national highways

Lower Thames Crossing

6.3 Environmental Statement Appendices
Appendix 8.4 – Freshwater Ecology

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Lower Thames Crossing

6.3 Environmental Statement Appendices
Appendix 8.4 – Freshwater Ecology

List of contents

Page number

List of plates

Page number

List of tables

1 Introduction

1.1.1 This document presents the results of the aquatic ecology desk study and field surveys undertaken between 2012 and 2022 to inform the Environmental Statement of the A122 Lower Thames Crossing project ('the Project'). There are a number of freshwater and brackish water bodies, which could potentially be impacted by the Project. Assessment of the ecology of the water bodies using a range of survey methods was performed around those areas most likely to be affected by the Project. The target areas are the North and South Portal sites, on the Essex and Kent sides of the Thames respectively, and the Mardyke, where a viaduct is currently planned to cross the water body. The South Portal is proposed to be constructed south of the Thames Estuary and Marshes Ramsar site.

1.1.2 This technical appendix reports the baseline aquatic ecology data for the water bodies identified within the three target areas.

2 Legislation and conservation status

2.1 Macro-invertebrates

2.1.1 Macro-invertebrates receive limited protection from conservation legislation. A small number of species are cited as features of protected areas, listed on the International Union for Conservation of Nature (IUCN) Red List and/or designated as Species of Principal Importance for Biodiversity under Section 41 of the Natural Environment and Rural Communities Act 2006. Macro-invertebrates are also a biological quality element assessed as part of classification for Water Framework Directive (WFD) (WFD UKTAG, 2014).

2.1.2 The Thames Estuary and Marshes Special Protection Area (SPA) and Ramsar site, including the Filborough Marshes, supports a number of aquatic invertebrates cited within Criteria 2 of the Ramsar designation (JNCC, 2004). The Ramsar site lies north of the proposed South Portal site.

2.2 White-clawed crayfish

2.2.1 White-clawed crayfish are fully protected in the UK under Schedule 5 of the Wildlife and Countryside Act 1981 and are also included in Appendix III of the Bern Convention and Annexes II and V of the European Habitats and Species Directive 1992, which is implemented in the UK under the Conservation Regulations 1994 (as amended) and the Conservation of Habitats and Species Regulations 2010. White-clawed crayfish have also been designated as a priority species listed on the UK Biodiversity Action Plan, which lists species and habitats as priorities for consideration when making planning decisions which may affect them. The combined result of this legislation makes it an offence to intentionally or recklessly disturb, capture, sell, injure or kill any white-clawed crayfish or to cause damage to their habitat in any way.

2.3 Fish

2.3.1 Freshwater fish are protected under the Salmon and Freshwater Fisheries Act 1975, and are a biological quality element assessed as part of classification for WFD. Like macro-invertebrates, some fish species are cited as features of protected areas, listed on the IUCN Red List and/or designated as Species of Principal Importance for biodiversity under Section 41 of the Natural Environment and Rural Communities Act 2006.

2.3.2 European eel Anguilla anguilla receives protection under The Eels (England and Wales) Regulations 2009, which outlines, amongst other factors, fishing close season for eels, construction and alteration of in-channel obstructions, eel passes on existing structures and screening of intakes and outfalls.

2.4 Macrophytes

2.4.1 Like macro-invertebrates, macrophytes have limited protection from conservation legislation. A small number of species are cited as features of protected areas, listed on the IUCN Red List and/or designated as Species of Principal Importance for biodiversity under Section 41 of the Natural Environment and Rural Communities Act 2006. Macrophytes are also a

biological quality element assessed as part of classification for WFD (WFD UKTAG, 2014).

2.4.2 The Thames Estuary and Marshes SPA and Ramsar site, including the Filborough Marshes, supports a number of macrophytes of national importance (JNCC, 2004).

3 Methodology

3.1 Desk study

Macro-invertebrate surveys

3.1.0 Macro-invertebrate surveys were undertaken on behalf of RWE Npower in 2008, 2016 (Colin Plant Associates, 2008 & 2016) and 2017 (Telfer, 2017) at areas around the Tilbury Power Station. Unfortunately, grid-references for the sites were not provided, but descriptions of the areas were reviewed in the survey reports, copies of which were obtained to inform this assessment. Samples were collected by 0.5mm pond net, using pond sweeps and all macro-invertebrate groups were identified to species levels.

3.1.1 There is no historic or current macro-invertebrate data available from the Environment Agency in each of the three study areas (Environment Agency Fish and Ecology Data Explorer, 2022).

Fisheries surveys

3.1.2 Environment Agency fish data is available from four locations on the Mardyke, within 5km of the proposed viaduct crossing (Table 3.1). Each of these sites were surveyed on a single occasion: three sites south of the proposed crossing were surveyed in 2013 and an additional site 2km north was surveyed in 2012. Abundance and density data of the fish species captured at each site were recorded.

Table 3.1 Relevant Environment Agency fish monitoring sites

Area	Site	Survey date	Grid reference (mid survey point)
Mardyke (south of proposed viaduct crossing)	Fourteen Arches Bridge	1 May 2013	TQ 59300 80400
Mardyke (south of proposed viaduct crossing)	North Stifford	25 April 2013	TQ 60000 80500
Mardyke (south of proposed viaduct crossing)	Grangewater	23 April 2013	TQ 61300 81700
Mardyke (north of proposed viaduct crossing)	Fen Farm Bridge	13 April 2012	TQ 61700 85200

3.1.3 There is no historic or current fish data available from the Environment Agency in the ditch systems of the North and South Portal (Environment Agency Fish and Ecology Data Explorer, 2022).

Macrophyte surveys

3.1.4 Macrophyte surveys were carried out at Filborough Marshes on part of the Thames Estuary and Marshes Ramsar site (Highways England, 2018). Seventeen ditches were surveyed in 2018. Macrophytes within the North Portal area and the Tilbury Main were screened out of the study due to lack of diversity and abundance. This was confirmed by a site walkover on 9 January 2020.

3.1.5 There is no historic or current macro-invertebrate data available from the Environment Agency in each of the three areas (Environment Agency Fish and Ecology Data Explorer, 2022).

Water body descriptions

3.1.6 Site descriptions and physical habitat data have been collected at each of the macro-invertebrate monitoring sites (Annex B). Physical habitat data has been used to inform the macro-invertebrate assessment and is required to enable comparable future macro-invertebrate monitoring and habitat assessment.

Macro-invertebrates

Site selection

3.1.7 Sampling sites were chosen to represent the heterogeneity of the habitat present and therefore the aquatic macro-invertebrate fauna of the site as a whole. Areas which were likely to be impacted were chosen to create a baseline dataset against which potential impacts of the Project on the freshwater ecology would be assessed. Site selection was based on a desk study including Ordnance Survey mapping, aerial imagery and information (including site photographs) collected from the water vole surveys. The final site selection was determined on site taking into account habitats present and accessibility. Samples were collected from three target areas (Table 3.2):

a. North portal: ditches within 500m radius of the northern tunnel portal. Sampled summer 2018, spring 2022 and summer 2022. Summer 2022 macro-invertebrate data is not yet available, and therefore not included within this report.

b. South Portal (2018, 2022): ditches within 1km radius of the southern portal. 2018: South Portal monitoring – focussing on the Filborough Marshes; summer 2018. 2022: South Portal monitoring – focussing on ditches east of Gravesend; autumn 2021, spring 2022 and summer 2022. Summer 2022 macro-invertebrate data is not yet available, and therefore not included within this report.

c. Mardyke: upstream and downstream of the proposed Mardyke viaduct crossing; summer and autumn 2018.

3.1.8 Many of the ditches within the proposed North Portal tunnel were ephemeral and brackish (0). A site walkover (9 January 2020) showed that many of the ditches, including the Tilbury Main, which forms a large portion of the ditch network, held water during the winter while in the summer months they were dry. At the lower end of the Tilbury Main, macro-invertebrates associated with estuarine/marine habitats were found. Although the Tilbury Main is designated as a main river, within this report, due to its physical properties with regard to ecology, it has been defined as a ditch.

Table 3.2 Macro-invertebrate monitoring sites

Area	Site name	Grid reference	Sampling method	Summer 18	Autumn 21	Spring 22	Summer 22
North Portal	W022N	TQ 67969 76911	Sweep	X			
	W029N	TQ 67274 76342	Sweep	X			
	W026N	TQ 67694 76553	Sweep	X			
	JN1	TQ 67244 76208	Sweep			X	X
	JN2	TQ 67696 76551	Sweep			X	X
	JN3	TQ 68078 76865	Sweep			X	X
	JN4	TQ 66513 76489	Sweep			X	X
	JN5	TQ 66892 76481	Kick			X	X
	JN6	TQ 67191 77129	Sweep			X	X
	JN7	TQ 66487 76940	Kick			X	X
	JN8	TQ 67845 75825	Sweep			X	X
	JN9	TQ 68701 76893	Sweep			X	X
	JN10	TQ 68695 76478	Kick			X	X
	JN11	TQ 68706 76697	Kick			X	X
South Portal	J1	TQ 67627 73776	Sweep	X			
	J2	TQ 67750 73444	Sweep/kick	X			
	J3	TQ 67945 73689	Sweep	X			
	J4	TQ 68152 73642	Sweep	X			
	J5	TQ 68013 73391	No access	X			
	MP1	TQ 67292 73855	Kick		X	X	X
	MP2	TQ 67336 73747	Kick		X	X	X
	MP3	TQ 67259 73630	Kick		X	X	X
	MP4	TQ 67211 73431	Kick		X	X	X
	MP5	TQ 67340 73478	Kick		X	X	X
Mardyke	Mardyke North	TQ 62091 83921	Sweep		X	X	X
	Mardyke South	TQ 62012 83642	Sweep		X	X	X

Sampling

3.1.9 WFD compliant sampling was undertaken following Environment Agency Operational Instruction Document no. 018_08 (Environment Agency, 2011) with the standardised three-minute sweep sampling method being used as described above.

Wash, sorting and identification of samples

3.1.10 Samples were identified to species level with the exception of Oligochata, Diptera and Sphaeridae, which is the most common procedure when analysing samples. Sample processing followed the Environment Agency Operational Instruction Document no. 024_08 (Environment Agency, 2011), with 10% of samples being selected for quality control.

Macro-invertebrate metrics

3.1.11 A number of standard biotic metrics and classification methodologies were used in the analysis of the macro-invertebrate data. These are discussed in more detail below.

Whalley, Hawkes, Paisley & Trigg (WHPT) metric, Average Score Per Taxon (WHPT ASPT) and Number of Taxa (WHPT NTAXA)

3.1.12 The WHPT metric is the classification method for the assessment of macro-invertebrates in rivers in relation to general degradation, including organic pollution under the WFD (UKTAG, 2014). In 2014 the WHPT scoring system replaced the Biological Monitoring Working Party (BMWP) scoring system: the WHPT metric is abundance-weighted and scores have been revised to be more representative of the family as a whole and reflect general pollution rather than just organic pressures (Paisley *et al*., 2007). Scores are assigned to macro-invertebrate families based on tolerance to pollution with the final WHPT score taking into account the abundance of each of the families. WHPT ASPT scores are calculated by dividing the WHPT score by the number of scoring taxa (WHPT NTAXA) to give the average score per taxon. While WHPT and WHPT ASPT scores are used as a measure of water quality, WHPT NTAXA is used as a measure of diversity.

3.1.13 WHPT score and WHPT ASPT were only used on the sites along the Mardyke as RICT cannot be used to classify ditches.

Community Conservation Index

3.1.14 The Community Conservation Index (CCI) (Chadd and Extence, 2004) represents the national rarity and diversity of species identified within a site and designates a conservation value to the sampled community. A Conservation Score (CS) based upon each species' national rarity is applied to each species (Table 3.3). CS scores are ranked from one to ten in level of rarity, with one being rated as a common species, and ten being rated as an endangered species (Chadd and Extence, 2004). The CCI is calculated from the sum of Conservation Scores divided by the number of contributing species to obtain the mean value. This is then multiplied by the Community Score (CoS), derived either from the rarest taxon present or the BMWP score, whichever is highest. The CCI value tends to fall in a range of between 0 and 40 (Table 3.3).

Table 3.3 Conservation Scores and classifications (Chadd and Extence, 2004)

Conservation Score (CS)	Classification
10	Red Data Book (RDB) 1 (Endangered)
9	RDB2 (Vulnerable)
8	RDB3 (Rare)
7	Notable (but not RDB status)
6	Regionally Notable
5	Local
4	Occasional
3	Frequent
2	Common
1	Very Common

Table 3.4 Conservation classes (Chadd and Extence, 2004)

Conservation class	Score	Description
Low	<5	Site supporting common species and low taxon richness
Moderate	5 to <10	Site supporting at least one species with limited distribution or moderate taxon richness
Fairly High	10 to<15	Site supporting at least one uncommon species or several of limited distribution or high taxon richness
High	15 to<20	Site supporting several uncommon species, one of which may be nationally rare or of high taxon richness
Very High	>20	Site supporting several rare species or very high taxon richness.

Proportion of Sediment-Sensitive Invertebrates (PSI)

3.1.15 The PSI scoring system is used to assess the impact of fine sediment accumulation on macro-invertebrate communities (Extence et al., 2011). Species or family are assigned a score based on their sensitivity to sediment. Calculation of the PSI score considers abundances of each scoring taxa. The resulting PSI scores indicate how sedimented the watercourse is; producing a numerical value to quantify a range from minimal sediment/unsedimented to heavily sedimented

Lotic Invertebrate Index for Flow Evaluation (LIFE)

3.1.16 The LIFE index (Extence et al., 1999) is used to link macro-invertebrates to flow conditions. Freshwater macro-invertebrates have precise requirements for flow conditions, and these can be used to determine not only predominant flow types but also changes in flow character. Each species or family within a sample is assigned to a flow group depending on their flow/velocity preference. A high LIFE score represents a higher number of taxa with a preference for high velocity habitats and vice versa.

Salinity Association Group Index (SAG)

3.1.17 Macroinvertebrate taxa at each site were assigned to one of five Salinity Association Groups (SAGs) according to Pickwell (2012). Using the recorded abundance and SAGs, a Salinity Associated Score (SAS) is calculated for each taxa, and these SASs are averaged to calculate a final SAG Index for each site (Pickwell, 2012). A SAG index score ≤4.5 indicates freshwater conditions, 4.5-5.5 indicates oligohaline conditions and ≥5.6 indicates mesohaline conditions.

WFD classification

3.1.18 WFD classifications are used by the Environment Agency to assess water body status. WFD classifications use morphological, chemical and biological quality elements to assess overall water body status. Water bodies are compared to near pristine reference sites and are given a classification ranging between Bad, Poor, Moderate, Good and High.

3.1.19 RICT is used to classify macro-invertebrate data under the WFD. RICT determines the ecological condition of a given location based on a comparison of macro-invertebrate communities observed at each study site, with macro-invertebrate communities observed in a network of reference sites. Reference site selection is based on the similarity of physical attributes with the study site (for example; width, depth, substrate composition, altitude, distance from source, alkalinity).

3.1.20 RICT reference sites are deemed to be as close as possible to pristine and not impacted by environmental stressors such as pollution, habitat modification or flow stress. Reference sites provide an expected macro-invertebrate community score for that river type. The observed macro-invertebrate community score at a given study site is divided by the expected community score. Reference and bias adjustments are then applied to obtain the Ecological Quality Ratio and WFD classification.

3.1.21 The WFD uses the pollution sensitivity/general degradation (WHPT ASPT) and diversity (WHPT NTAXA) EQR scores to determine whether a watercourse meets Good Ecological Status (GES), or Good Ecological Potential (GEP) for designated heavily modified waterbodies, as required under the Directive. For WFD classification the lower scoring of the WHPT ASPT and WHPT NTAXA EQR scores determines the macro-invertebrate classification of a given site.

RICT and subsequently WFD Classifications are not suitable for use on the macro-invertebrate communities in the North and South Portals due to the ditch-like nature of the watercourses. RICT is suitable for us on the Mardyke sites.

Macrophytes

3.1.22 LTC North Portal macrophytes were assessed in 2022, at the same eleven locations as the macro-invertebrate sites (Annex A), with the addition of Site M75.

3.1.23 In 2022, for South Portal, five macrophyte sites were identified to the west of Filborough Marshes, in the ditches located on the boundary of the Thames Estuary RAMSAR site and the South Thames Estuary and Marshes SSSI (Annex A). This ditch system is proposed to receive treated discharges of runoff

from the south portal construction compound. The sites match the summer 2022 macro-invertebrate sites. One site (JN5) was not surveyed due to access issues.

3.1.24 Macrophyte communities for both LTC North and South Portals were assessed following the Environment Agency methodology for surveying freshwater macrophytes in rivers (Environment Agency, 2011; Operational Instruction 131_07). This is a standardised WFD method where specific macrophytes which are wetted more than 85% of the year are surveyed from a 100m river section. As part of the methodology, a cover value is assigned to each macrophyte species to provide an indication of the prevalence within the survey area (Table 3.5). Other physical variables including width, depths, flow-types and substrates were also noted.

Table 3.5 Macrophyte Species Cover Values (%)

Species Cover value	Percentage coverage of entire survey reach
1	<0.1
2	0.1 – 1
3	1 - 2.5
4	2.5 – 5
5	5 – 10
6	10 – 25
7	25 – 50
8	50 – 75
9	>75

3.1.25 LEAFPACS is the standard analytical tool method for the characterisation of watercourses using macrophytes and is used to indicate nutrient status of a watercourse. LEAFPACS is not suitable for use in ditch systems of the North and South Portal. However a number of metrics (which support LEAFPACS2) can be used to infer the condition of the community. These are summarised below.

a. River Macrophyte Nutrient Index (RMNI): Derived from the RMNI scores of the taxa recorded in the field survey, each species is ascribed a score based on its nutrient preferences. The RMNI score gives an indication of nutrient enrichment with scores ranging from 1 (low) to 10 (high);

b. Number of Taxa (NTAXA): A diversity metric (the number of scoring taxa recorded in the field survey), specifically only taxa which are considered truly aquatic;

c. Number of Functional Groups (NFG): A diversity metric of individual taxa which are truly aquatic (i.e. hydrophytes). These are allocated to 24 ‘functional groups’ and,

d. Cover of Green Filamentous Algae (ALG): This is the percentage cover of green filamentous algae over the whole of the surveyed section of river.

4 Results

4.1 Overview

4.1.1 The results presented below for each target area combine both desk and field study data, apart from the macro-invertebrate desk study for the Tilbury Power Station (Colin Plant Associates, 2008 & 2016) (Telfer, 2017), which is discussed below.

4.2 Tilbury Power Station

4.2.1 Colin Plant Associates were commissioned by Bioscan (UK) Ltd to undertake an assessment of macro-invertebrates on land adjacent to the Tilbury Power Station. Surveys were undertaken in 2007 (Colin Plant Associates, 2008) and 2016 (Colin Plant Associates, 2016). In 2017 another report commissioned by Bioscan was undertaken (Telfer, 2017). For all of these reports, land was split into compartments, and maps of the compartment boundaries are shown in subsequent reports.

4.2.2 A wide range of sampling methodologies were used for the collection of terrestrial and aquatic macro-invertebrates. The reports do not specify exactly where each species came from and as some aquatic species have a terrestrial life stage this information could help determine whether the species were caught using terrestrial or aquatic sampling methodologies. No water quality data, abundance of species, grid-references or taxa lists for each site or number of sites surveyed were provided.

4.2.3 In the 2008 report (Colin Plant Associates, 2008) a number of Red Data Book species were recorded: Grapodytes bilineatus (RDB3) in Compartments 13, 14 and 15, Stratiomys longicornis (RDB2) in Compartment 13, Lestes dryas (RDB3) in Compartments 13 and 14. A number of nationally scarce macro-invertebrates, predominantly beetles, were present.

4.2.4 Both the 2016 (Colin Plant Associates, 2016) and 2017 (Telfer, 2017) reports included several aquatic macro-invertebrates which are nationally scarce. No Red Data Book species were found.

4.3 Mardyke

Macro-invertebrates

4.3.1 The macro-invertebrate communities were surveyed in summer and autumn 2018, to establish a baseline north and south of the proposed construction of the viaduct as part of the LTC Scheme (Annex A). The Mar Dyke stream is a flowing watercourse, typical of a lowland area. The nature of its habitat enables further analysis of macro-invertebrate data than the ditch systems of LTC North and South; RICT and WFD Classifications have been performed.

4.3.2 The Mar Dyke, both north and south sites, is a small watercourse, heavily vegetated, shaded and a freshwater environment (SAG). Access to the watercourse was made difficult by the dense vegetation growth on the banks and within the channel.

4.3.3 Species diversity varied between seasons; different life-forms are present throughout macro-invertebrate life-cycles. Higher WHPT NTAXA scores were observed in autumn (north 15, south 22) than summer (north 14, south 12). However, a larger sample area was accessible in autumn for the south site, which may account for a greater species diversity. Lower WHPT ASPT scores across all samples suggest a community with a prevalence of species les sensitive to water quality.

4.3.4 Species observed were typical of a slower flowing habitat (LIFE sp) and sedimented to heavily sedimented riverbed (PSI sp). This included Mollusca (snails), Zygoptera (damselfly larvae), Diptera (fly larvae) and Dytiscidae (beetles).

4.3.5 A Low conservation value (CCI) was achieved at all sites, except the south site in autumn which achieved Very High value. This was due to the presence of the dragonfly species; Scarce chaser (*Libellula fulva*). This species has a CCI score of 8; RDB3 Rare (Table 4.2).

4.3.6 The Mar Dyke macro-invertebrate sites have been classified for WFD purposes. Both sites in summer and the north site in autumn fail to achieve Good status based on lower than expected species diversity. The south site in autumn achieves High WFD status, indicating the observed community is what is expected under the habitat conditions.

Table 4.1 Macro-invertebrate metrics Mardyke sites

Site	Season	WHPT ASPT WFD Class	WHPT NTAXA WFD Class	Overall WFD Classification
Mardyke South	Summer	High	Bad	Bad
Mardyke North	Summer	High	Moderate	Moderate
Mardyke South	Autumn	High	High	High
Mardyke North	Autumn	High	Moderate	Moderate

Table 4.2 Species of conservation interest – Mardyke

Location	Date sampled	Species present	Group	Abundance	CS score	CS definition
Mardyke South	8 November 2018	*Libellula fulva*	Dragonfly	1	8	Rare (RDB3)

White-clawed crayfish

4.3.7 Phase 1 habitat suitability mapping suggested potential habitat for white-clawed crayfish at two areas near the Mardyke crossing: a pond within Top Meadow Golf Course and an unnamed stream within Thames Chase. Further assessment of the sites during walk-overs (26 November 2019 and 9 January 2020), the lack of data provided by the EA and the fact that no white-clawed crayfish were caught in macro-invertebrate samples, suggest that it is highly unlikely they are present.

Fish

4.3.8 Historical fish data from Environment Agency surveys in 2012 and 2013 are presented in Table 4.3. Fourteen Arches Bridge, North Stifford and Grangewater were sites all south of the Mardyke crossing area, while Fen Farm Bridge was north of the crossing area. The surveys south of the Mardyke crossing area recorded a variety of fish species, albeit in low densities. At the Fourteen Arches Bridge site nine species were recorded: European eel recorded the highest density with 1.16 per 100m^2, all other species recorded densities of less than one fish per 100m^2. The North Stifford site recorded nine species, with roach being recorded in the highest densities at 6.36 per 100m^2. European eels were reported at densities of 1.83 per 100m^2, and all other species were recorded at densities of less than one per 100m^2. At the Grangewater site eight species were recorded, European eels and roach had the highest densities of 3.71 and 2.46 per 100m^2 respectively, all other species had densities of less than one per 100m^2.

4.3.9 The Fen Farm Bridge site survey in 2012 recorded only one fish, a dace, giving a density of 0.95 per 100m^2 (Table 4.3).

Table 4.3 Environment Agency electrofishing survey data, Mardyke (2012/2013) densities of fish per 100m²

Species	Site name/survey year							
	Fourteen Arches Bridge 2013		North Stifford 2013		Grangewater 2013		Fen Farm Bridge 2012	
	A*	D*	A*	D*	A*	D*	A*	D*
Three-spined stickleback *Gasterosteus aculeatus*	7	0.27	16	0.45	10	0.37	0	0
Common carp *Cyprinus carpio*	2	0.08	5	0.14	1	0.04	0	0
Dace *Leuciscus*	0	0	0	0	0	0	1	0.95
European eels elvers *Anguilla anguilla*	28	1.16	46	1.83	99	3.71	0	0
Goldfish *Carassius auratus*	0	0	12	0.34	0	0	0	0
Gudgeon *Gobio gobio*	1	0.04	11	0.31	7	0.33	0	0
Perch *Perca fluviatilis*	17	0.78	1	0.03	3	0.11	0	0
Roach *Rutilus rutilus*	1	0.04	209	6.36	64	2.46	0	0
Rudd *Scardinius erythrophthalmus*	2	0.08	4	0.11	3	0.11	0	0
Ruffe *Gymnocephalus cernuus*	4	0.16	0	0	0	0	0	0
Tench *Tinca tinca*	19	0.74	22	0.73	2	0.07	0	0
A: Fish abundance **D: Fish density**								

4.4 North Portal

Macro-invertebrates

4.4.1 Macro-invertebrate samples were collected in 2018 (3 sites) and 2022 (11 sites; Annex A). All sites indicate slightly brackish conditions, with SAG scores in excess of 4.5. A summary of species with a SAG Group of III (highest group recorded), which indicates the taxa are characteristic brackish water taxa, tolerant of a wide range of salinity conditions from long-term brackish to near freshwater, are provided in Table 4.4.

Table 4.4 Species identified with SAG Group III – North Portal

Species	Site (2018)	Site (2022)
Agabus conspersus (Beetle)	WO29	JN3
Berosus affinis (Beetle)	WO22N	JN3

Species	Site (2018)	Site (2022)
Colymbetes fuscus (Beetle)		JN3
Corophium multisetosum (Amphipod)		JN8
Enochrus bicolor (Beetle)	WO26N	JN3, JN10
Gammarus duebeni (Shrimp)	WO22N WO29	JN1, JN3, JN4, JN5, JN9, JN10, JN11
Hygrotus parallelogrammus (Beetle)	WO26N	
Nereis diversicolor (Polychaete)		JN8
Noterus clavicornis (Beetle)	WO29	JN1
Notonecta viridis (Backswimmer)	WO26N	
Ochthebius marinus (Beetle)		JN3
Sphaeroma rugicauda (Sea Slater)		JN8
Palaemon sp.(Prawn)	WO22N	
Palaemonetes varians (Prawn)	WO22N	JN10
Rhantus frontalis (Beetle)	WO26N	JN1
Sigara selecta (Water boatman)		JN10
Sigara stagnalis stagnalis (Water boatman)		JN10

4.4.2 The macro-invertebrate communities at all sites indicate a slow flowing, sedimented environment confirming on-site observations at the time of sampling. Typical slow-flowing taxa which prefer ditch-like conditions were identified, including Coleoptera (beetles), Mollusca (snails), Corixidae (water boatman) and Notonectidae (backswimmers).

4.4.3 In 2018, WHPT NTAXA indicates greatest diversity was at site WO26N with 16 taxa, WO29 with 9 taxa and site WO22N with 5 taxa. In 2022, WHPT NTAXA ranged from 2 taxa at site JN8 to 10 taxa at sites JN1 and JN3. Low WHPT ASPT scores indicate species present are less sensitive to water quality.

4.4.4 CCI scores at the three ditches sampled in 2018 were all in excess of 20 indicating Very High conservation value. In 2022, JN3 and JN10 achieved a score of 20 or above. A number of species of conservation interest (CCI 7 or above, Notable) were present. These were all species of beetle, some of which classed as Nationally Scarce (Foster, 2010) and are presented in Table 4.5.

Table 4.5 Species of conservation interest - North Portal sites

Species	Site (2018)	Site (2022)	CCI Value	Foster (2010)
Agabus conspersus	WO29	JN3	Notable	Nationally Scarce
Berosus affinis	WO22N	JN3	Notable	
Enochrus bicolor	WO26N	JN3, JN10	Notable	Nationally Scarce
Enochrus halophilus	WO26N		Notable	Nationally Scarce
Hygrotus parallelogrammus	WO26N		Notable	Nationally Scarce

Species	Site (2018)	Site (2022)	CCI Value	Foster (2010)
Hygrotus quinquelineatus	WO26N		Notable	Nationally Scarce
Ochthebius marinus		JN3	Notable	
Rhantus frontalis	WO26N	JN1	Notable	Nationally Scarce

White-clawed crayfish

4.4.5 During the Phase 1 habitat suitability mapping, no potential white-clawed crayfish habitat was recorded. This was confirmed by subsequent walkover surveys. A lack of third-party data and the fact that no white-clawed crayfish were caught in the macro-invertebrate samples, indicated that it was highly unlikely that they are present.

Fish

4.4.6 Although no fish surveys have been completed on the watercourses in the North Portal target area, there are two tidal sluices connecting the catchment to the Thames Estuary. As a result of this connectivity, it has been assumed that eels (*Anguilla anguilla*) are likely to be present in the catchment. It has also been assumed that minor coarse fish species may also be present in the permanent ditches in the study area.

Macrophytes

4.4.7 The macrophyte communities in the ditches surveyed in 2022 for the LTC North Portal were typical of a lowland, slow flowing ditch system. Full details of the macrophyte assemblage and total cover values are provided in Annex A. A description is provided below.

4.4.8 Species diversity was low throughout all sites; one species, the common reed *Phragmites australis* was identified at site JN2, JN4 and JN7. Three species were identified at site M75; filamentous algae, common reed *Phragmites australis* and a horned pondweed *Zannichellia palustris*. Two species were identified at all other sites. Number of scoring taxa (NTAXA) and number of functional groups (NFG) was considerably lower; M75 had 2 scoring taxa, whilst the remainder of the sites achieved 1 or 0.

4.4.9 Though species diversity was low, abundance was high at the majority of sites; seven sites had 90% or more cover of macrophytes. The remainder of sites had 65% or less. At site JN11 macrophytes were absent throughout 95% of the survey reach.

4.4.10 *P.australis* was prevalent at all sites except JN1 and JN11, where sea clubrush *Bolboschoenus maritimus* dominated and site M75 where *Z. palustris* had over 75% cover of the channel.

4.4.11 RMNI scores at all sites are above 7; RMNI scores give an indication of nutrient enrichment with scores ranging from 1 to 10. The percentage of green filamentous cover over each reach surveyed was greatest at site M75 (37.5%), followed by site JN1 (17.5) and JN8 (0.5%). No algae was recorded at the remainder of the sites.

4.4.12 No invasive species were identified in the 2022 macrophyte surveys in the North Portal sites.

4.5 South Portal

Macro-invertebrates

4.5.1 The LTC South Portal Scheme area is within the Thames Estuary and Marshes Ramsar, SPA and SSSI site. Twenty-seven invertebrate species are noted in the RAMSAR citation (JNCC, 2022) as Rare, Vulnerable or Endangered. The SSSI citation (Natural England, 2022) mentions over 100 Nationally Scarce species of invertebrate, but not listed.

4.5.2 The macro-invertebrate communities surveyed in 2018 (Filborough Marshes) and 2022 (west of Filborough Marshes) are typical of a low-land ditch system; slow/slack flowing water and heavily sedimented (Annex A). Taxa comprised species which are typical of this habitat; Coleoptera (beetles), Mollusca (snails and pea mussels) and waterbugs (Corixidae and Notonectidae).

4.5.3 The macro-invertebrate communities in the LTC South Portal areas are typically brackish water species (oligohaline; salinity 0.5 – 5 PSU); SAG scores at all sites, except one, are between 4.5 and 5.5. The exception is site MP1 in autumn 2021 which recorded a SAG score of 6.12, indicating a mesohaline (salinity 5 – 18 PSU) habitat. A summary of species with a SAG Group of III (highest group recorded), which indicates the taxa are characteristic brackish water taxa, tolerant of a wide range of salinity conditions from long-term brackish to near freshwater, are provided in Table 4.6.

Table 4.6 Species identified with SAG Group III – South Portal

Species	Site (2018)	Site (2022)
Agabus conspersus (Beetle)		MP1
Berosus affinis (Beetle)	JN2, JN3, JN5	
Colymbetes fuscus (Beetle)		MP1
Noterus clavicornis (Beetle)	JN2, JN3, JN4	MP1
Notonecta viridis (Backswimmer)	JN1, JN4	
Rhantus frontalis (Beetle)		MP1
Sigara stagnalis stagnalis (Water boatman)		MP2

4.5.4 The macro-invertebrate communities in the Filborough Marshes (2018) consisted of between 19 taxa (JN4 and JN5) and 28 taxa (site JN2). WHPT ASPT scores suggest a prevalence of species less sensitive of water quality.

4.5.5 The community in the ditch system to the west of the Filborough Marshes (2022) had a lower diversity compared to the 2018 survey. Diversity ranged from 10 taxa (MP3) to 19 (MP4). WHPT ASPT scores were also lower in 2022, drawing a similar conclusion to that of the 2018 data from the Filborough Marshes.

4.5.6 Conservation values across the sites sampled ranged from Fairly High to Very High in the 2018 data from the Filborough Marshes. Site J1 was classified as Fairly High; this was due to a large number of low scoring CCI species – no individual species identified as Notable or above. Site J2 was classified as High, with the Notable beetle *Berosus affinis* being recorded (Table 4.7). Sites J3, J4 and J5 were classed as being of Very High conservation status, this is due to a number of species of high conservation value identified.

4.5.7 The beetles *Hydrochus ignicollis* (RDB3 Rare, Near Threatened (Foster, 2010)) and *Ochthebius exaratus* (RDB2 Vulnerable) and the soldier fly *Stratiomys longicornis* (RDB2, Vulnerable) were identified at sites JN3 and JN5, JN3 and JN4 respectively (Table 4.7), and are all listed in the RAMSAR citation.

4.5.8 The conservation value of the sites surveyed in 2022, to the west of Filborough Marshes, ranged from Low to High. Site MP1 achieved High, with two Notable species identified, the beetles *Rhantus frontalis* and *Agabus conspersus*. Both of these beetles are considered Nationally Scarce (Foster, 2010). Site MP2 achieved Fairly High, and this was due to an abundance of lower scoring species rather than individual high scoring species. The remainder of the sites achieved Low to Moderate.

Table 4.7 Macro-invertebrate species of conservation interest (CCI 7, Notable or greater) – South Portal

Species	CCI Value	Site (2018)	Site (2022)	Foster (2010)
Agabus conspersus (Beetle)	7 Notable		MP1	Nationally Scarce

Species	CCI Value	Site (2018)	Site (2022)	Foster (2010)
Berosus affinis (Beetle)	7 Notable	J2, J3, J5		
Hydrochus ignicollis (Beetle)	8 RDB3 Rare	J3, J5		Near Threatened
Ochthebius exaratus (Beetle)	9 RDB2 Vulnerable	J3		
Rhantus frontalis (Beetle)	7 Notable		MP1	Nationally Scarce
Stratiomys longicornis (Soldier fly)	9 RDB2 Vulnerable	J4		

White-clawed crayfish

4.5.9 Phase 1 habitat suitability mapping suggested there was suitable habitat for white-clawed crayfish in one pond south of the A2. Further assessment of the sites and the fact there was no third-party data, nor specimens caught in macro-invertebrate samples, indicated that it was highly unlikely they were present.

Macrophytes

4.5.10 The LTC South Portal Scheme area is within the Thames Estuary and Marshes RAMSAR, SPA and SSSI site. The RAMSAR citation (JNCC, 2022) and SSSI citation (Natural England, 2022) notes the site supports nationally important species. In the following summary, identification of these species in the desk and field study is noted.

4.5.11 The macrophyte data from the Filborough Marshes (Thames Estuary RAMSAR site; LTC, 2018) indicates communities within the ditches were similar throughout the Marshes. Prevalent macrophytes include species of duckweed (*Lemna* sp.), Rigid Hornwort (*Ceratophyllum demersum*), Soft Hornwort (*Ceratophyllum submersum;* SSSI nationally scarce) and sea clubrush (*Bulboschoenus maritimus*). Sharp Rush (*Juncus acutus*) considered nationally scarce in Kent was recorded (LTC, 2018).

4.5.12 Nine of the 17 ditches sampled in 2018 (LTC, 2018) identified invasive species; New Zealand Pigmyweed (*Crassula helmsii*), and Water Fern (*Azolla filiculoides*). Macro-invertebrate sampling noted the invasive species New Zealand Pigmyweed at sites J1 and J2.

4.5.13 The macrophyte communities in the ditches surveyed in 2022 for the LTC South Portal to the west of Filborough Marshes were typical of a lowland, slow flowing ditch system (Annex A). A description is provided below.

4.5.14 Sites MP1, MP3 and MP4 were similar in character and macrophyte composition. Fifteen species were identified at sites MP1 and MP3 and twelve at MP4; between 5 and 7 truly aquatic taxa were identified (NTAXA), from 4/5 hydrophyte groups (NFG). Total coverage of macrophytes was 99% at each of these sites. There was a prevalence of duckweed (*Lemna minor*, *Lemna minuta* and *Lemna trisulca*), common reed (*Phragmites australis*) and bulrush (*Typha latifolia*). Sites MP1 and MP3 had a prevalence of hornwort (*Ceratophyllum*

demersum). Cover of filamentous algae (ALG) was highest at site MP4 (87.5%), 37.5% at MP3 and 1.6% at MP1. A number of species present are indicative of a nutrient rich environment (RMNI).

4.5.15 Site MP2 was a heavily shaded ditch, with approximately 50% of access prevented due to trees and scrub. This limited the ability to survey the macrophyte community in its entirety. Where access permitted, seven species were observed, bulrush (*T. latifolia*) and duckweed (*L. minuta*) prevailed. Total cover of macrophytes within the stretch surveyed was 25%. Two truly aquatic taxa were present (NTAXA) from 1 functional group (NFG). RMNI scored 8.7 which suggests a more nutrient enriched environment. No filamentous algae was recorded (ALG).

4.5.16 No invasive species were identified in the 2022 macrophyte surveys in the South Portal sites.

5 Assumptions and limitations

5.1.1 A number of ditches surveyed in 2018 for the North Portal were dry when visited.

5.1.2 At a number of sites in both 2018 and 2022, access was difficult as a result of the physical characteristics of the channels, including steep banks, dense bank top vegetation, deep water and silt. This often limited both the locations at which macro-invertebrate samples could be collected and the sampling methodology used.

5.1.3 For WFD Classification of macro-invertebrates, one spring and one autumn sample (and associated variables) should be collected per year. Sites may be classified using macro-invertebrate data from one, two or three years. For the purposes of this report, WFD classification has been calculated from one summer and one autumn sample (Mar Dyke data only), therefore caution must be taken with WFD assessment of the macro-invertebrate community.

6 Discussion

6.1 Mardyke

6.1.1 The Mardyke macro-invertebrate communities are typical of what would be expected in a slow-flowing, lowland river with abundant macrophyte growth. The observed differences in calculated metrics between the summer and autumn samples from the southern site are likely due to the lifecycles of certain species, where part of the lifecycle is terrestrial and may not be present in the aquatic environments at that time, as well as sample variation as a result of accessibility; sampling was difficult due to dense riparian vegetation and steep banks.

6.1.2 The rare (RDB3) dragonfly *Libellula fulva* recorded, is generally associated with slow-flowing rivers with good water quality, with a mix of submerged and floating vegetation (British Dragonfly Society, not dated). Although the species has a Red Data Book score of three, it is found widely across nine counties, therefore the invertebrate community has been given a county-level valuation.

6.1.3 Reported fish densities across all surveyed sites were low, although the species encountered, varied. Due to the low densities and commonality of the fish species present, the fish community (excluding eels) has been given a local valuation.

6.1.4 European eel are listed on IUCN Red List as critically endangered due to decline in abundances across all lifecycles (ZSL, 2018). It is included within Annex II of the Convention on Migratory Species and is provided with protections under the Eels (England and Wales) Regulations 2009. At two of the three sites surveyed on the Mardyke south of the proposed viaduct crossing, eels were the fish caught in the highest densities. Due to the legislation around eels they have been assessed as regionally important.

6.1.5 It is highly unlikely that white-clawed crayfish are found within this area due to limited suitable habitat and no evidence of their presence within the study area. As such, no valuation has been given to this receptor.

6.2 North Portal

6.2.1 The diversity of notable beetles identified across the survey sites was high in both the desk study (Colin Plant Associate, 2008 & 2016) (Telfer, 2017) and field studies. The beetles of the genus *Enochrus*, which were found within North Portal sites, are normally associated with brackish water conditions (National Biodiversity Network, not dated). Most of the CCI scoring beetles were ranked by the JNCC (Foster, 2010) as nationally scarce. However, many of the species identified across the sites are known to exist at other locations across the south-east of England and were recorded in low abundances in the samples. As a result, the macro-invertebrate community across the North Portal area has been given a county-level valuation.

6.2.2 It has been assumed that European eel and minor species are present in the permanently wetted watercourses across the North Portal area. As outlined previously, eels are a critically endangered species and as a result they have been given a regional valuation.

6.3 South Portal

6.3.1 All of the survey sites within the South Portal area are within the Thames Estuary and Marshes Ramsar site. Species which are listed in the Ramsar designation will be encompassed in the Ramsar valuation, whereas receptors that are not will be valued separately.

6.3.2 The ditch network sampled within the Thames Estuary and Marshes Ramsar site was diverse and contained a number of macro-invertebrate species of conservation interest. Macro-invertebrate species form part of Ramsar designation for the site (Ramsar Information Sheet, 2000). Six species of conservation interest were recorded at five sites and included three notable species, one rare (RDB3) and two vulnerable (RDB2) species. Of the RDB species present, Hydrochus ignicollis and Stratiomys longicornis, are listed in the Ramsar designation and so have been excluded from the valuation of the macro-invertebrate receptor (to avoid double counting with the designated site). With regard to the other species present, the three notable species of conservation are relatively widespread across the country (National Biodiversity Network, not dated) and therefore macro-invertebrates have been valued as having county-level importance.

6.3.3 It is highly unlikely that white-clawed crayfish are found within this area due to limited suitable habitat and no evidence of their presence within the study area. As such, no valuation has been given to this receptor.

6.3.4 Sharp rush was the only macrophyte of conservation importance recorded. Sharp rush is a saltmarsh plant found principally on the Welsh coast and east coast of Ireland. The conservation status in England is considered of least concern, but the species has a limited distribution and scarcity in Kent (Kitchener, 2016). Macrophytes have been valued as having county-level importance. The species water soldier, which falls under the Ramsar designation within the Thames Marshes (JNCC, 2008) was not found within the survey area.

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Annexes

Annex A Species List

Table A.1 Macro-invertebrate species list and metrics for the Mardyke survey sites

Species	Site / Survey Date			
	Mardyke South	Mardyke North	Mardyke South	Mardyke North
	Summer 2018	Summer 2018	Autumn 2018	Autumn 2018
Asellus aquaticus	6	13	28	15
BAETIDAE		2		
Caenis horaria			6	1
Caenis luctuosa/macrura			28	2
Calopteryx sp.	2	5		
Calopteryx splendens	3	9	7	3
Cataclysta lemnata		2		
Centroptilum luteolum	1			
Cercyon sp.	1			
Chironomidae	7	88	39	26
Cloeon dipterum		14		
COENAGRIONIDAE	3	2	7	1
Dendrocoelum lacteum			1	
Diptera	1			2
Dixa nebulosa		12	1	
Erpobdella octoculata	1		1	3
ERPOBDELLIDAE		1		
Gammarus fossarum/pulex agg	1	34	5	2
Gammarus pulex	1	1	5	1
GERRIDAE		3		
Glyphotaelius pellucidus			4	
Gyraulus albus			4	
Gyraulus crista			1	
Hydropsyche angustipennis	3	1	1	3
Hydropsyche sp.	1			
Hydroptila sp.		1		
Ilybius fuliginosus		1		
Ilybius sp.		1		

Species	Site / Survey Date			
	Mardyke South	Mardyke North	Mardyke South	Mardyke North
	Summer 2018	Summer 2018	Autumn 2018	Autumn 2018
Ischnura elegans		1	3	1
Libellula fulva			1	
LIMNEPHILIDAE			3	1
Limnephilus sp.			2	
LIMONIIDAE			1	
Lymnaea stagnalis		3		
LYMNAEIDAE		2		
Lype reducta			1	
Mystacides azurea			1	
Oligochaeta			4	69
Oulimnius sp.			4	1
Oulimnius tuberculatus			2	
Physa fontinalis				1
PHYSIDAE				1
Sialis lutaria	2		1	
SIMULIIDAE	1		1	
SPHAERIIDAE			1	
Sphaerium sp.			2	1
Stagnicola palustris		3		
SUCCINEIDAE		3	1	
Valvata piscinalis				1
LIFE (SP)	6.78	6.11	6.50	6.50
LIFE (F)	7.09	6.83	6.58	6.62
CCI	4.50	4.36	18.95	3.27
PSI (sp)	33.33	10.53	6.67	10.53
PSI (f)	42.86	44.44	38.46	25.00
WHPT ASPT	4.25	4.5	4.61	4.03
WHPT NTAXA	12	14	22	15
WHPT	51	63	101.4	60.5
SAG	4.3	4.6	4.5	4.6

Table A.2 North Portal Summer 2018 macroinvertebrate list and metrics

Species	Site		
	WO26N	W022N	W029
Aeshna sp.	3		
Agabus bipustulatus			1
Agabus conspersus			1
Anisoptera Gen. sp.	1		
Berosus affinis		7	
Cercyon marinus	1		
Chironomidae	116	229	75
Cladocera	117		
COENAGRIONIDAE	43	2	
COLYMBETINAE	4		
CORIXINAE	5	21	
CULICIDAE	254		
CULICINAE	563		
CURCULIONIDAE	2		
Diptera			4
DYTISCIDAE	3		
Enochrus bicolor	3		
Enochrus halophilus	2		
Enochrus sp.	1		
Enochrus testaceus	5		
EPHYDRIDAE	1		
Gammarus duebeni		4	21
Haliplus lineatocollis	1		
Helophorus sp.	2		
Hesperocorixa linnaei	3		
Hesperocorixa sahlbergi	2		
Hydrobius fuscipes	1		4
HYDROPHILIDAE	1		
Hydroporus erythrocephalus	1		
Hygrotus impressopunctatus	3		
Hygrotus parallelogrammus	4		
Hygrotus quinquelineatus	6		
Ischnura elegans	61		

Species	Site		
	WO26N	W022N	W029
Laccobius minutus	4		
LIMONIINAE			2
Nemotelus sp.			1
Nepa cinerea	2		1
Noterus clavicornis			1
Notonecta glauca	1		
Notonecta viridis	3		
Ochthebius minimus	3		
Palaemon sp.		2	
Palaemonetes varians		32	
Plea leachi	2		
PSYCHODIDAE	2		
Rhantus frontalis	4		
Scirtes sp.	2		11
Sigara dorsalis/striata		177	
Sigara lateralis	1		
STRATIOMYIIDAE	13		
LIFE (SP)	5.14	5.33	5.67
LIFE (F)	5.09	6.00	6.17
CCI	23.86	28.00	21.00
PSI (sp)	0.00	14.29	16.67
PSI (f)	13.04	14.29	35.71
WHPT ASPT	4.25	3.24	4.22
WHPT NTAXA	16	5	9
WHPT	68	16.2	38
SAG	5.95	8.4	7.6

Table A.3 North Portal Spring 2022 Macroinvertebrate species list and metrics

Species	Site										
	JN1	JN2	JN3	JN4	JN5	JN6	JN7	JN8	JN9	JN10	JN11
Agabus conspersus			2								
Anacaena limbata				14							
Asellus aquaticus				1			1				
Berosus affinis			1								
CERATOPOGONIDAE	1				19						
Chironomidae	229	102	22		18	11	14		2	10	108
Coleoptera		2									
Collembola				1	1						
Colymbetes fuscus			1								
CORIXIDAE			1							1	
Corophium multisetosum								112			
CURCULIONIDAE										1	1
Cymbiodyta marginella			1								
Diptera					1				2	6	
Dytiscus marginalis			1								
Enochrus bicolor			1							16	
Enochrus testaceus	1										
Gammarus duebeni	2		18	1	135				40	49	6
Gammarus sp.					55				18		
Glyphotaelius pellucidus						1					
Helius sp.	1	3	1								
Helophorus flavipes					1						
Helophorus grandis		1					1				
Helophorus obscurus/ flavipes					1						
Helophorus sp.	1										
Hydrobius fuscipes	2	1	3		5	2	2				
HYDROPHILIDAE							2			1	
Hydroporus memnonius				2							

Species	Site										
	JN1	JN2	JN3	JN4	JN5	JN6	JN7	JN8	JN9	JN10	JN11
Hydroporus planus		1		3							
Hygrotus inaequalis			1								
Ilybius fuliginosus	1										
Ilybius/Agabus	1		1			1	1				
Ischnura elegans	1										
Laccobius bipunctatus	3										
Laccobius minutus		1									
Laccophilus minutus			1				1				
Lepidoptera						1				1	
LIMNEPHILIDAE	14		1		2						
Limnephilus affinis/incisus	37		13	24	56				3	18	3
Limnephilus lunatus	40										
Limnephilus marmoratus						1					
Limnephilus marmoratus/flavicornis					1						
Limnephilus politus			1								
Limnephilus sp.					1						
Noterus clavicornis	25										
Ochthebius marinus			1								
Ochthebius minimus			1								
Ochthebius sp.		1									
Oligochaeta		2					1	6			2
Palaemonetes varians										42	
Potamopyrgus antipodarum									18	298	25
Proasellus meridianus						2	5				
Radix balthica	16					3	3				
Rhantus frontalis	1										
Scirtes sp.							7				
Sigara lateralis		1									
Sigara scotti			1								

Species	Site										
	JN1	JN2	JN3	JN4	JN5	JN6	JN7	JN8	JN9	JN10	JN11
Sigara selecta										2	
Sigara sp.			2							7	1
Sigara stagnalis										10	
STRATIOMYIIDAE			6								
TABANIDAE			2								
Sphaeroma rugicauda								3			
Nereis diversicolor								19			
Polydora sp.											3
LIFE (SP)	5.33	5.20	5.43	5.60	5.40	5.60	5.83	N/A	7.00	5.40	7.00
LIFE (F)	5.86	6.00	6.33	6.00	7.00	6.00	6.00	7.00	6.67	5.60	6.25
CCI	16.10	1.80	27.00	7.20	6.75	6.00	5.00	2.00	12.00	32.20	12.00
PSI (sp)	4.17	0.00	7.14	8.33	35.71	0.00	0.00	0.00	57.14	11.76	16.67
PSI (f)	25.00	27.27	40.00	30.00	55.56	11.11	9.09	0.00	100.00	40.00	50.00
WHPT ASPT	4.04	4.54	5.13	5.68	4.82	4.18	4.24	4.70	3.95	5.00	3.45
WHPT NTAXA	10	8	10	5	5	6	7	2	4	6	6
WHPT	40.4	36.3	51.3	28.4	24.1	25.1	29.7	9.4	15.8	30	20.7
SAG	6.33	5.00	6.83	6.67	6.50	4.67	4.80	10.00	8.00	8.13	7.50

Table A.4 South Portal Summer 2018 Macro-invertebrate species list and metrics

Species	Site				
	J1	J2	J3	J4	J5
Acari		1			
Alboglossiphonia heteroclita			1		
Anacaena limbata			7		3
Anopheles sp.				6	
ANOPHELINAE	19	16	4		
ASELLIDAE		9			
Asellus aquaticus	9	27	394		59
Athripsodes aterrimus	1				
Athripsodes sp.			2		1
Berosus affinis		2	5		1
Brachycercus harrisella					21
Caenis robusta	2	14	66	3	
Cataclysta lemnata	2	1	14	8	3
CERATOPOGONIDAE	1	1	1		
CHAOBORIDAE	37	1			
Chironomidae	91	15	24	81	26
Cladocera		146	7	1	2
Cloeon dipterum	126	8	11	71	81
COENAGRIONIDAE	31	111	177	25	114
Collembola			2		
Copepoda Gen. sp.	2	41	1	11	
Corixa punctata	1	5			
Corixa sp.	1				
CORIXIDAE		1		2	1
CORIXINAE	5				
Crangonyx pseudogracilis/floridanus	1	148	217		
CULICIDAE	5	4		112	3
CULICINAE	33	1		25	
CURCULIONIDAE			29		
Diptera			5		3
Dixella sp.			2		
Dugesia lugubris/polychroa	5		6		

Species	Site				
	J1	J2	J3	J4	J5
Dugesia tigrina		13	75		
EPHYDRIDAE	2				
Gyraulus crista	11		3	2	58
HALIPLIDAE	1	4	5	1	
Haliplus ruficollis	1	2	1	2	1
Haliplus ruficollis group	5	7	1	3	1
Haliplus sp.	3	14	37	3	
Helobdella stagnalis		1	5		
Hesperocorixa linnaei	7			3	
Hippeutis complanatus		7	15		14
Hydracarina	3		9	5	2
Hydraena testacea			2		
Hydrobius fuscipes			3		
Hydrochus ignicollis			4		1
Hydroglyphus geminus		1			
HYDROPHILIDAE	2	1		3	
HYDROPORINAE	11	3	4	1	1
Hydroporus palustris			3		
Hygrotus inaequalis	1	2	4	4	3
Hygrotus sp.	4				
Ilyocoris cimicoides cimicoides	3	15	72	3	2
Ischnura elegans		12	3		
Laccobius bipunctatus					1
Laccobius minutus	1		1		
Lepidoptera		2			
Leptocerus sp.					3
Leptocerus tineiformis	28	6	9	59	11
LIMONIIDAE				2	
LIMONIINAE			4		
Lymnaea stagnalis		5	1	5	
Musculium lacustre		9			
Noterus clavicornis		4	36	6	
Notonecta glauca	3	1		1	
Notonecta viridis	1			1	

Species	Site				
	J1	J2	J3	J4	J5
Ochthebius exaratus			1		
Ochthebius minimus	1				
Oligochaeta		33	15		
Ostracoda		1			
Physa fontinalis	9				
PHYSIDAE	3	322		76	5
Pisidium sp.			19		
Plea leachi	29	7	83	166	54
Potamopyrgus antipodarum		41	1		
Ptychoptera sp.			1		
PTYCHOPTERIDAE					2
Radix balthica	4	12	2	13	2
Ranatra linearis	1				
Sialis lutaria					2
Sigara distincta/falleni/fallanoidea		1			
Sigara dorsalis	1	2		2	
Sigara dorsalis/striata	1	8		1	
Sigara lateralis	1	7		2	
Sigara sp.				1	
SPHAERIIDAE		1			
STRATIOMYIIDAE	5	3	125	8	2
Stratiomys longicornis				1	
SUCCINEIDAE			5		
Theromyzon tessulatum		4			
TIPULIDAE		1			
Triaenodes bicolor			1		
Tricladida			2		
LIFE (SP)	5.27	5.43	5.47	5.22	5.39
LIFE (F)	5.50	5.13	5.45	5.44	5.82
CCI	10.91	16.86	35.08	33.18	30.63
PSI (sp)	0.00	0.00	2.90	0.00	5.88
PSI (f)	14.29	6.67	14.29	14.81	9.68
WHPT ASPT	4.12	3.68	4.39	3.92	4.04

Species	Site				
	J1	J2	J3	J4	J5
WHPT NTAXA	25	28	27	19	19
WHPT	102.9	103.1	118.6	5.22	76.8
SAG	5.19	5.47	5.32	5.38	5.17

Table A.5 South Portal Autumn 2021 and Spring 2022 Macro-invertebrate species list and metrics

Species	Site							
	MP1	MP2	MP3	MP4	MP1	MP2	MP3	MP4
	Autumn 2021	Autumn 2021	Autumn 2021	Autumn 2021	Spring 2022	Spring 2022	Spring 2022	Spring 2022
Agabus conspersus	2							
Agabus sp.	5							1
Alboglossiphonia heteroclita					4			
ASELLIDAE		6		12		3		
Asellus aquaticus	131	106	80	174	18	125	9	132
BAETIDAE								2
Callicorixa praeusta praeusta		2					2	1
CERATOPOGONIDAE					3			
CHAOBORIDAE	3	1						
Chironomidae	12	67	18	19	1	74	64	119
Cloeon dipterum		1	135	9	1	2	10	32
COENAGRIONIDAE		1	1					
Colymbetes fuscus	1							
Corixa sp.	1							
Crangonyx pseudogracilis/floridanus	86	1	20	9	7	8	5	88
Diptera			1					
Diptera Gen. sp.							1	
Dugesia lugubris/polychroa				1				6
Dugesia sp.				1				
DYTISCIDAE								1
GLOSSIPHONIIDAE	6		4	4				2

Species	Site							
	MP1	MP2	MP3	MP4	MP1	MP2	MP3	MP4
	Autumn 2021	Autumn 2021	Autumn 2021	Autumn 2021	Spring 2022	Spring 2022	Spring 2022	Spring 2022
Glyphotaelius pellucidus						1		
Gyraulus crista			5	2				20
Haliplus lineatocollis	2							
Haliplus ruficollis group	1				1			
Haliplus sp.	2		1	2				2
Helobdella stagnalis	8		10		2		2	
Hesperocorixa linnaei		8		1		2		3
Hesperocorixa sahlbergi		1						
Hydrobius fuscipes	1							2
Hydroporus memnonius	1							
Hydroporus palustris	3							1
Hygrotus inaequalis	11							
Hyphydrus ovatus	5							
Laccophilus minutus	1							
Lepidoptera	32	5	2	1		1		
LIMNEPHILIDAE	8	3	1			1	1	1
Limnephilus lunatus								4
Limnephilus marmoratus						1		
Limnephilus sp.	6		3	1				
Limnephilus vittatus					1			
LYMNAEIDAE					1			
Noterus clavicornis	2							
Notonecta glauca	1			1				
Oligochaeta	46		75	2	60	1	71	33
Physa fontinalis	66	6	33		2	5	4	1
PLANARIIDAE								7
Polycelis felina	1			1				5
Polycelis nigra/tenuis	1			1				4
Polycelis sp.			1					2
Potamopyrgus antipodarum		16		1		23		2
Proasellus meridianus		3				3		

Species	Site							
	MP1	MP2	MP3	MP4	MP1	MP2	MP3	MP4
	Autumn 2021	Autumn 2021	Autumn 2021	Autumn 2021	Spring 2022	Spring 2022	Spring 2022	Spring 2022
PSYCHODIDAE			4					
PTYCHOPTERIDAE		1						6
Radix balthica	29		6	10	1	1		1
Rhantus frontalis	1							
SCIOMYZIDAE	2							
Sigara dorsalis				3			5	5
Sigara dorsalis/striata					1			
Sigara falleni					1		2	
Sigara lateralis					5			
Sigara sp.			2				2	7
Sigara stagnalis stagnalis		1						
SPHAERIIDAE	110	4	6	6	2	1	1	1
Theromyzon tessulatum	1			1				
Tricladida				25				9
LIFE (SP)	5.67	5.75	5.43	5.92	5.82	5.80	5.75	5.82
LIFE (F)	5.21	5.91	6.00	5.92	6.10	5.89	6.25	5.94
CCI	15.11	12.50	3.50	5.18	5.00	6.00	3.86	4.93
PSI (sp)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PSI (f)	5.88	16.67	16.67	12.00	15.79	17.65	25.00	10.81
WHPT ASPT	3.41	3.62	3.66	3.43	3.53	3.42	3.76	3.77
WHPT NTAXA	18	12	16	16	13	11	10	19
WHPT	61.3	43.4	58.6	54.8	45.9	37.6	37.6	71.6
SAG	6.17	5.31	5.33	5.29	5.09	5.10	4.89	5.05

Table A.6 North Portal Summer 2022 Macrophyte species and metrics

Species	Site											
	JN1	JN2	JN3	JN4	JN5	JN6	JN7	JN8	JN9	JN10	JN11	M75
Aster tripolium											1	
Bolboschoenus maritimus	9									4	4	
Frogspawn algae	2											5
Green filamentous algae	6							2				7
Phragmites australis		9	5	9	9	9	9	6	6	8		6
Potamogeton pectinatus			1						1			
Solanum dulcamara					1	1						
Zannichellia palustris												9
Number of species	2	1	2	1	2	2	1	2	2	2	2	3
Total cover of macrophytes (%)	100	90	10	90	90	90	90	20	20	65	5	100
RMNI	7.63	7.70	8.01	7.70	7.70	7.70	7.70	7.68	7.97	7.68	7.65	8.21
NTAXA	1	0	1	0	0	0	0	1	1	0	0	2
NFG	1	0	1	0	0	0	0	1	1	0	0	2
ALG	17.5	0	0	0	0	0	0	0.5	0	0	0	37.5

Table A.7 South Portal Summer 2022 Macrophyte species and metrics

Species	Total Cover Value			
	MP1	MP2	MP3	MP4
Alisma plantago-aquatica	1	1	1	2
Apium nodiflorum				1
Callitriche sp.	2		1	3
Carex sp.	2	1	1	1
Ceratophyllum demersum	9		9	
Epilobium hirsutum			1	1
Filamentous algae	3		7	9
Iris pseudoacorus	1	1	1	
Juncus effusus	1			
Lemna minor	2	1	1	4
Lemna minuta	9	5	9	9
Lemna trisulca	7		7	
Mentha aquatica				6
Phragmites australis	7		5	3
Potamogeton trichoides			1	
Solanum dulcamara	1	1	1	1
Sparganium erectum	7			
Typha latifolia	6	6	4	7
Veronica sp.	1		1	
Total number of species	15	7	15	12
Total macrophyte cover (%)	99	25	99	99
RMNI	8.55376	8.77357	8.53541	8.03854
NTAXA	6	2	7	5
NFG	4	1	5	4
ALG	1.7	0	37.5	87.5

Annex B Site Descriptions

B.1 Mardyke

Site (NGR)	Survey	Description	Photograph
Mardyke North (TQ 62091 83921)	2018	The channel was approximately 2m wide and 60cm deep. The channel was densely vegetated, with soft silt bed. The banks were steep sided and heavily vegetated making access difficult.	
Mardyke South (TQ 62012 83642)	2018	A straight channel approximately 3m wide and 60cm deep with silt dominated substrate. The channel was densely vegetated with emergent macrophytes. Sampling was limited in areas due to steep banks.	

B.2 North Portal

Site (NGR)	Date surveyed	Description	Photograph
W022N (TQ 67969 76911)	2018	This site is situated on a deep, straight ditch with steep banks and soft silt substrate. The channel is approximately 3m wide and 0.5m deep with no in channel macrophyte growth or marginal vegetation. Both banks are lined with dense vegetation including hawthorn and brambles.	
W026N (TQ 67274 76342)	2018	The ditch was approximately 3.5m wide and > 1m deep, comprised of silt channel bed. Emergent marginal macrophytes were present throughout the reach; no submerged macrophyte growth was observed.	
W029N (TQ 67694 76553)	2018	This site was a ditch/ponded area within a larger wetland area; access was limited. The surface of the water had oily film and produced a strong smell when disturbed. Width could not be estimated due to the dense emergent macrophyte growth. Depth	

Site (NGR)	Date surveyed	Description	Photograph
		within the sample area was 0.2m. Water levels were low at the time of sampling resulting in a smaller wetted area.	
JN1 (TQ 67244 76208)	2022	The ditches within the North Portal sampled in 2022 were all very similar. Low-lying ditch habitats, slow or slack flows and silt dominated substrates. Emergent macrophytes covered large areas of the site, resulting in a heavy shaded channel. At discrete locations, where emergent vegetation was absent, open water prevailed, often with submerged vegetation recorded. Banks were steep and soft in places, and the majority of macro-invertebrate samples were sweep. Width at most sites was 2.5m, with the exception of site JN1 which was 6.5m. Sample depth ranged from 10cm – 60cm.	
JN2 (TQ 67696 76551)			
JN3 (TQ 68078 76865)			
JN4 (TQ 66513 76489)			

Site (NGR)	Date surveyed	Description	Photograph
JN5 (TQ 66892 76481)			
JN6 (TQ 67191 77129)			
JN7 (TQ 66487 76940)			
JN8 (TQ 67845 75825)			
JN9 (TQ 68701 76893)			
JN10 (TQ 68695 76478)			

Site (NGR)	Date surveyed	Description	Photograph
JN11 (TQ 68706 76697)			
M75 (TQ 66723 76658)			

B.3 South Portal

Site (NGR)	Survey	Description	Photograph
J1 (TQ 67627 73776)	2018	Site J1 is located in a ditch which is parallel to a footpath with dense bramble and hawthorn. Grasses and rushes dominated the opposite banks. The field to the east is grazed by cattle; poaching was observed. Submerged and emergent macrophytes covered the entire survey area. Channel width and depth were estimated; 3m wide and 1m-1.5m deep. The substrate was soft silt. The invasive non-native New Zealand pygmyweed was present on the eastern bank.	
J2 (TQ 67750 73444)	2018	Site J2 lies on a ditch between two fields; grazed by cattle to the north and horses to the south. Areas of poaching were identified on the southern bank. The channel was estimated as 3m wide and 80cm deep. Shallow banks, soft silt substrate and dense macrophyte growth were observed. The invasive non-native New Zealand pygmyweed was recorded at this site.	
J3 (TQ 67945 73689)	2018	Site J3 was located on a small meander of ditch between two fields grazed by cattle. This was the most sinuous channel of the ditches surveyed in 2018. The channel was approximately 5m wide and 1.5m deep, comprised of silt and in channel macrophyte	

Site (NGR)	Survey	Description	Photograph
		cover was approximately 70%. The banks had low gradient with marginal emergent vegetation growth.	
J4 (TQ 68152 73642)	2018	Site J4 was located between two fields grazed by cattle, in a straightened reach. The channel had approximately 85% submerged macrophyte cover and deep soft silt substrate. The channel was approximately 2.5m wide and was 30cm deep within the sample area.	
J5 (TQ 68013 73391)	2018	Site J5 was located on a ditch which flows between two grazed fields. The channel had approximately 90% cover of submerged macrophytes. The channel was approximately 3m wide and 1.2m deep with soft, silt substrate.	
MP1 (TQ 67292 73855)	2022	See description below for MP3 and MP4.	

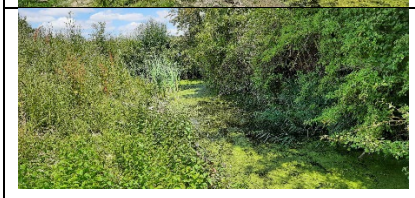
Site (NGR)	Survey	Description	Photograph
MP2 (TQ 67336 73747)	2022	Site MP2 is a small ditch heavily vegetated by trees and bushes on both banks causing almost 100% shading of the channel. Average channel depth is approximately 80cm and width 2.5cm. Extensive detritus was recorded within the channel, overlying a silt substrate.	
MP3 (TQ 67259 73630)	2022	Sites MP1, MP3 and MP4 were all similar in habitat characteristics. The channel comprised gentle banks, heavily vegetated on the east banks, with areas of emergent vegetation stands and open water sections heavily dominated by floating and submerged macrophytes. Poaching was evident in discrete locations by horses in the adjacent fields on the west banks. Substrate comprised 100% silt, which made access into the channel difficult due to the soft nature of the bed. This also made measuring depth difficult; average sample depth was approximately 30cm. Width ranged from 2.5m – 6.5m.	
MP4 (TQ 67211 73431)	2022		

Plate B.1 Mardyke macro-invertebrate and fish sample sites (2018)

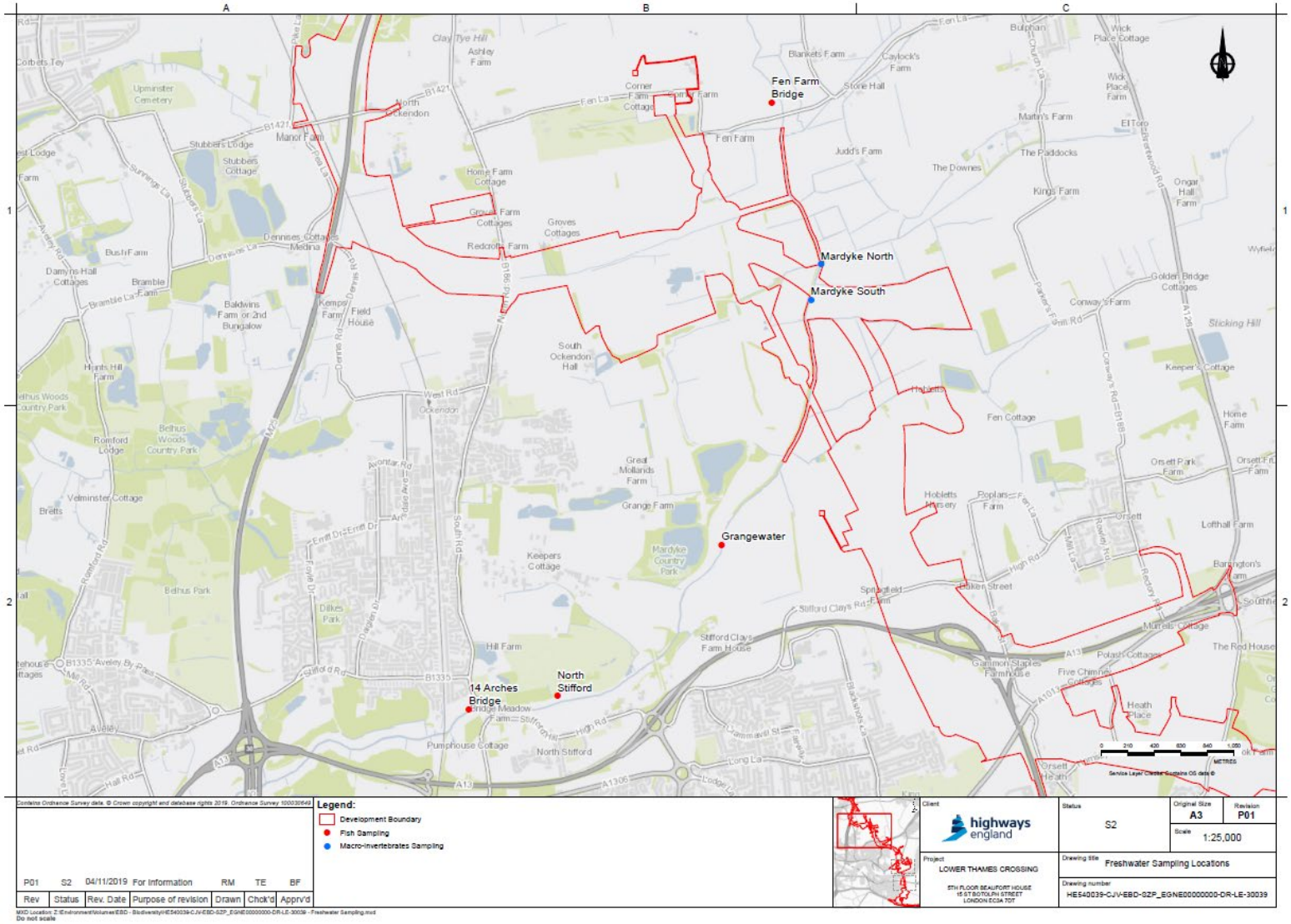


Plate B.2 North Portal area macro-invertebrate sample sites (2018)

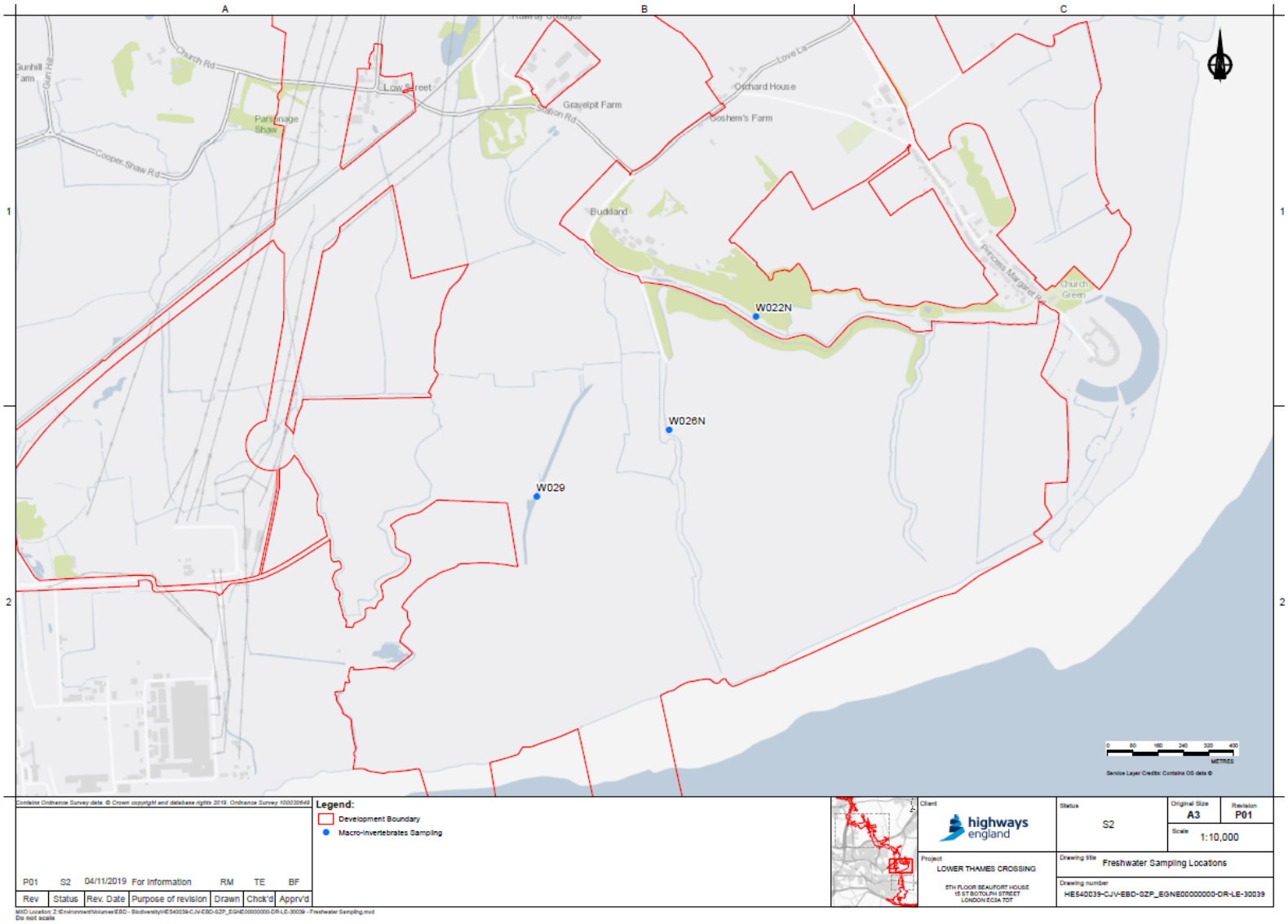
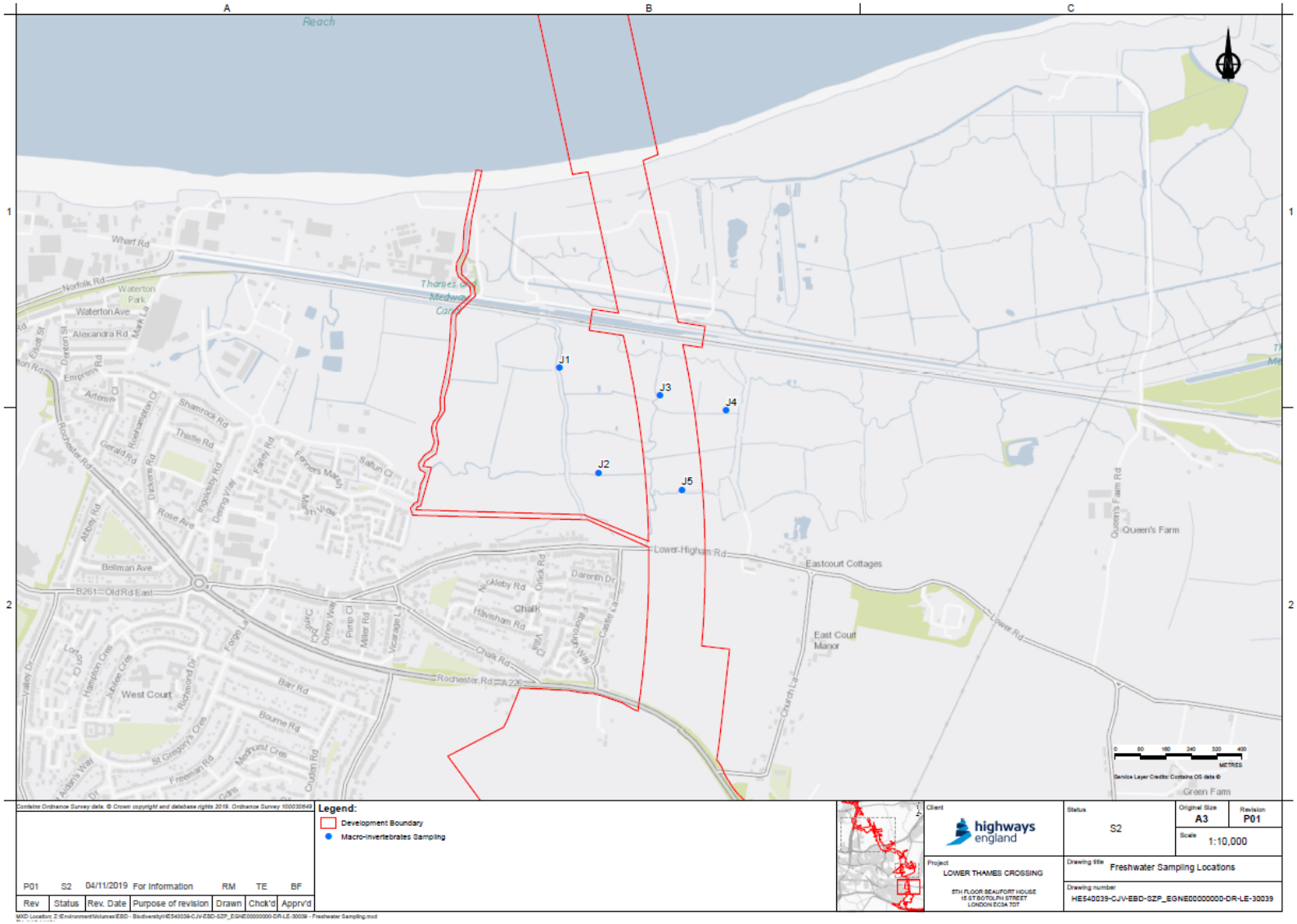


Plate B.3 South Portal macro-invertebrate sample sites (2018)



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