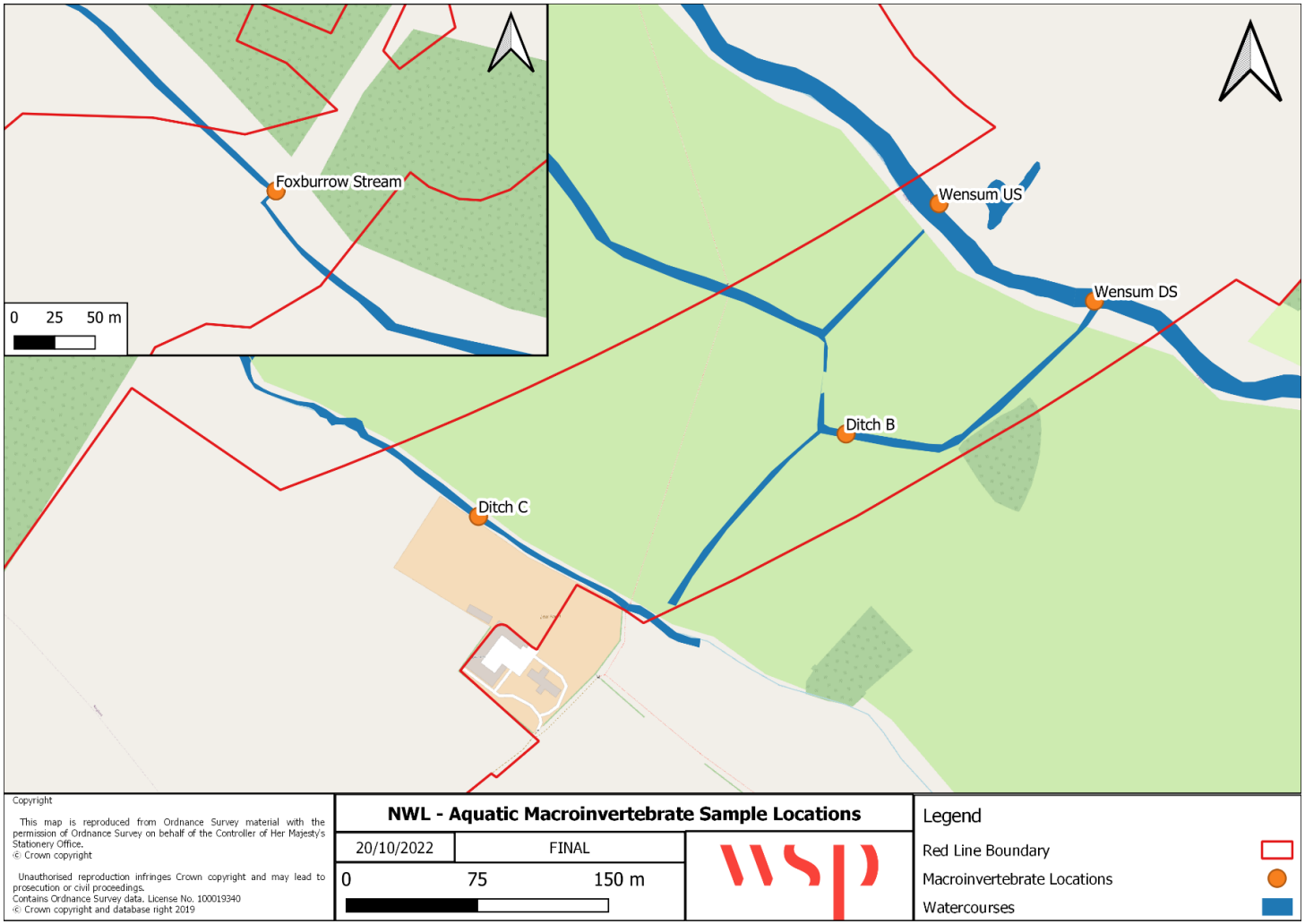
| Site | NGR |
|---|---|
| River Wensum Upstream | TG 14015 15463 |
| River Wensum Downstream | TG 14118 15368 |
| Ditch B | TG 13993 15297 |
| Ditch C | TG 13802 15233 |
| Foxburrow Stream | TG 10517 13346 |

3.2.3 Aquatic macroinvertebrate samples were collected using standard three-minute kick sampling of all in channel habitats in proportion to their occurrence on Ditch B, Ditch C and Foxburrow stream. These surveys were carried out using a standard sampling net (1mm mesh), with a one-minute timed hand search following the Environment Agency (2017) procedure. This sampling method conforms to BS EN ISO 10870:2012 Water Quality – Guidelines for the selection of sampling methods and devices for benthic macroinvertebrates in fresh waters (British Standards Institution, 2012). Due to the depth of the River Wensum, the three-minute kick sample method was not suitable, therefore both samples were collected via bankside sweep.

3.2.4 A standardised field sheet was completed to record details of channel and bank physical habitat (bank material, substrate, flow types, channel features, bank structure), riparian land use and potential sources of anthropogenic stress.

3.2.5 Samples were placed in one-litre sample pots, preserved in Industrial Denatured Alcohol (IDA) on site and transported to the laboratory for sorting and identification to Taxonomic Level 5, in adherence with Environment Agency (2014) procedures.

**Figure 3-1 – Map displaying aquatic macroinvertebrate sampling sites and locations**



**Biological Metrics**

3.2.6 The use of biological metrics allowed the assignation of ecological values to the aquatic macroinvertebrate communities observed, and an assessment of pressures on those communities to be made.

River Invertebrate Classification Tool

3.2.7 The River Invertebrate Classification Tool (RICT) determines the ecological condition of a given watercourse based on a comparison of aquatic macroinvertebrate communities observed at each sampling location, with the aquatic macroinvertebrate communities observed at reference sites (Davy-Bowker et al, 2008). RICT reference sites are deemed to be as close as possible to pristine conditions and not impacted by environmental stressors such as pollution, habitat modification or flow stress. Reference sites provide an expected aquatic macroinvertebrate community score for that river type. The observed aquatic macroinvertebrate community score at a given watercourse is divided by the expected community score. Reference and bias adjustments are then applied to obtain the Ecological Quality Ratio (EQR). RICT can derive EQR scores for a number of biological metrics. These metrics are discussed further below.

Whalley, Hawkes, Paisley and Trigg

3.2.8 The Whalley, Hawkes, Paisley and Trigg (WHPT) metric (UKTAG, 2014) is based on the tolerance of different aquatic macroinvertebrates to organic pollution. Each aquatic macroinvertebrate family is assigned a score from -1.6 to 13, depending on their tolerance to pollution and abundance category (on a continuous scale, -1.6 is for highly abundant pollution-tolerant taxa, 13 is for highly abundant pollution-intolerant taxa) and an overall score is produced from the total. The WHPT index is widely used to determine the ecological water quality of running waters and specifically the detection of organic pollution. As such, any extrapolation of other water quality pressures should be undertaken with caution.

3.2.9 The Average Score Per Taxon (ASPT) is derived from the WHPT index. By dividing the total WHPT score by the number of scoring taxa present (NTAXA), the average score per taxon can be calculated. This metric is more easily comparable with other sites and enables an assessment of biological water quality that is less influenced by the presence of a greater proportion of low scoring taxa or sampling effort than the overall WHPT score. In both the case of WHPT score and ASPT, higher scores indicate better ecological quality.

Lotic-invertebrate Index for Flow Evaluation

3.2.10 Aquatic macroinvertebrates have specific requirements for flow conditions and can be used to determine not only predominant flow types (Extence et al., 1999), but also changes in flow character. The Lotic-invertebrate Index for Flow Evaluation (LIFE) metric uses abundance data to assign a flow preference score to aquatic macroinvertebrate families present in a sample and an overall score for the sampling site can be interpreted as an abundance-weighted average score per taxon metric. The family-level LIFE score is calculated in RICT as a ratio of the observed/expected at reference sites (O/E) for the sample.

3.2.11 There are currently no WFD-related class boundaries for LIFE EQRs, but a threshold of 0.94 is used to indicate the presence of flow stressed aquatic macroinvertebrate communities (Environment Agency, 2012).

Proportion of Sediment-sensitive Invertebrates

3.2.12 The Proportion of Sediment-sensitive Invertebrates (PSI) metric acts as a proxy for the quantity of fine sediment at a site (Extence et al., 2011). Aquatic macroinvertebrate species are assigned a fine sediment sensitivity rating that ranges from highly insensitive to highly sensitive to fine sediment. The PSI score is calculated as the percentage of sensitive taxa in the sample and used to indicate how sedimented a watercourse is, from minimally sedimented/un-sedimented to heavily sedimented (Table 3-2).

**Table 3-2 – Proportion of Sediment-sensitive Invertebrates (PSI) scores and interpretation**

| PSI Score | Riverbed condition |
|---|---|
| 81 – 100 | Minimally sedimented / un-sedimented |
| 61 – 80 | Slightly sedimented |
| 41 – 60 | Moderately sedimented |
| 21 – 40 | Sedimented |
| 0 – 20 | Heavily sedimented |

3.2.13 There are currently no WFD-related class boundaries for PSI EQRs, but a threshold of 0.70 is used to indicate the presence of low stressed aquatic macroinvertebrate communities (Turley et al., 2016).

Community Conservation Index

3.2.14 The diversity and conservation interest of an aquatic macroinvertebrate community at each sampling site can be represented by analysing species level data through the Community Conservation Index (CCI). The CCI incorporates elements of taxon rarity and richness to summarise the conservation value of aquatic macroinvertebrate communities (Chadd and Extence, 2004). Scores defined within Chadd and Extence (2004) are assigned to species within the sample to derive a total sample conservation score which infers a conservation value from the criteria listed in Table 3-3.

**Table 3-3 – Community Conservation Index (CCI) scores and classification descriptions**

| Conservation Score | Conservation Classification | Description |
|---|---|---|
| 0 ≤ 5 | Low | Sites supporting only common species and/or a community of low taxon richness. |
| 5 ≤ 10 | Moderate | Sites supporting at least one species of restricted distribution and/or a community of moderate taxon richness. |
| 10 ≤ 15 | Fairly high | Sites supporting at least one uncommon species, or several species of restricted distribution and/or a community of high taxon richness. |
| 15 ≤ 20 | High | Sites supporting several uncommon species, at least one of which may be nationally rare and/or a community of high taxon richness. |
| > 20 | Very high | Sites supporting several rarities, including species of national importance, or at least one extreme rarity (such as taxa included in the British RDBs) and/or a community of very high taxon richness (potentially of national significance and may merit statutory protection). |

Water Framework Directive Aquatic Macroinvertebrate Classification

3.2.15 The WFD uses the pollution sensitivity (WHPT ASPT) and aquatic macroinvertebrate richness (WHPT NTAXA) EQR scores to determine whether a watercourse meets Good Ecological Status, as required under the WFD.

3.2.16 There are five ecological status classes: Bad, Poor, Moderate, Good and High.

3.2.17 Where an aquatic macroinvertebrate community is recorded at, or above Good Ecological Status, then biological or physical pressures including flow and anthropogenic pollution are not assumed to be affecting aquatic ecology.

3.2.18 Watercourses failing to meet Good Ecological Status for aquatic macroinvertebrates may be influenced by a variety of stressors, and EQRs

can be interrogated to determine the likely cause of failure to meet Good Ecological Status.

3.2.19 For WFD classification the lower scoring of these EQR scores determines the aquatic macroinvertebrate classification of a given site.

3.2.20 A relative WFD class was calculated from the aquatic macroinvertebrate community identified at each of the five sample locations for comparison purposes.

## 3.3 Macrophyte Survey

Field Survey

3.3.1 Macrophyte surveys were undertaken on 15 and 16 August 2022. Three sampling locations were chosen based on where there are route crossings of the Wensum, Ditch C and Foxburrow Stream. A fourth location was chosen due to the Proposed Scheme realignment no longer crossing Hall Ditch, therefore the next closest Ditch (Ditch B) was surveyed. The sampling site grid references are provided in Table 3-4. Survey locations are shown in Figure 3-2.

**Table 3-4 - National Grid References for macrophyte survey locations**

| Site | Upstream NGR | Downstream NGR |
|---|---|---|
| River Wensum | TG 14042 15415 | TG 14128 15371 |
| Foxburrow Stream | TG 10491 13370 | TG 10531 13310 |
| Ditch B | TG 13966 15290 | TG 13907 15226 |
| Ditch C | TG 13765 15260 | TG 13857 15203 |

3.3.2 The Survey Area on the River Wensum included the length and width of river that the proposed viaduct will cross, and an additional approximate 30m either side of the crossing.

3.3.3 All surveys were carried out using the Water Framework Directive UK Technical Advisory Group's methodology for assessing macrophytes in rivers (WFDUKTAG) (WFDUKTAG, 2014). This method conforms with CEN 14184:

2003 Water Quality – Guidance standard for the surveying of aquatic macrophytes in running waters.

3.3.4 The methodology specifies that a 100m stretch of the watercourse should be sampled between 01 June and 30 September and that sampling should not be completed during or immediately after high flows.

3.3.5 The presence of all macrophytes present with the Survey Area were recorded to species level where possible. Where this was not possible species were recorded under its genus or other aggregate taxon level.

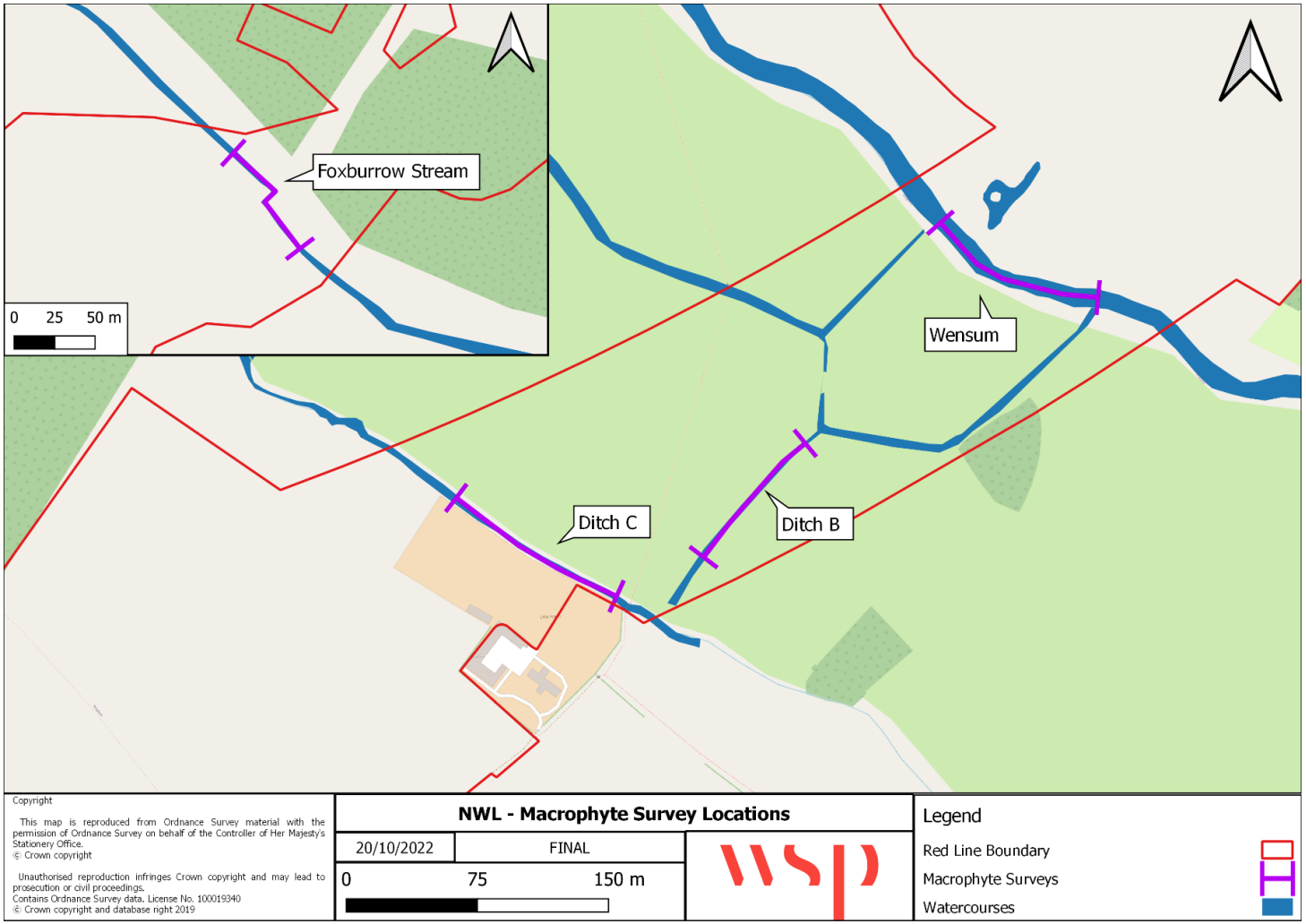
3.3.6 The percentage of the river channel (up to the height of bank that would typically be submerged for >50 % of the year) covered by each species was estimated by assigning it an appropriate taxon cover value, as detailed in Table 3-5.

**Table 3-5 - Cover values for lotic macrophyte taxa.**

| Percentage cover range (% of channel area) | Taxon cover level | Mid-point percentage |
|---|---|---|
| <0.1 | 1 | 0.05 |
| 0.1<1 | 2 | 0.5 |
| 1<2.5 | 3 | 1.7 |
| 2.5<5 | 4 | 3.8 |
| 5<10 | 5 | 7.5 |
| 10<25 | 6 | 17.5 |
| 25<50 | 7 | 37.5 |
| 50<75 | 8 | 62.5 |
| ≥75 | 9 | 87.5 |

3.3.7 Biological indices were not calculated for Ditch B and Ditch C due to their function as drainage ditches and poor compatibility with the River Predictions and Classification Systems for Macrophytes (LEAFPACS2) classification tool (refer to paragraph 3.3.15). Percentage cover range and Ellenberg Light Indicator values were recorded. This data can be found in Appendix B.

**Figure 3-2 – Map displaying macrophyte survey locations**



## 3.4 Biological Indices

3.4.1 The condition of the River Wensum and Foxburrow stream macrophyte community within the Survey Area was assessed by calculating various indices using data recorded during the field survey. These indices are detailed in the following paragraphs within this section.

River Macrophyte Nutrient Index (RMNI)

3.4.2 The RMNI is a measure of the plants that grow in the river and their association with high nutrient levels. It is measured on a scale from 1-10.

3.4.3 Each scoring macrophyte taxon was assigned its corresponding RMNI species score. RMNI was then calculated using the equation:

$$RMNI = \frac{\sum_{j=1}^{n}(C_j x\ R_j)}{\sum_{j=1}^{n} C_j}$$

where:

- 'Rj' is the river macrophyte nutrient index score for taxon 'j';
- 'j' represents a scoring taxon and has a value of 1 to 'n' indicating which taxon it represents; and,
- 'Cj' is the taxon cover value for taxon 'j'.

Number of Macrophyte Taxa (NTAXA)

3.4.4 NTAXA is the number of truly aquatic (non-helophyte) scoring taxa recorded in the field survey, which is used as a measure of diversity.

Number of Functional Groups (NFG)

3.4.5 NFG is a diversity metric calculated by assigning all truly aquatic (non-helophyte) scoring taxa to one of 24 'functional groups'. The NFG value is given by the sum of the number of different functional groups of taxa that were identified as being present in the river.

Cover of Green Filamentous Algae (ALG)

3.4.6 ALG is the percentage cover of green filamentous algae over the whole survey section. This was calculated by adding up the mid-point percentage cover values for all algae species identified as being present.

3.4.7 The value for the parameter ALG represents the total coverage of the riverbed by green filamentous algae and will range from 0-100. This metric is used as a measure of nutrient enrichment.

## 3.5 River Predictions and Classification Systems for Macrophytes (LEAFPACS2)

3.5.1 The River LEAFPACS2 classification tool was used to contextualise RMNI, NTAXA, NFG, and ALG metric scores. Ecological Quality Ratios (EQRs) are derived from these metrics based on observed data and site-specific predicted reference values derived from the physical and chemical parameters listed in Table 3-6.

**Table 3-6 - Predictive reference parameters for LEAFPACS2**

| Invariant data | Variant data |
|---|---|
| National Grid Reference (NGR) | Alkalinity |
| Slope | Not applicable |
| Distance from source | Not applicable |
| Altitude | Not applicable |

3.5.2 EQRs are normalised so they fit the same scale and combined to provide an overall EQR representing an ecological status class as defined by the WFD ('High', 'Good', 'Moderate', 'Poor' and 'Bad'). The class boundaries are outlined in Table 3-7 below.

**Table 3-7 - River LEAFPACS2 class boundaries**

| Status class boundary | EQR |
|---|---|
| High/Good | 0.8 |
| Good/Moderate | 0.6 |

| Status class boundary | EQR |
|---|---|
| Moderate/Poor | 0.4 |
| Poor/Bad | 0.2 |

Ellenberg Light Indicator Values

3.5.3 Ellenberg light indicator values score flora along gradients reflecting various habitat preferences (Ellenberg et al. 1991). The purpose of these indicator values is to assess the ecological niche of regional flora. The values and associated tolerances are described in Table 3-8.

**Table 3-8 - Ellenberg light indicator values and descriptions (Ellenberg et al. 1991)**

| Value | Description |
|---|---|
| 1 | Plant in deep shade |
| 2 | Between 1 and 3 |
| 3 | Shade plant, mostly less than 5% relative illumination, seldom more than 30% illumination when trees are in full leaf |
| 4 | Between 3 and 5 |
| 5 | Semi-shade plant, rarely in full light, but generally with more than 10% relative illumination when trees are in leaf |
| 6 | Between 5 and 7 |
| 7 | Plant generally in well-lit places, but also occurring in partial shade |
| 8 | Light-loving plant rarely found where relative illumination in summer is less than 40% |
| 9 | Plant in full light, found mostly in full sun |

## 3.6 Fish Surveys

3.6.1 Three survey locations were chosen based on where there are route crossings of the Wensum, Ditch C and Foxburrow Stream.

3.6.2 A 40-minute timed catch per unit effort (CPUE) electric fishing survey was conducted over a 150m stretch of the River Wensum between NGRs TG 14012 15454 and TG 13841 15598 (see Figure 3-3) on 31 August 2022. The survey was carried out from a boat by a two-person fishing team using a

single anode with a generator powered control box system operated from the boat.

3.6.3 A qualitative (presence/likely absence) electric fishing survey was conducted over a 100m stretch of the ditch network crossed by the proposed viaduct between NGRs TG 13711 15295 and TG 13652 15321 (see Figure 3-3) on 31 August 2022. The survey was carried out by a two-person fishing team who waded the watercourse whilst sampling using an E-Fish 500W Backpack System until a representative catch was collected.

3.6.4 A quantitative single run electric fishing survey was conducted over a 100m stretch of Foxburrow Stream between NGRs TG 10532 13314 and TG 10494 13367 (see Figure 3-3) on 01 September 2022. The survey was carried out by a two-person fishing team who waded the watercourse whilst sampling using an E-Fish 500W Backpack System.

3.6.5 Electric fishing is the term applied to a process that establishes an electric field in the water in order to capture fish. When exposed to the field, most fish become oriented toward the anode and as the density of the electric field increases, they swim toward it. In close proximity to the anode, they are immobilised.

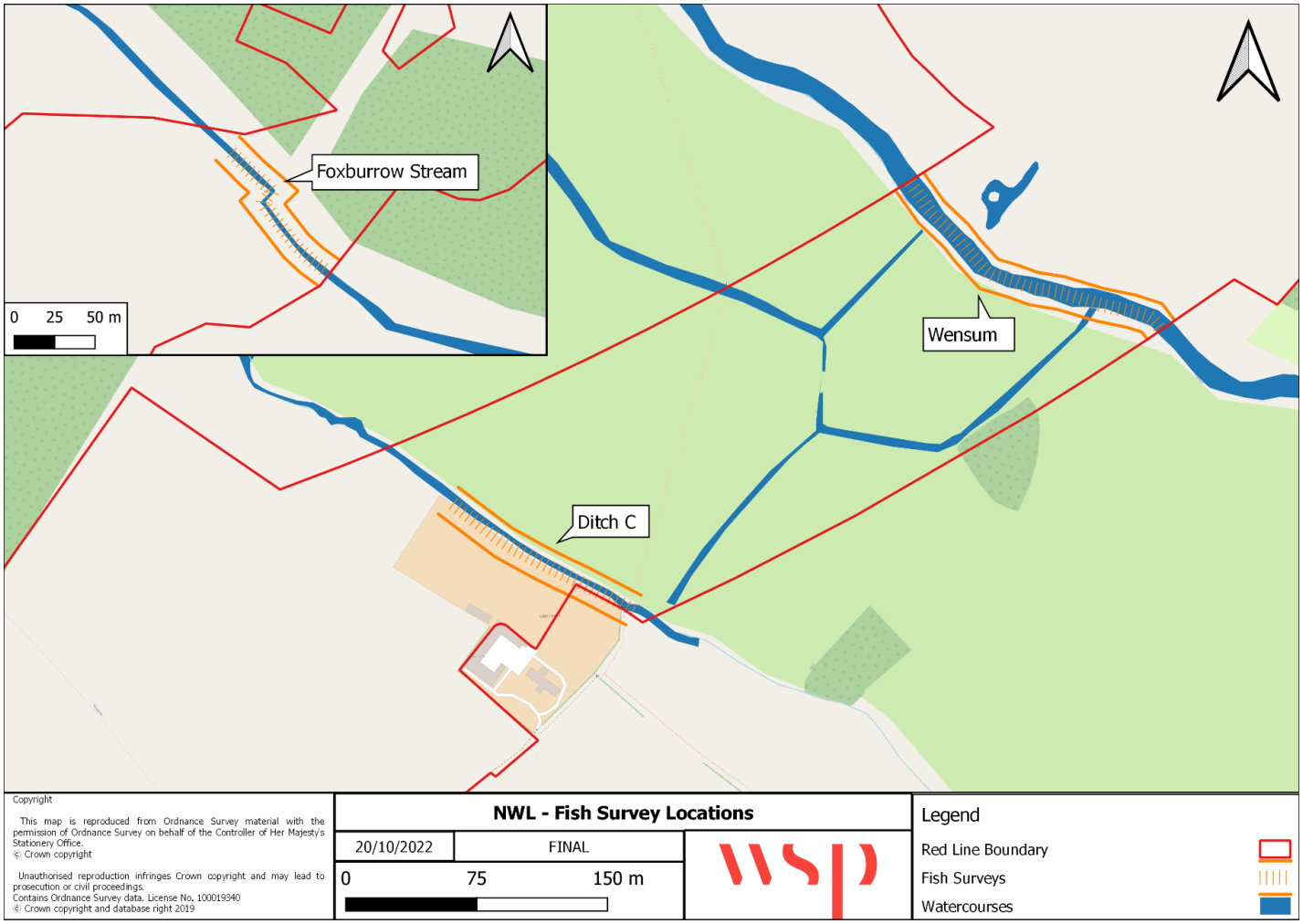
3.6.6 Electric fishing methods and techniques following guidelines developed by the Environment Agency (Beaumont et al., 2002; EA, 2001; EA, 2007) and which conformed to British Standard BS EN 14011:2003 Water Quality. Sampling of Fish with Electricity (British Standards Institution, 2003).

3.6.7 During all surveys, one surveyor moved the anode side to side and up and down to “draw” fish towards the current. The second surveyor removed immobilised fish from the electrical field with the use of a dipnet.

3.6.8 Following capture, fish were transferred to an aerated container from which they were identified to species level, measured from the tip of their snout to the end of the middle caudal fin rays (fork length), before being returned safely to the watercourse.

3.6.9 Once each electric fishing had ceased, a fish habitat survey was carried out. These surveys included an assessment of water depth channel width, flow types, substrate composition and bank characteristics. The vegetation types present, percentage canopy cover and percentage fish cover, were also recorded.

**Figure 3-3 – Map displaying fish survey locations**



## 3.7 Notes and Limitations

3.7.1 Every effort has been made to provide a comprehensive description of the aquatic habitats and communities within the Survey Area; however, the following specific limitations apply to this assessment:

- Ecological survey data is typically valid for 12 to 18 months unless otherwise specified. The likelihood of surveys needing to be updated increases with time and is greater for mobile species or in circumstances where the habitat or its management has changed significantly since the surveys were undertaken. Factors to be considered include (but are not limited to): whether a site supports, or may support, a mobile species which could have moved on to site, or changed its distribution within a site (CIEEM, 2019).
- Further surveys were not carried out on the unnamed ditch located at NGR TG 14094 15467 due to the presence of a high fence and hedgerow preventing access to the channel. A visual habitat assessment was conducted as part of a habitat condition assessment, which indicated the ditch had a poor habitat condition score. The ditch also showed signs of eutrophication, with extensive duckweed and algae cover observed.
- The aquatic macroinvertebrate sampling methods used were selected to provide the data necessary for the calculation of a range of biological quality indices. It is not intended that the sampling methods will capture a full list of all species present within the water body, which will vary according to season and abundance of individual species. Identification to species level is not always possible where juvenile or damaged specimens are present in the sample, or are not identified to species level as standard. Nevertheless, through the calculation of appropriate indices, it is possible to evaluate the biological quality of the waterbody in relation to others.

# 4 Results

## 4.1 Desk Study

Designated Nature Conservation Sites

4.1.1 Two statutory designated nature conversation sites of interest were identified within 2km of the Survey Area:

- River Wensum SAC; and,
- River Wensum SSSI.

4.1.2 There are no additional designated sites with aquatic species as a primary reason for selection or as a qualifying feature within 2km of the Survey Area.

River Wensum Special Area of Conservation

4.1.3 One of the primary reasons for the selection of this site as a Special Area of Conservation (SAC) is Annex I habitat consisting of 'watercourses of plain to montane levels with Ranunculion fluitantis and Callitricho-Batrachion vegetation' (JNCC, 2019a).

4.1.4 This habitat type (hereafter referred to as 'HT 3260') is characterised by the abundance of water-crowfoots Ranunculus spp., subgenus Batrachium. Floating mats of these white-flowered species are characteristic of river channels in early to mid-summer. They may modify water flow, promote fine sediment deposition, and provide shelter and food for fish and invertebrate animals (JNCC, 2019b).

4.1.5 White-clawed crayfish Austropotamobius pallipes, an Annex 2 species, are a primary reason for the selection of this site as a SAC. As with most of the remaining crayfish populations in the south and east of England, the threats from non-native crayfish species and crayfish plague are severe. Designation of the river as a SAC provides protection to these vulnerable populations.

4.1.6 Bullhead Cottus gobio, brook lamprey Lampetra planeri and Desmoulin's whorl snail Vertigo moulinsiana are all Annex 2 species present as a qualifying feature of the SAC, but not as a primary reason for site selection.

River Wensum Site of Special Scientific Interest

4.1.7 The River Wensum has been selected as a Site of Special Scientific Interest (SSSI) as an example of an enriched, calcareous lowland river. Whilst the river is of rich ecological and cultural value in its present state, the condition of the River Wensum SSSI aquatic units is currently regarded as being "Unfavourable – Recovering".

4.1.8 The Wensum has an abundant and diverse mollusc community which includes the nationally rare, Desmoulin's whorl snail, a species associated with aquatic vegetation at the river edge. Two other aquatic molluscs which occur, *Valvata piscinalis* and *Gyraulus albus*, have a localised distribution in England. Water beetles are well represented within the diverse macroinvertebrate community; *Brychnus elevatus*, of localised distribution in England, is found in deep slow-flowing sections of the river. The mayflies *Ephemerella ignita*, *Caenis luctuosa*, *Centroptilium luteolum* and *Centroptilium pennulatum* are also notable as they are of local distribution. There is a species of stonefly, *Amphinemura standfussi*, more usually associated with upland rivers. The flatworm *Crenobia alpina* is of note, being a relict in southern England where it is confined to cold-water springs (Natural England, 1993).

## 4.2 Environment Agency Records

Aquatic Macroinvertebrates

4.2.1 A search of the Environment Agency Fish and Ecology Data Explorer website revealed the nearest Environment Agency aquatic macroinvertebrate monitoring location on the River Wensum is located approximately 1.63km upstream of the River Wensum upstream site.

4.2.2 The most recent data from this monitoring location are from a survey carried out in spring 2021 at NGR TG 12918 16356. No autumn survey data are available from this location. The biological metrics derived from Environment Agency survey data collected at this location are displayed in Table 4-1.

**Table 4-1 – Environment Agency aquatic macroinvertebrate biological metrics for the River Wensum 2021**

| Date | WHPT-ASPT | WHPT-NTAXA | LIFE (TL5) | PSI (TL5) | CCI (TL5) |
|---|---|---|---|---|---|
| 26/03/2021 | 5.04 | 32 | 6.31 | 23.64 | 13.72 |

4.2.3 No protected species were identified in the sample, however the invasive non-native species (INNS) New Zealand mud snail *Potamopyrgus antipodarum* was recorded.

4.2.4 The PSI scores classify the River Wensum at this monitoring location as Sedimented, while the CCI scores classify the monitoring location as having Fairly High conservation value. The LIFE score indicates the predominant presence of taxa associated with slow flowing water but is above the threshold that indicates flow may be a possible pressure acting on the macroinvertebrate community present. The WHPT-ASPT score indicates a mixed community of both pollution tolerant and intolerant taxa.

4.2.5 The nearest Environment Agency monitoring location to the Foxburrow Stream aquatic macroinvertebrate sampling site is on the River Tud, approximately 8km downstream at NGR TG 16987 11267. Foxburrow Stream joins the River Tud approximately 3km downstream of the proposed culvert crossing. The biological metrics derived from Environment survey data collected at this location are displayed in Table 4-2.

**Table 4-2 – Environment Agency aquatic macroinvertebrate biological metrics for the River Tud 2019**

| Date | WHPT-ASPT | WHPT-NTAXA | LIFE (TL5) | PSI (TL5) | CCI (TL5) |
|---|---|---|---|---|---|
| 15/05/2019 | 6.13 | 30 | 7.54 | 55.26 | 12 |
| 05/11/2019 | 5.75 | 28 | 7.38 | 47.22 | 7.5 |

4.2.6 As with the River Wensum, no protected species were found in the River Tud, however, the New Zealand mud snail was present in both the spring and autumn samples.

4.2.7 The PSI scores classify the River Tud at this site as Moderately Sedimented and the CCI scores indicate a conservation value of Moderate to Fairly High. The LIFE scores indicate the predominant presence of taxa associated with moderate to high flowing water. The WHPT-ASPT scores indicate a mixed community of both pollution tolerant and intolerant taxa, with autumn producing a higher score and a more pollution sensitive community.

Macrophytes

4.2.8 Two Environment Agency macrophyte monitoring locations on the River Wensum were identified in the desk study. The nearest is located at NGR TG 12918 16356, approximately 1.7km upstream of the proposed viaduct crossing over the River Wensum. Results from the most recent survey at this location, undertaken on 11 August 2021, are displayed in Table 4-3 and Table 4-4.

4.2.9 The second macrophyte monitoring location is located approximately 7km downstream of the proposed viaduct crossing, at NGR TG 15970 13710. Results from the most recent surveys at this location, undertaken on 13 July 2017, are displayed in Table 4-5 and Table 4-6.

**Table 4-3 - Environment Agency macrophyte biometric data for the River Wensum 2021**

| Site | Date | RMHI | RMNI | NTAXA | NFG | RFA_PC |
|---|---|---|---|---|---|---|
| River Wensum | 11/08/2021 | 8.15 | 8.46 | 14 | 10 | 7.50 |

**Table 4-4 - Environment Agency macrophyte taxon list for River Wensum 2021**

| Taxon | Common Name | Taxon Cover Value |
|---|---|---|
| *Apium nodiflorum* | Fool's watercress | 2 |
| *Berula erecta* | Lesser water parsnip | 1 |
| *Butomus umbellatus* | Flowering rush | 3 |
| *Callitriche* sp. | Water-starwort | 1 |
| *Ceratophyllum demersum* | Rigid hornwort | 1 |

| Taxon | Common Name | Taxon Cover Value |
|---|---|---|
| *Cladophora glomerata/Rhizoclonium hieroglyphicum* | Filamentous algae (reticulated) | 5 |
| *Elodea nuttallii* | Nuttall's waterweed | 3 |
| *Fontinalis antipyretica* | Greater water-moss | 2 |
| *Glyceria maxima* | Reed sweet grass | 6 |
| *Lemna gibba* | Gibbous duckweed | 1 |
| *Lycopus* sp. | Gypsywort | 1 |
| *Mentha aquatica* | Water mint | 1 |
| *Myosotis scorpioides* | Water forget-me-not | 2 |
| *Persicaria hydropiper* | Water pepper | 2 |
| *Phalaris arundinacea* | Reed canary grass | 5 |
| *Potamogeton pectinatus* | Fennel pondweed | 5 |
| *Potamogeton perfoliatus* | Clasping-leaved pondweed | 6 |
| *Ranunculus sceleratus* | Celery-leaved buttercup | 2 |
| *Rorippa nasturtium-aquaticum* agg. | Watercress | 2 |
| *Sagittaria sagittifolia* | Arrowhead | 4 |
| *Solanum dulcamara* | Bittersweet | 1 |
| *Sparganium emersum* | European bur-reed | 5 |
| *Sparganium erectum* | Branched bur-reed | 5 |
| *Stachys palustris* | Marsh woundwort | 1 |
| *Schoenoplectus lacustris* | Common clubrush | 6 |
| *Veronica anagallis-aquatica* | Water speedwell | 3 |
| *Veronica beccabunga* | Brooklime | 2 |
| **No data** | **Total number of taxa** | 27 |

4.2.10 A total of five macrophyte species listed on the designation for HT 3260; lesser water parsnip *Berula erecta*, water-starwort *Callitriche* spp, greater water-moss *Fontinalis antipyretica*, fennel pondweed *Potamogeton*

*pectinatus*, and clasping-leaved pondweed *Potamogeton perfoliatus* were recorded in the Environment Agency survey.

4.2.11 The RMHI and RMNI scores indicate a community associated with low flow and high nutrient levels respectively. The RFA-PC score describes the percentage cover of green filamentous algae at the survey location.

4.2.12 One INNS, Nuttall's waterweed *Elodea nuttallii* was recorded during the Environment Agency survey.

**Table 4-5 - Environment Agency macrophyte biometric data for the River Wensum 2017**

| Site | Date | RMHI | RMNI | NTAXA | NFG | RFA_PC |
|---|---|---|---|---|---|---|
| River Wensum | 13/07/2017 | 8.12 | 8.14 | 18 | 12 | 1 |

**Table 4-6 - Environment Agency macrophyte taxon lists for the River Wensum 2017**

| Taxon | Common Name | Taxon Cover Value |
|---|---|---|
| *Apium nodiflorum* | Fool's watercress | 2 |
| *Berula erecta* | Lesser water parsnip | 3 |
| *Butomus umbellatus* | Flowering rush | 1 |
| *Callitriche* sp. | Water-starwort | 3 |
| *Cladophora* sp. | Filamentous algae (reticulated) | 2 |
| *Elodea nuttallii* | Nuttall's waterweed | 2 |
| *Epilobium hirsutum* | Hairy willowherb | 2 |
| *Fontinalis antipyretica* | Greater water-moss | 3 |
| *Glyceria maxima* | Reed sweet grass | 4 |
| *Impatiens glandulifera* | Himalayan balsam | 1 |
| *Iris pseudacorus* | Yellow iris | 2 |
| *Lemna gibba* | Gibbous duckweed | 2 |
| *Myosotis scorpioides* | Water forget-me-not | 2 |

| Taxon | Common Name | Taxon Cover Value |
|---|---|---|
| *Myriophyllum spicatum* | Spiked water milfoil | 2 |
| *Nuphar lutea* | Yellow waterlily | 3 |
| *Oenanthe fluviatilis* | River water dropwort | 2 |
| *Phalaris arundinacea* | Reed canary grass | 3 |
| *Potamogeton pectinatus* | Fennel pondweed | 2 |
| *Potamogeton perfoliatus* | Clasping-leaved pondweed | 3 |
| *Ranunculus (Batrachian)* spp. | Water-crowfoot | 4 |
| *Rorippa nasturtium-aquaticum* agg. | Watercress | 2 |
| *Sagittaria sagittifolia* | Arrowhead | 2 |
| *Sparganium emersum* | European bur-reed | 3 |
| *Sparganium erectum* | Branched bur-reed | 3 |
| *Stachys palustris* | Marsh woundwort | 2 |
| *Schoenoplectus lacustris* | Common clubrush | 6 |
| *Veronica anagallis-aquatica/Veronica catenata* | Water speedwell | 2 |
| Zygnematalean | Filamentous algae (unbranched) | 2 |
| **No data** | **Total number of taxa** | **28** |

4.2.13 Water-crowfoot *Ranunculus (Batrachian)* spp. was recorded in the survey, a species characteristic of the River Wensum SAC. In addition, six macrophyte species; lesser water parsnip, water-starwort, greater water-moss, fennel pondweed, clasping-leaved pondweed and spiked water milfoil *Myriophyllum spicatum* listed on the designation for the HT 3260 were recorded in the survey.

4.2.14 The RMHI and RMNI scores indicates a community associated with low flow and high nutrient levels respectively. The RFA-PC score describes the percentage cover of green filamentous algae at the survey location.

4.2.15 Two non-native species were recorded survey, in the form Nuttall's waterweed and Himalayan balsam *Impatiens glandulifera*.

4.2.16 A search for Environment Agency macrophyte data from Foxburrow Stream and within the ditch network returned no results.

Fish

4.2.17 A search of the Environment Agency's Ecology and Fish Data Explorer returned data from two Environment Agency catch depletion electric fishing surveys. The first survey was carried out in 2019 at a site approximately 8.2km downstream of the proposed crossing (NGR TG 14082 15387). Results from the most recent survey at this location, undertaken in 2019, are displayed in Table 4-7. The results from the second survey location, carried out approximately 6.8km downstream of the proposed crossing (TG 15829 13727) in 2013, are displayed in Table 4-8.

**Table 4-7 - Environment Agency fish data for the River Wensum 2019**

| **Common Name** | **Latin Name** | **No. of Individuals** |
|---|---|---|
| Minnow | *Phoxinus phoxinus* | 274 |
| Dace | *Leuciscus leuciscus* | 79 |
| Roach | *Rutilus rutilus* | 36 |
| Chub | *Squalius cephalus* | 33 |
| Pike | *Esox Lucius* | 10 |
| Gudgeon | *Gobio gobio* | 8 |
| Stone loach | *Barbatula barbatula* | 5 |
| Bullhead | *Cottus gobio* | 3 |
| Perch | *Perca fluviatilis* | 3 |
| Three-spined stickleback | *Gasterosteus aculeatus* | 2 |
| Common bream | *Abramis brama* | 1 |
| Brook lamprey ammocoete | *Lampetra planeri* | 1 |
| European eel elver | *Anguilla anguilla* | 1 |

| Common Name | Latin Name | No. of Individuals |
|---|---|---|
| **Not Applicable** | **Total** | **456** |

4.2.18 A total of 456 fish were caught during the survey, with the minnow *Phoxinus phoxinus* dominating the assemblage. Two species of conservation interest, brook lamprey *Lampetra planeri* and European eel *Anguilla anguilla* were recorded in the Environment Agency survey. Bullhead is also considered to be a species of conservation interest as a qualifying feature of the River Wensum SAC designation.

**Table 4-8 - Environment Agency fish data for the River Wensum 2013.S**

| Common Name | Latin Name | No. of individuals |
|---|---|---|
| Minnow | *Phoxinus phoxinus* | 680 |
| Bullhead | *Cottus gobio* | 130 |
| Dace | *Leuciscus leuciscus* | 82 |
| Chub | *Squalius cephalus* | 51 |
| Stone loach | *Barbatula barbatula* | 38 |
| Gudgeon | *Gobio gobio* | 34 |
| Perch | *Perca fluviatilis* | 19 |
| Three-spined stickleback | *Gasterosteus aculeatus* | 14 |
| Barbel | *Barbus barbus* | 12 |
| Brook lamprey ammocoete | *Lampetra planeri* | 8 |
| Roach | *Rutilus rutilus* | 6 |
| Pike | *Esox Lucius* | 4 |
| European eel elver | *Anguilla anguilla* | 3 |
| Brown/sea trout | *Salmo trutta* | 1 |
| **Not Applicable** | **Total** | **1082** |

4.2.19 A total of 1082 fish were caught during the survey. Minnow dominated the assemblage. Three species of conservation interest, brook lamprey, European eel, and brown/sea trout *Salmo trutta* were recorded in the survey.

Bullhead is also considered to be a species of conservation interest as it is a qualifying feature of the River Wensum SAC designation.

## 4.3 Water Framework Directive

4.3.1 The River Wensum within the Survey Area falls within the WFD 'Wensum Upstream (US) Norwich' water body (GB105034055881) (Environment Agency, 2022a) waterbody. The River Wensum is designated as a WFD watercourse, whilst the connected drainage ditch network, located to the south-west of the river within the Survey Area, is classed as an ordinary watercourse.

4.3.2 The 2019 WFD ecological status of the 'Wensum Upstream (US) Norwich' water body was classified as Moderate overall. The water body is monitored for macrophytes/phytobenthos, fish and invertebrates, which were classified as Moderate, High and High respectively.

4.3.3 Diffuse source pollution from poor nutrient and livestock management and point source pollution from continuous sewage discharge are listed as reasons for Macrophytes/phytobenthos not achieving Good status.

4.3.4 The 2019 WFD physico-chemical status of the 'Wensum Upstream (US) Norwich' water body was Good overall. Temperature achieved Good status, whilst ammonia, biological oxygen demand, dissolved oxygen, phosphate, and pH achieved High status.

4.3.5 The hydromorphological designation of the 'Wensum Upstream (US) Norwich' water body is 'heavily modified' and is considered to be heavily influenced by anthropogenic activity.

4.3.6 The River Tud within the Survey Area falls within the WFD 'Tud' water body (GB105034051000) (Environment Agency, 2022a). The River Tud is designated as a WFD watercourse. The Foxburrow Stream is a tributary of the River Tud, located within the Tud WFD water body catchment.

4.3.7 The 2019 WFD ecological status of the 'Tud' water body was Good (Environment Agency, 2022a), The water body is monitored for fish and invertebrates, which were classified as Good and High respectively.

4.3.8 The 2019 WFD physico-chemical status of the 'Tud' water body was Moderate overall. Phosphate achieved Moderate status. Temperature achieved Good status, whilst ammonia, dissolved oxygen, and pH achieved High status.

4.3.9 The reason for the physico-chemical status not achieving Good status is listed as diffuse source pollution from poor nutrient and livestock management, and transport drainage, and point source pollution from continuous sewage discharge, affecting the phosphate element.

4.3.10 The hydromorphological designation of the 'Tud' water body is 'heavily modified' and is considered to be heavily influenced by anthropogenic activity (Environment Agency, 2022a).

## 4.4 Aquatic Macroinvertebrate Survey

Biological Metrics

4.4.1 The full aquatic macroinvertebrate taxon list is presented in Appendix A. Images of sampling locations are displayed in Appendix C.

4.4.2 The biological metrics calculated for each site based on the aquatic macroinvertebrate communities present are displayed in Table 4-9.

**Table 4-9 – Biological metrics for the five aquatic macroinvertebrate sampling sites in spring and autumn 2022**

| Site | Season | WHPT-ASPT (TL2) | WHPT-NTAXA (TL2) | LIFE (O) (TL5) | LIFE (E) (TL5) | LIFE EQR | PSI (O) (TL5) | PSI (E) (TL5) | PSI EQR | CCI (TL5) |
|---|---|---|---|---|---|---|---|---|---|---|
| River Wensum Upstream | Spring | 5.05 | 30 | 6.39 | 6.66 | 0.96 | 25.00 | 22.66 | 1.10 | 4.50 |
| River Wensum Upstream | Autumn | 4.27 | 27 | 6.21 | 6.42 | 0.97 | 13.79 | 19.17 | 0.72 | 9.21 |
| River Wensum Downstream | Spring | 5.22 | 28 | 6.52 | 6.66 | 0.98 | 32.08 | 22.68 | 1.41 | 5.00 |
| River Wensum Downstream | Autumn | 4.66 | 26 | 6.27 | 6.42 | 0.98 | 20.75 | 19.18 | 1.08 | 9.44 |
| Ditch B | Spring | 5.10 | 19 | 5.96 | 6.49 | 0.92 | 3.39 | 19.37 | 0.18 | 13.53 |
| Ditch B | Autumn | 4.07 | 23 | 6.04 | 6.28 | 0.96 | 7.02 | 16.63 | 0.42 | 4.85 |
| Ditch C | Spring | 3.77 | 18 | 6.13 | 6.77 | 0.91 | 9.76 | 26.02 | 0.38 | 4.20 |
| Ditch C | Autumn | 4.29 | 24 | 6.21 | 6.55 | 0.95 | 10.64 | 22.73 | 0.47 | 13.56 |
| Foxburrow Stream | Spring | 5.10 | 17 | 6.53 | 8.41 | 0.78 | 40.63 | 76.93 | 0.53 | 7.33 |
| Foxburrow Stream | Autumn | 5.41 | 18 | 6.47 | 8.44 | 0.77 | 50.00 | 75.24 | 0.66 | 7.20 |

4.4.3 Across all sites, 130 different taxa were identified. Of these, the River Wensum sites contained the greatest diversity of WHPT scoring taxa, whilst Foxburrow Stream displayed the lowest diversity of WHPT scoring taxa.

4.4.4 The observed LIFE scores suggest the predominant presence of taxa associated with standing to slow flowing water at all sites, in both spring and autumn 2022. In spring, Ditch B and Ditch C had LIFE EQR values below the guideline threshold of 0.94, indicating that the aquatic macroinvertebrate communities at these sampling locations may be flow stressed. The LIFE EQR results also show that the aquatic macroinvertebrate communities from the Foxburrow Stream sampling location may also have been flow stressed in both spring and autumn 2022.

4.4.5 In spring 2022, the observed PSI scores classify Ditch C and Ditch B as Heavily Sedimented, the River Wensum Upstream and Downstream as Sedimented, and Foxburrow Stream as Moderately Sedimented. In autumn 2022, the observed PSI scores classify as Ditch C, Ditch B and River Wensum Upstream as Heavily Sedimented, the River Wensum Downstream as Sedimented, and Foxburrow Stream as Moderately Sedimented. In both spring and autumn 2022, the Ditch B, Ditch C, and Foxburrow Stream samples had PSI EQR scores below the threshold of 0.70, which is indicative of fine sediment pressure.

4.4.6 The observed CCI scores classify the River Wensum Upstream, River Wensum Downstream and Ditch C as having an aquatic macroinvertebrate community of Low conservation value in spring 2022. Foxburrow Stream was classified in spring 2022 as having an aquatic macroinvertebrate community of Moderate conservation value. Ditch B was classified in spring 2022 as having Fairly high conservation value due to the presence of the red-legged moss beetle *Hydraena rufipes*. In autumn 2022 the observed CCI scores classify Ditch B as having an aquatic macroinvertebrate community of Low conservation value, with River Wensum Upstream, River Wensum Downstream and Foxburrow Stream having aquatic macroinvertebrate communities of Moderate conservation value. Ditch C was classified in

autumn 2022 as having Fairly high conservation value due to the presence of the red-legged moss beetle.

## 4.5 River Invertebrate Classification Tool

4.5.1 RICT analysis was performed to produce relative WFD classification scores for aquatic macroinvertebrates; outputs are summarised in Table 4-10.

**Table 4-10 – RICT output for the five aquatic macroinvertebrate sampling sites in spring and autumn 2022**

| Site | Index | Spring EQR | Autumn EQR | Combined EQR | Overall classification | Confidence of class (%) |
|---|---|---|---|---|---|---|
| River Wensum Upstream | WHPT-ASPT | 1.09 | 0.98 | 1.04 | High | 86.90 |
| River Wensum Upstream | WHPT-NTAXA | 1.29 | 1.11 | 1.20 | High | 86.90 |
| River Wensum Downstream | WHPT-ASPT | 1.13 | 1.05 | 1.09 | High | 97.59 |
| River Wensum Downstream | WHPT-NTAXA | 1.21 | 1.07 | 1.14 | High | 97.59 |
| Ditch B | WHPT-ASPT | 1.04 | 0.96 | 1.00 | High | 55.60 |
| Ditch B | WHPT-NTAXA | 0.82 | 0.95 | 0.89 | High | 55.60 |
| Ditch C | WHPT-ASPT | 0.82 | 0.97 | 0.90 | Good | 61.93 |
| Ditch C | WHPT-NTAXA | 0.80 | 1.00 | 0.90 | Good | 61.93 |
| Foxburrow Stream | WHPT-ASPT | 0.80 | 0.90 | 0.85 | Moderate | 56.57 |
| Foxburrow Stream | WHPT-NTAXA | 0.93 | 1.15 | 1.04 | Moderate | 56.57 |

4.5.2 Foxburrow Stream achieved Moderate status. Ditch C achieved Good status, whilst the River Wensum Upstream and Downstream, and Ditch B achieved High status.

4.5.3 The results indicate that the aquatic macroinvertebrate assemblage in Foxburrow Stream is likely to be adversely affected by stressors such as pollution, flow pressures and anthropogenic activities.

## 4.6 Aquatic Macroinvertebrate Assemblage and Conservation Status

4.6.1 The River Wensum Upstream spring sample contained large numbers of mud snails (Bithyniidae) and pond snails (Lymnaeidae). Similarly, the autumn sample was dominated by valve snails (Valvatidae), mud snails, and the whirlpool ram's horn snail *Anisus vortex*. The most abundant species in both the spring and autumn 2022 samples was an INNS, the New Zealand mud snail.

4.6.2 The most abundant taxa recorded in the River Wensum Downstream in the spring sample included mud snails and mayflies (Baetidae and Ephemerellidae). In autumn, the sample was dominated by the faucet snail *Bithynia tentaculata* and an INNS, the New Zealand mud snail.

4.6.3 Foxburrow Stream displayed the lowest diversity of taxa. The spring sample was dominated by the freshwater amphipods *Gammarus pulex/fossarum* agg., and *Gammarus pulex*, with limited numbers of other taxa, mostly non-biting midges (Chironomidae). The autumn sample from Foxburrow stream was also dominated by the freshwater amphipod *Gammarus pulex/fossarum* agg. The remaining taxa were dominated by phantom crane flies (Ptychopteridae) and non-biting midges.

4.6.4 In spring, Ditch C was dominated by non-biting midges and water hoglouse *Asellus aquaticus*. The predominant taxa within the Ditch C autumn sample were the beetle *Haliplus ruficollis*, the water boatman *Sigara dorsalis*, and water hoglouse.

4.6.5 The Ditch B spring sample was dominated by water hoglouse, valve snails, and water scavenger beetles Hydrophilidae. In autumn, the sample from Ditch B was dominated by water hoglouse, mosquitoes (Culicidae), and moth flies (Psychodidae).

4.6.6 An INNS, the New Zealand mud snail, was recorded in both spring and autumn samples taken from the River Wensum upstream and downstream sampling locations. The species was also recorded in the spring sample taken from Ditch C. A second INNS, the freshwater amphipod *Crangonyx pseudogracilis/floridanus* agg. Was recorded in both seasons in Ditch B, in the spring sample from Ditch C, and in the autumn River Wensum Upstream sample. The invasive non-native *Physella* sp., a species of bladder snail was also observed in the River Wensum Downstream autumn sample.

4.6.7 Three species of note under Community Conservation Index scoring, red-legged moss beetle, grannom caddisfly, and pale evening dun mayfly, were identified in the samples, detailed in Table 4-11.

4.6.8 One individual of the red-legged moss beetle was recorded in the Ditch B spring sample, with another individual recorded in the Ditch C autumn sample. The beetle has a conservation score of 7 and as such is Notable (scarce in Great Britain but not of Red Data Book status).

4.6.9 Three individuals of the grannom caddisfly were recorded in the River Wensum upstream autumn sample, with another individual recorded in the River Wensum downstream autumn sample. The caddisfly has a conservation score of 6 and as such is Regionally Notable (uncommon in some parts of the country).

4.6.10 One individual of the pale evening dun mayfly was recorded in the River Wensum upstream autumn sample, with another individual recorded in the Ditch C autumn sample. The mayfly has a conservation score of 6 and as such is Regionally Notable.

**Table 4-11 – Aquatic macroinvertebrates identified with a Conservation Score of six or greater**

| Latin name | Common name | Conservation Score | Status |
|---|---|---|---|
| *Hydraena rufipes* | Red-legged moss beetle | 7 | Notable (but not Red Data Book status) |
| *Brachycentrus subnubilus* | Grannom caddisfly | 6 | Regionally Notable |
| *Procloeon bifidum* | Pale evening dun mayfly | 6 | Regionally Notable |

## 4.7 Macrophyte Survey

River Wensum

4.7.1 The River Wensum within the Survey Area had a mean width of approximately 8m and had a water depth greater than 1m for 100% of the surveyed section.

4.7.2 Several isolated willow trees were noted on the left-hand bank which resulted in shading of the watercourse margins.

4.7.3 Images of the surveyed stretch of the River Wensum are displayed in Appendix D.

4.7.4 A total of 24 macrophyte taxa were recorded, 12 of which are LEAFPACS2 scoring taxa. The majority of the Survey Area was dominated by macrophytes with an Ellenberg light indicator value of 7. The full macrophyte taxon list is presented in Appendix B.

4.7.5 Clasping-leaved pondweed was the most dominant species, accounting for 60% of the Survey Area's total macrophyte cover. Unbranched bur-reed *Sparganium emersum* accounted for 30% of the total macrophyte coverage, followed by arrowhead (25%) and branched bur-reed (20%).

**Table 4-12 - Macrophyte species with taxon cover of 4 or above that were sampled during the macrophyte survey of the River Wensum carried out on 15 August 2022**

| Common Name | Latin Name | Taxon Cover Value | % Cover Range | Ellenberg Light Indicator Value |
|---|---|---|---|---|
| Fool's watercress | *Apium nodiflorum* | 4 | 2.5 < 5 | 7 |
| Curled pondweed | *Potamogeton crispus* | 5 | 5 < 10 | 7 |
| Common reed | *Phragmites australis* | 6 | 10 < 25 | 7 |
| Stream water-crowfoot | *Ranunculus penicillatus subsp. pseudofluitans* | 6 | 10 < 25 | 7 |
| Arrowhead | *Sagittaria sagittifolia* | 6 | 10 < 25 | 7 |
| Branch bur-reed | *Sparganium erectum* | 6 | 10 < 25 | 7 |
| Reed sweet grass | *Glyceria maxima* | 7 | 25 < 50 | 7 |
| Unbranched bur-reed | *Sparganium emersum* | 7 | 25 < 50 | 7 |
| Clasping-leaved pondweed | *Potamogeton perfoliatus* | 8 | 50 < 75 | 7 |

4.7.6 Stream water-crowfoot, a species characteristic of the River Wensum SAC, was the only species of water-crowfoot observed. This species was found to cover 15% of the Survey Area and has an Ellenberg light indicator value of 7.

4.7.7 Furthermore, five species or groups listed in the designation for the HT 3260 were sampled; water-starwort, greater water-moss, spiked water milfoil, clasping-leaved pondweed, and curled pondweed *Potamogeton crispus*.

4.7.8 The observed RMNI, NTAXA and NFG in the River Wensum were all higher than the expected values for these parameters as predicted by LEAFPACS2.

4.7.9 The overall EQR for the surveyed stretch of the River Wensum was 0.80, indicating a representative WFD macrophyte score of 'High'

**Table 4-13 - River Wensum LEAFPACS2 class calculator results**

| Parameter | Observed Value | Expected Value | Raw EQR | Adjusted EQR | Final EQR | WFD Class |
|---|---|---|---|---|---|---|
| RMNI | 8.14 | 7.92 | 0.89 | 0.86 | 0.80 | High |
| NTAXA | 12 | 10.01 | 1.20 | 1.20 | 0.80 | High |
| NFG | 11 | 6.29 | 1.75 | Not applicable | 0.80 | High |
| ALG | 3.80 | Not applicable | 0.96 | 0.75 | 0.80 | High |

Foxburrow Stream

4.7.10 Foxburrow Stream was less than 1m wide throughout the surveyed section and had a water depth of approximately 0.2m.

4.7.11 Images of the surveyed stretch of Foxburrow Stream are displayed in Appendix D.

4.7.12 A total of eight macrophyte taxa were recorded, two of which are LEAFPACS2 scoring taxa. The majority of the Survey Area was dominated by macrophytes with an Ellenberg light indicator value of 7.

4.7.13 Foxburrow Stream contained both free floating and emergent macrophyte species. Fool's watercress *Apium nodiflorum* was the most dominant species, accounting for 50% of the total macrophyte cover. Occasional cattle poaching

of both banks was found to have locally reduced the abundance of emergent species.

**Table 4-14 - Macrophyte species with taxon cover of 4 or above that were sampled during the macrophyte survey of Foxburrow Stream carried out on 15 August 2022**

| Common Name | Latin Name | Taxon Cover Value | % Cover Range | Ellenberg Light Indicator Value |
|---|---|---|---|---|
| Fool's watercress | *Apium nodiflorum* | 7 | 25 < 50 | 7 |

4.7.14 The observed RMNI was higher than the expected value for this parameter as predicted by LEAFPACS2. Both the observed NTAXA and NFG values were lower than the expected values for these parameters.

4.7.15 The overall EQR for the surveyed stretch of Foxburrow Stream was 0.35, which classifies the macrophyte quality component at the site as having 'Poor' ecological status.

**Table 4-15 - River Wensum LEAFPACS2 class calculator results**

| Parameter | Observed Value | Expected Value | Raw EQR | Adjusted EQR | Final EQR | WFD Class |
|---|---|---|---|---|---|---|
| RMNI | 8.09 | 6.85 | 0.61 | 0.50 | 0.35 | Poor |
| NTAXA | 2 | 10.01 | 0.20 | 0.20 | 0.35 | Poor |
| NFG | 2 | 6.29 | 0.32 | Not applicable | 0.35 | Poor |
| ALG | 0.00 | Not applicable | 1.00 | 0.75 | 0.35 | Poor |

## 4.8 Ditch Network

Ditch A

4.8.1 Ditch A was 3m wide for the entire surveyed section. The ditch had an approximate water depth of 0.7m and no perceptible flow at the time of

survey. Little macrophyte growth was noted, with evidence that the channel had recently been dredged and the bank slopes reshaped.

4.8.2 Images of the surveyed stretch of Ditch A are displayed in Appendix D.

4.8.3 Small patches of frogbit *Hydrocharis morsus-ranae* and fool's watercress were recorded. The main area of frogbit growth was recorded at approximately TG 14032 15412, with smaller isolated patches recorded elsewhere in Ditch A. Frogbit is a species that can grow rapidly and survives winter as dormant buds. The species is classified as Vulnerable on the Vascular Plant Red List for Great Britain (Cheffings and Farrell, 2005). As the majority of the frogbit growth in Ditch A is located close to the River Wensum, away from the proposed viaduct location, it is expected that the impact of the Proposed Scheme on the frogbit within Ditch A will likely be low.

4.8.4 Where vegetation on the scraped banks had started to re-grow, species including hairy willowherb *Epilobium hirsutum* and bittersweet *Solanum dulcamara* were present. The bankside and bank top vegetation community was found to consist of plant species that predominantly occupy terrestrial habitats.

Ditch B

4.8.5 The channel of Ditch B was less than 1m wide throughout the surveyed section with an approximate water depth of 0.3m. There was no visible flow at the time of survey and the channel was heavily choked with vegetation.

4.8.6 Images of the surveyed stretch of Ditch B are displayed in Appendix D.

4.8.7 The ditch contained a modest diversity of submerged, floating and emergent macrophyte species. The ditch was dominated by the growth of reed sweet grass *Glyceria maxima*, which accounted for 90% of the total macrophyte coverage.

4.8.8 The remaining emergent vegetation was found to consist mostly of water mint *Mentha aquatica*, reed canary grass *Phalaris arundinacea*, and reedmace *Typha latifolia*.

Ditch C

4.8.9 The channel of Ditch C was 2-3m wide throughout the surveyed section with approximately 0.4m depth of turbid water and no visible flow at the time of survey. A layer of brown scum had accumulated across much of the water surface and, where macrophytes were sampled, they were smothered in silt and displayed early signs of decomposition. Filamentous green algae was also present throughout the surveyed stretch. These observed organic accumulations and decomposition are likely a result of agricultural run-off entering the watercourse following heavy rain. Agricultural run-off can be of poor quality, and may contain contaminants such as pesticides, nutrients and ammonia which can degrade aquatic habitats.

4.8.10 Images of the surveyed stretch of Ditch C are displayed in Appendix D.

4.8.11 The ditch contained a moderate diversity of submerged, floating and emergent plant species, including small patches of water-starwort. Emergent vegetation was found to consist mostly of reed sweet grass. Occasional cattle poaching of the northern bank was found to have locally reduced the abundance of emergent species.

## 4.9 Fish Surveys

River Wensum

4.9.1 A total of nine fish species were caught during a 40-minute timed electric fishing survey of a 225m stretch of the River Wensum. No species of conservation importance were caught. These results, which include catch counts, fork lengths, and biomass, are outlined in Table 4-16.

**Table 4-16 – Catch data from the River Wensum fish survey, 31 August 2022**

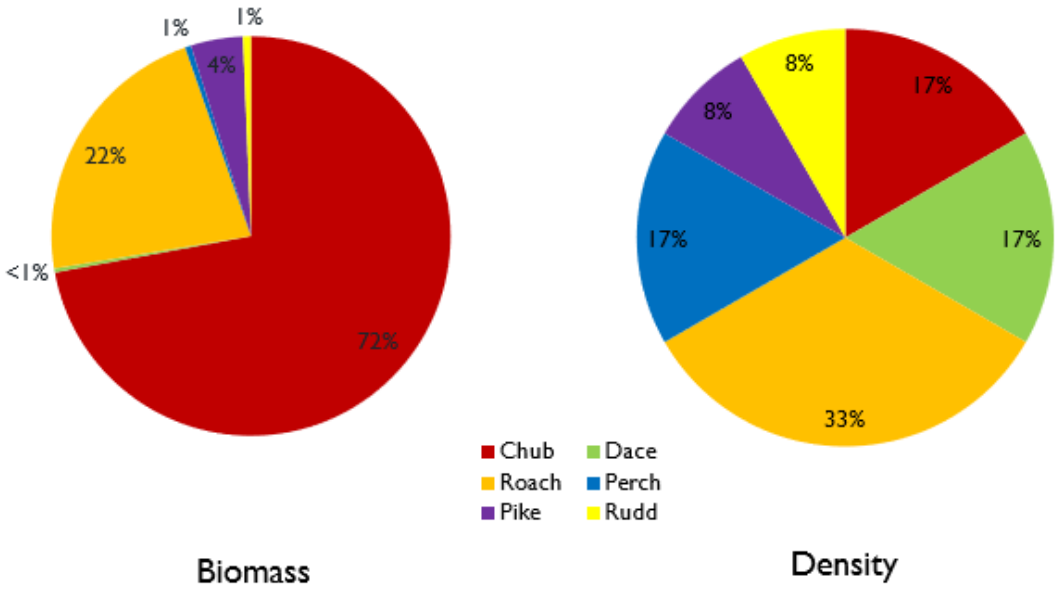
| Common name | Scientific name | Catch count | Lengths of individuals (mm) | Number of individuals caught per minute | Biomass (g) caught per minute |
|---|---|---|---|---|---|
| Dace | *Leuciscus leuciscus* | 2 | 89, 54 | 0.05 | 0.2 |
| Pike | *Esox lucius* | 1 | 246 | 0.025 | 2.6 |
| Chub | *Squalius cephalus* | 2 | 480, 169 | 0.05 | 44.4 |
| Perch | *Perca fluviatilis* | 2 | 81, 77 | 0.05 | 0.3 |
| Roach | *Rutilus rutilus* | 4 | 280, 124, 99, 180 | 0.10 | 13.7 |
| Rudd | *Scardinius erythrophthalmus* | 1 | 100 | 0.025 | 0.4 |
| Stone loach | *Barbatula barbatula* | 1 | 169 | 0.025 | 1.6 |
| Minnow | *Phoxinus phoxinus* | 10-99 (note 1) | Not applicable | Not applicable | Not applicable |
| Three Spined-Stickleback | *Gasterosteus aculeatus* | 1-9 (note 1) | Not applicable | Not applicable | Not applicable |

Note 1: Log abundance assigned to minor species in accordance with Environment Agency methodology.

4.9.2 Minnow *Phoxinus phoxinus* were the most abundant species caught, accounting for 74% of the total number of individuals captured. Roach *Rutilis rutilus* accounted for 33% of all non-minor species caught (see Figure 4-1).

4.9.3 Chub accounted for 72% of the total fish biomass sampled (see Figure 4-1), which reflects the large size (between 480mm and 169mm) of the two individuals caught (see Table 4-16).

**Figure 4-1 - Species percentage contribution to the total fish abundance and biomass of fish caught (excluding minor species) during the River Wensum fish survey, 31 August 2022**




4.9.4 Chub is shown in red, biomass 72%, density 17% of total. Dace is shown in green, biomass <1%, density 17% of total. Roach is shown in orange, biomass 22%, density 33% of total. Perch is shown in blue, biomass 1%, density 17% of total. Pike is shown in purple, biomass 4%, density 8% of total. Rudd is shown in yellow, biomass 1%, density 8% of total.

4.9.5 The mean wet width of the watercourse along the surveyed section was 8m. The mean depth of water was in excess of 1m and was slightly turbid.

4.9.6 The flow types present consisted of a single deep glide (95%) and still margins (5%).

4.9.7 A description of instream substrate was unattainable due to depth and turbidity of water, however based on flow types present, it is likely to consist of an overlaying silt layer, with gravel or sand substrate beneath. Grab samples at the location also indicated the presence of a thick silt layer.

4.9.8 The surrounding land use was improved pasture. The bank face vegetation structure along both banks was simple (two to three types). Evidence of cattle

poaching was evidence on both banks. Fish cover was provided by undercut banks (20%) and canopy cover (shading) over the watercourse was 10%. Extensive macrophyte growth on both banks and within the channel provided extensive shelter from predation and phytophilic spawning areas.

4.9.9 The physico-chemical properties of the water at the River Wensum survey location are displayed in Table 4-17.

**Table 4-17 - The physico-chemical properties of the River Wensum on 31 August 2022**

| Parameter | Value |
|---|---|
| Temperature (°C) | 16.5 |
| Conductivity (µS/cm$^{-1}$) | 633 |
| Dissolved oxygen (% saturation) | 86.5 |
| Dissolved oxygen (mg/l) | 8.38 |
| pH | 7.91 |

Ditch C

4.9.10 A total of three species of fish were caught during the qualitative (presence/likely absence) survey of the ditch network, including brook/river lamprey, which are species of conservation importance. Brook lamprey is a qualifying feature of the River Wensum SAC designation. However, it is difficult to differentiate brook/river lamprey ammocoetes in the field and thus they have been reported as an aggregate group. The number of species caught is shown in Table 4-18.

**Table 4-18 – Catch data from Ditch C fish survey, carried out on 31 August 2022**

| Common name | Scientific name | Number of individuals caught |
|---|---|---|
| Brook/river lamprey | *Lampetra* spp. | 1 |
| Minnow | *Phoxinus phoxinus* | 35 |
| Three-spined stickleback | *Gasterosteus aculeatus* | 1 |

4.9.11 The mean wet width of the watercourse along the surveyed section was 1.5m. The mean depth of water was 0.55m and noted as slightly turbid.

4.9.12 Instream substrate consisted of silt (20%) and gravel (80%). The substrate was stable and uncompacted. Patches of overlaying silt covered much of the gravel. Patches of filamentous green algae covered the remaining open areas of gravel.

4.9.13 A surface scum of organic material was present along most of the surveyed section. A pungent anaerobic smell was released when the substrate was disturbed.

4.9.14 The flow types present consisted of a single slow flowing deep glide (90%) and still margins (10%).

4.9.15 The surrounding land use close to the watercourse was improved pasture. The bank face vegetation structure along both banks was uniform (one type).

4.9.16 Fish cover provided by marginal vegetation (40%). Canopy cover (shading) over the watercourse was 2%.

4.9.17 The physico-chemical properties of the water at Ditch C survey location are displayed in Table 4-19.

**Table 4-19 – The physico-chemical properties of Ditch C on 31 August 2022**

| Parameter | Value |
|---|---|
| Temperature (°C) | 15.1 |
| Conductivity (µS/cm$^{-1}$) | 617 |
| Dissolved oxygen (% saturation) | 103.5 |
| Dissolved oxygen (mg/l) | 10.48 |
| pH | 7.56 |

## 4.10 Foxburrow Stream

4.10.1 No fish were caught during the quantitative one-run electric fishing survey of a 100m section of Foxburrow Stream.

4.10.2 The mean wet width of the watercourse along the surveyed section was 0.65m. The mean depth of water was 0.04cm and noted as slightly turbid.

4.10.3 Instream substrate consisted of silt (40%) sand (30%), gravel (15%), pebble (10%) and cobble (5%). The substrate was stable and uncompacted. The flow types present consisted of a single slow flowing shallow glide (70%), still margins (20%) and riffle (10%).

4.10.4 The surrounding land use close to the watercourse was meadowland. The bank face vegetation structure along both banks was complex (four or more types).

4.10.5 Extensive cattle poaching was present along both banks of the surveyed section.

4.10.6 Fish cover was provided by draped vegetation (40%). Canopy cover (shading) over the watercourse was 10%.

4.10.7 The physico-chemical properties of the water at the Foxburrow Stream survey location are displayed in Table 4-20.

**Table 4-20 – The physico-chemical properties of Foxburrow Stream on 01 September 2022**

| **Parameter** | **Value** |
|---|---|
| Temperature (°C) | 16.4 |
| Conductivity (µS/cm$^{-1}$) | 707 |
| Dissolved oxygen (% saturation) | 93.7 |
| Dissolved oxygen (mg/l) | 9.16 |
| pH | 7.85 |

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