Ashfield Land Management and Gazeley GLP Northampton s.à.r.l

Annex L: Aquatic Survey Report

Fish, Macroinvertebrate, and Crayfish Surveys

Rail Central

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RSK GENERAL NOTES

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1 INTRODUCTION

Purpose of Report

This document reports on the findings of aquatic ecology surveys carried out in connection with a proposed Strategic Rail Freight Interchange close to Milton Malsor, Northamptonshire. The surveys focussed on sections of the Milton Malsor Brook and a small stream (hereafter referred to as Rothersthorpe Stream) located to the south of Junction 15a of the M1 motorway.

The current proposals include the potential realignment of the Milton Malsor Brook and the potential crossing of the Rothersthorpe Stream as part of plans to create a new slip road for the M1 motorway. The aquatic ecology surveys, including fish surveys, macroinvertebrate surveys and crayfish surveys, were undertaken to provide an ecological baseline against which any changes to the aquatic habitats and associated ecological features as a result of the proposed works can be assessed. Furthermore the surveys aimed to identify any fish or macroinvertebrate species of conservation interest (e.g. protected species).

Structure of this Report

The remainder of this report is set out as follows:

- *Section 3* describes the survey and assessment methods;
- *Section 4* presents the results of the surveys;
- *Section 5* details the discussion and conclusions;
- *Section 7* discusses recommendations; and
- *Section 6* lists the documents referenced in this report

Appendix A provides the invertebrate survey results; and

Appendix B provides the figures

2 METHODS

Aquatic Invertebrate Survey

Surveys of a single baseline sample site in each of the watercourses (Milton Malsor Brook and Rothersthorpe Stream) were carried out on 5 October 2017 by RSK ecologists. Sample locations are shown in *Figure L1* and also provided in *Table L4*. Sampling was for the purpose of assessing the biological water quality at each location and to evaluate the taxa present (e.g. to identify whether there were any species of conservation importance present such as protected or invasive species).

The method used to sample invertebrates followed the standard four-minute combined kick sampling technique, adhering to EA guidelines (Environment Agency 1999). The surveys were undertaken by two people at all times for safety reasons. Briefly, the sampling methodology, divided between each habitat type, comprised:

- 30 seconds of netting of any surface-active macroinvertebrates, such as pond skaters (*Hemiptera: Gerridae*) and whirligig beetles (*Coleoptera: Gyrinidae*);
- 3 minutes of active kicking and disturbing substrates and sediment with additional sweeping of vegetation where present; and
- 30 seconds of hand searching for macroinvertebrates, such as those adhering to submerged logs, stones or other debris, for example leeches (*Hirudinea*) and caddisfly larvae (*Trichoptera*).

Care was taken to ensure that all habitats and micro-habitats, both typical and atypical, were proportionally represented in the sample, and that surface-active insects and species adhered to submerged logs and stones were included.

Samples were preserved in methylated spirits and stored at the RSK laboratory. After rigorous sorting of samples all recovered macroinvertebrates were identified to family level, and the relative abundance of each identified taxon was recorded.

Macroinvertebrate Data Interpretation

General

The interpretive tools described below were used to examine the invertebrate datasets. Collectively, these are referred to as the biotic scores of a sample as explained below.

Biological Monitoring Working Party Score (BMWP)

The BMWP score relates to the pollution tolerance of an invertebrate assemblage and, therefore, the biological water quality of the relevant water body. This ascribes a numerical score (from 1 to 10) to a range of invertebrate families, depending on their tolerance/intolerance to organic (and other) pollution which can be related to water

quality. Pollution sensitive families score more highly than pollution tolerant ones. Therefore, the cumulative score of these assigned values gives a good indication of biological water quality, with higher values indicating better water quality (*Table L1*).

Table L1 allows general comparisons to be drawn regarding BMWP scores and actual water quality categories, as used by the Environment Agency.

Category	BMWP
Very Good	>150
Good	101 – 150
Fair	51 – 100
Poor	16 – 50
Very Poor	0 - 15

Average Score per Taxon (ASPT)

The ASPT is a derived index, which is obtained simply by dividing the BMWP score by the number of scoring families. The product is, therefore, somewhat independent of taxon richness. Using ASPT together with BMWP thus allows easier comparisons across samples and sites. Both measures are routinely used by the Environment Agency in assessing the biological water quality of rivers.

As a guide, a BMWP score of over 80 and an ASPT score of 5.0 or above indicates 'good to very good' biological water quality. A BMWP score of 50 to 80 and ASPT score of 4.0 to 5.0 indicates 'moderate to good' water quality. BMWP scores less than 50 and ASPT scores of less than 4.0 suggest 'reduced to poor' water quality.

NTAXA (Taxon Richness)

This is the number of invertebrate taxa recorded, and is the most widely used measure of biodiversity. A taxon in this case is taken to mean a group of related animals, such as a species, a genus or a family.

Community Conservation Index

The Community Conservation Index (CCI) is an expression of conservation value, it accounts for community richness as well as the relative rarity of species present (Chadd and Extence, 2004). Each species is assigned a Conservation Score (CS) of 1 to 10 based on the parameters outlined in *Table L2.*

Table L2. Conservation Scores (CSs) for freshwater invertebrate species in Britain

CS	Definition
10	Red Data Book 1 (RDB1 – Endangered)
9	Red Data Book 2 (RDB2 – Vulnerable)

8	Red Data Book 3 (Rare)
7	Notable (not not Red Data Book status)
6	Regionally Notable
5	Local
4	Occasional (species not in categories 10-5, which occur in up to 10% of all samples from similar habitats)
3	Frequent (species not in categories 10-5, which occur in > 10-25% of all samples from similar habitats)
2	Common (species not in categories 10-5, which occur in > 25-50% of all samples from similar habitats)
1	Very Common (species not in categories 10-5, which occur in >50-100% of all samples from similar habitats)

The sum of the CSs is then calculated and divided by the number of contributing species to give a mean measure of conservation value. This is then multiplied by a Community Score (CoS) which is derived from the rarest taxon present or the BWMP score.

CCI calculation can be applied to specific taxa in a sample rather than mandatory identification of all taxa present in a sample. However, it should be noted that the greater the size of the species dataset obtained, the better the resolution of the final score index.

CCs can range from 0 to >40, an interpretation guide of scores is provided below:

- 0.0 to 5.0 – sites supporting at least one uncommon species and/or a community of low taxon richness – **low conservation value**
- 5.0 to 10.0 – sites supporting at least one species of restricted distribution and/or a community of moderate taxon richness – **moderate conservation value**
- 10.0 to 15.0 – sites supporting at least one uncommon species or several species of restricted range and/or a community of high taxon richness – **fairly high conservation value**
- 15.0 to 20.0 – sites supporting several uncommon species, at least one of which may be nationally rare and / or a community of high taxon richness – **high conservation value**
- >20.0 – sites supporting several rarities, including species of national importance, or at least one extreme rarity (e.g. taxa included in the British RDBs) and / or a community of very high taxon richness – **very high conservation value**

LIFE

LIFE (Lotic-invertebrate Index for Flow Evaluation) was used to assess the flow regime to which the invertebrate communities at the sites were adapted, ranging from fast to slow flows. This would provide a base-line state against which any potential future changes that might arise from the planned scheme could be assessed.

The Invertebrate species and families present are assigned to a particular flow group with flow sensitivity scores calculated based on the relevant flow group and abundance categories (Extence *et al*, 1999). The LIFE score is then calculated as the average flow score for the invertebrates within the sample.

As a guide LIFE scores less than 6.00 generally indicate sluggish or still water conditions. As current velocity increases, so do LIFE scores. LIFE values greater than 7.5 indicate very fast flows. LIFE scores will change throughout the seasons depending on flow conditions and care must be taken when comparing scores from samples collected in different seasons.

PSI

The PSI (Proportion of Sediment-sensitive Invertebrates) index was used to assess the preferred silt regime that the current, base-line fauna in the streams was adapted to. The amount of siltation within a watercourse is often determined by the flow regime and PSI scores can be linked to LIFE scores, with decreasing flow - reduction in the LIFE score - often leading to increased siltation and reduction in the PSI. Heavy rainfall and increased run-off during and post construction could increase silt-loading to the nearby watercourses, a factor that would be picked up by significant decreases in the PSI scores from the established baseline.

The PSI scores are calculated based on published sediment sensitivities and abundance categories (Extence *et al*, 2013). Each species or family of invertebrates is assigned a sensitivity to fine sediment score. The PSI score is then calculated as follows:

$$PSI = \left[\frac{\sum \text{Scores for Sediment Sensitivity Groups A \& B}}{\sum \text{Scores for all Sediment Sensitivity Groups A; B; C \& D}} \right] \times 100$$

The condition of the river bed is then classified according to the criteria shown in *Table L3.*

Table L3. Interpretation of PSI Scores

PSI	River Bed Condition
81–100	Minimally sedimented / unsedimented
61–80	Slightly sedimented
41–60	Moderately sedimented
21–40	Sedimented
0–20	Heavily sedimented

Crayfish surveys

A walkover survey was undertaken at both watercourses in May 2017 to assess their suitability for White-clawed Crayfish (*Austropotamobius pallipes*). The survey took into consideration the following features within the watercourses:

- water depth;
- water velocities (crayfish are often absent from very fast flowing water);
- turbidity;
- substrate;
- presence of potential refuges (e.g. woody debris, undercut banks, boulders, tree roots etc.).

Both watercourses were subsequently surveyed using day time hand searching / hand netting methods and night time torch surveys which are in accordance with standard survey methods for White-Clawed Crayfish (e.g. see Peay, 2003).

During the walkover survey potential electrofishing sites were also identified.

Electrofishing surveys

Two survey sites were electrofished, one on each of the two watercourses, and these were selected following the crayfish walkover survey. Electrofishing took place on 5 October 2017 and the site locations are given in *Table 4*.

Table L4. Electrofishing survey locations.

Site / watercourse name	Macroinvertebrate Upstream survey location (NGR)	Macroinvertebrate downstream survey location (NGR)	Upstream limit of the electrofishing survey (NGR)	Downstream limit of the electrofishing survey (NGR)
Milton Malsor Brook	SP 72900 55456	SP 72954 55578	SP 72956 55580	SP 72927 55515
Rothersthorpe Stream	SP 72516 57000	SP 72567 57101	SP 72567 57103	SP 72535 57031

Figure L1 illustrates the locations of the survey reaches as defined by the upstream and downstream stop net locations. The figure also shows the locations for the aquatic invertebrate samples.

Stop nets were positioned at the upstream and downstream limits of each survey reach. Surveys were then undertaken using electrofishing methods. A three-catch removal method was used with each of the three electrofishing 'runs' being undertaken in a downstream to upstream direction. All fish captured on each run were transferred to water-filled holding buckets until the completion of surveys in that reach. Between each run, time was allowed for the water to clear following disturbance of the substrate by surveyors.

Upon completion of surveys in each reach all fish were identified (species), measured (fork length or total length to the nearest millimetre depending on the species) and enumerated before being released back into the watercourse reach from which they were captured.

Basic site data (including physical river characteristics) were recorded on standard proformas in the field and are summarised in the relevant part of the results section of this report.

Throughout the report normal convention if followed with respect to bank identification i.e. banks are designated Left Hand Bank (LHB) or Right Hand Bank (RHB) whilst looking downstream.

Standard biosecurity practices ('Check, Clean, Dry') were followed throughout surveys with all equipment being sterilised or thoroughly dried before arrival at the survey site and upon completion of the surveys.

3 RESULTS

The following sections of this report provide site details, fish and macroinvertebrate survey results for each of the two survey reaches identified in *Figure L1*.

Milton Malsor Brook Site Description

This survey reach was located on the Milton Malsor Brook immediately south of Gayton Road on the western outskirts of Milton Malsor in Northamptonshire. Upstream and downstream stop nets were positioned at the approximate grid references provided in *Table 4*. Macroinvertebrate samples were taken from upstream and downstream of the survey reach immediately prior to fish surveys being undertaken.

The survey reach was approximately 100 m long with an average wetted width of 2 m (width range = 1.1 m to 2.3 m) and an average depth of 0.2 m (depth range = o.1 m to 0.4 m). Water levels were considered to be relatively low with little rainfall during the days preceding the survey. Water clarity at the start of the survey was moderately good with the substrate clearly visible throughout the majority of the survey reach.

The substrate throughout the survey reach was comprised predominantly of fine sand and silt with significant areas of gravel and coarse sand, small patches of compacted clay and the occasional boulder. The dominant flow type throughout the reach was shallow run with small areas of shallow slack water.

Throughout the survey reach there were occasional in-channel features which may provide refuge areas for fish and other aquatic life (e.g. crayfish and macroinvertebrates) and these included tree root systems, large and coarse woody debris, undercut banks and overhangs. Numerous burrows considered likely to be crayfish burrows were also observed in the river banks at multiple locations throughout the survey reach.

The land adjacent to the survey reach was mainly arable land with trees and shrubs lining the majority of the channel resulting in heavy shading throughout the entire reach.

Rothersthorpe Stream Site Description

The upstream limit of the Rothersthorpe Stream survey reach was located just downstream of a culvert on the southern side of the A43 which runs just to the south of Junction 15a of the M1 motorway in Northamptonshire. Stop nets were placed at the upstream and downstream limits of the survey reach at the approximate grid references provided in *Table 4*. Macroinvertebrate samples were taken from upstream and downstream of the survey reach immediately prior to fish surveys being undertaken.

The survey reach was approximately 100 m long with an average wetted width of 1 m (width range = 0.75 to 2m). The average depth throughout the reach was 0.2 m with a depth range of <0.05 m to 0.5 m. Water levels were considered to be relatively low with little rainfall during the days preceding the survey. Water clarity at the start of the survey was moderately good with the substrate clearly visible throughout the majority of the survey reach apart from the very deepest areas (e.g. depth > 0.4 m) where the substrate was difficult to see.

The substrate throughout the surveyed reach was comprised predominantly of fine silt and compacted clay with some small areas or gravel and coarse sand. The flow type throughout the reach was mostly shallow run with some small areas of riffle and deep and shallow slack water.

There were several sections of the channel that contained features which provide refuge areas for fish and other aquatic life such as crayfish and macroinvertebrates. These included tree root systems and large and coarse woody debris including one large woody debris dam approximately two-thirds of the way along the reach.

The land adjacent to the RHB was a field of elephant grass and the land adjacent to the LHB was a mixture of scrub and deciduous woodland beyond which was the Grand Union Canal.

Aquatic Invertebrates

A full list of the invertebrate assemblages recorded in the samples is presented in *Appendix A*. The table below summarises the biotic scores recorded at each site.

Table L5. Summary of Biotic Scores

Site	NTAXA	BMWP	ASPT	CCI	LIFE	PSI
Milton Malsor (US)	13	57	4.38	5.00	6.9	33.33
Milton Malsor (DS)	11	37	3.70	2.33	6.9	33.33
Junction 15a (US)	11	46	4.60	4.00	7.2	53.33
Junction 15a (DS)	8	33	4.71	1.00	7.8	50.00

Constraints

The results presented in this report are based on surveys carried out in autumn on a single site visit. Although late summer is a suitable time of year, it is likely that the invertebrate assemblages are more diverse than the results suggest. Repeating surveys throughout the year would produce a more comprehensive list of invertebrate species, and reduce the impact of seasonality on the results.

There is also likely to be a seasonal fluctuation in river flow and corresponding sedimentation, PSI and LIFE scores. Comparisons between post-construction and

baseline results should take account the timing of the baseline surveys for more accurate conclusions to be drawn.

Numerous attempts to gain advice from the Environment Agency about the scope and methods of the proposed aquatic surveys, were unsuccessful.

Crayfish

The habitat within both watercourses was assessed as being suitable for crayfish. There were varying flow types which included slow flowing deeper areas and pools and faster flowing shallow areas. The substrate was not optimal for crayfish due to a lack of larger features such cobble and boulders. This notwithstanding there were numerous other features within the channel that would provide suitable refuges for crayfish including tree root systems, woody debris and undercut banks. Several holes considered likely to be crayfish burrows were also observed in the banks at several locations.

The crayfish surveys in both watercourses encountered crayfish identified as the invasive non-native Signal Crayfish (*Pacifastacus leniusculus*). No other crayfish species were found.

Electrofishing

Milton Malsor Brook

A total of eight individual species comprised of two different species were caught during the surveys. Both species are classed as minor species by the Environment Agency. The species numbers, estimated density, average length and length range are detailed in *Table L6*.

Table L6. A summary of the fish survey results from the Milton Malsor Brook.

Species	Total number caught	Estimated density (number of individuals per m^2)*	Mean length (mm)	Length range (mm)
Bullhead (*Cottus gobio*)	2	0.013	60	50 - 70
Three-Spined Stickleback (*Gasterosteus aculeatus*)	6	0.04	34.1	29 - 50

*Estimated density is calculated based on the total number of individual fish caught over three consecutive electrofishing runs divided by the total estimated area fished (i.e. 100 m [survey reach length] x 2 m [survey reach average wetted width]).

The Three-Spined Stickleback was the most abundant species comprising 75% of the total catch.

One Signal Crayfish was also observed during the electrofishing surveys.

Rothersthorpe Stream

A total of 18 individual fish were comprised of four different species were caught during the surveys. All species were those that are classed by the Environment Agency as being minor species. The species numbers, estimated density, average length and length range are all detailed in *Table L7*.

Table L7. A summary of the fish survey results from the Rothersthorpe Stream.

Species	Total number caught	Estimated density (number of individuals per m^2)*	Mean length (mm)	Length range (mm)
Bullhead (*Cottus gobio*)	4	0.04	46.75	31 - 80
Minnow (*Phoxinus phoxinus*)	3	0.03	48	40 - 56
Stone Loach (*Barbatula barbatula*)	6	0.06	66.2	40 - 79
Three-Spined Stickleback (*Gasterosteus aculeatus*)	5	0.05	31.8	25 - 41

There was very little difference between the species with respect to abundance. Stone Loach was the most abundant overall, with Minnow being the least abundant. The proportion of the total catch for each species caught is illustrated in *Plate L1*.

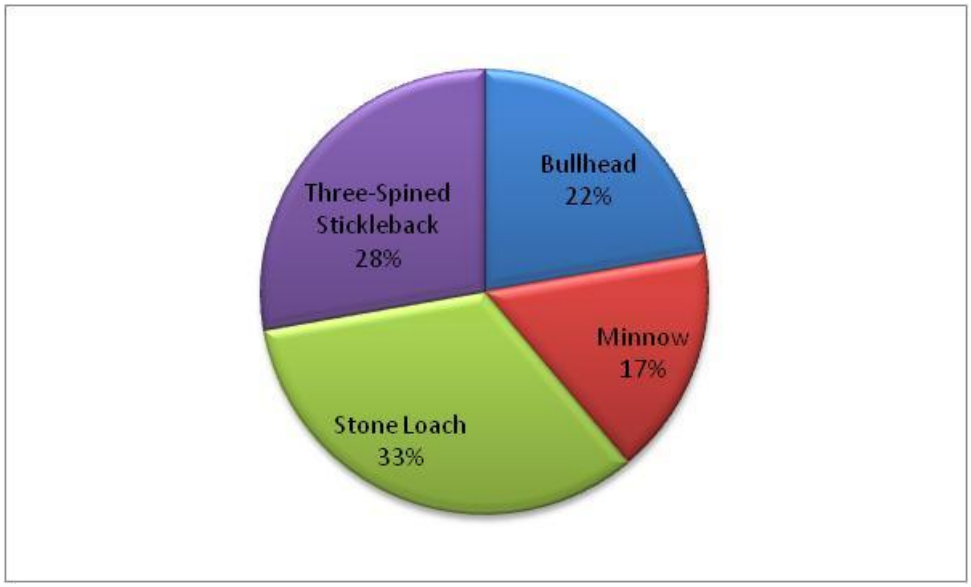


Plate L1. Pie chart illustrating the fish community composition for the Rothersthorpe Stream based on electrofishing catches using a three-run depletion method.

Two Signal Crayfish were also observed during the electrofishing surveys.

4 DISCUSSION

In-channel aquatic habitat

Milton Malsor Brook

The habitat within the Milton Malsor Brook included some in-channel diversity with respect to flow types and substrate composition. The channel was relatively straight perhaps indicative of historic realignment / channelisation. Large and coarse woody debris was present in several locations and there were areas with undercut banks and submerged root systems.

The aforementioned features all provide sufficient refuge and foraging habitat to support a reasonable diverse macroinvertebrate and fish community. The only obvious limiting factor from a physical habitat perspective is the degree of shading from riparian trees along the surveyed reach which will inhibit algal and macrophyte growth which can be important for some macroinvertebrate and fish species for reproduction, foraging / feeding and as refuges.

Rothersthorpe Stream

Similar to the Milton Malsor Brook, the Rothersthorpe Stream contained a variety of flow types and substrate types throughout. The channel was very straight and deeply incised with very steep banks on either side which may be indicative of historic realignment and dredging. Various features within the channel would provide adequate refuges for fish and macroinvertebrates although there was a notable absence of algae or macrophytes which is probably linked to the majority of the surveyed reach being heavily shaded by riparian trees.

Summary

Both watercourses are currently limited in terms of their habitat potential primarily by a lack of channel sinuosity, steep banks (particularly in the case of Rothersthorpe Stream) which restrict lateral connectivity of the channel with the riparian zone and heavy shading from riparian trees. This notwithstanding the physical habitat includes features which should support a greater diversity and abundance of macroinvertebrates and fish than was observed. It is likely therefore that there are other factors which are currently limiting the aquatic fauna such as water quality.

Aquatic Invertebrate Assemblages

The biotic scores for water quality are broadly moderate for all sites with the exception of the downstream Milton Malsor Brook site which has poor water quality.

The baseline results for the Community Conservation Index assessment shows both watercourses have low conservation value, however the Milton Malsor Brook upstream

site is close to having moderate conservation value. Both downstream sites have lower conservation value than the corresponding upstream sites.

The LIFE scores indicate that the invertebrate assemblages are typical of fast flowing watercourses with the samples taken around Junction 15a showing the fastest flows.

The baseline results for PSI scores show the Milton Malsor Brook sites to be classed as sedimented and the sites around Junction 15a to be moderately sedimented.

Comparisons between the sites are not required for the purposes of this assessment. Instead, these results should be used as a baseline against which changes in flow and sedimentation as a result of the proposed works, can be assessed.

Crayfish

The invasive, non-native Signal Crayfish was observed within both watercourses during surveys. This species grows larger and is more aggressive than the native White Clawed Crayfish and is known to outcompete it where both species occur together usually resulting in the localised extinction of White Clawed Crayfish. Furthermore, Signal Crayfish can carry a fungal disease known as crayfish plague to which they are immune but which is known to be fatal to White Clawed Crayfish. Unsurprisingly therefore no White Clawed Crayfish were observed.

Fish

The fish communities on both watercourses were considered to be poor both in terms of the species richness (total number of different species) and the overall abundance and density of fish. Milton Malsor Brook in particular had a very poor fish community. Although the physical habitat observed was not particularly optimal for supporting high fish densities or high species richness the results were still poorer than might be expected for a watercourse of this type. It is considered likely therefore that there are other factors which may also be limiting the fish communities in both brooks.

All the species caught are considered to be so-called minor species by the Environment Agency. However, Bullhead (*Cottus gobio)* is a Species of Principal Importance and is cited under Annex II of the EU Habitats Directive.

Summary

Both the macroinvertebrate and fish communities indicate that both watercourses are sub-optimal with respect to the species and abundances observed. The reasons are not clear based on the limited information gained from this study. It is likely that the in-

channel physical habitat, high levels of riparian shading and water quality are all contributing.

5 RECOMMENDATIONS

The survey results suggest that both watercourses are already pressured systems resulting in aquatic fauna communities that are less species rich and with lower population densities than might be expected from similar watercourses located elsewhere. Consequently any additional pressures resulting from the proposed works are likely to exacerbate this situation.

The works will be carefully planned to minimise or, preferably, eliminate any adverse impacts on the watercourses. River restoration measures which will provide a greater diversity of in-channel habitats and improve water quality (e.g. by reducing diffuse runoff from surrounding farm land and roads.

A c. 780m length of Milton Malsor Brook will need to be diverted. It will be profiled to provide a variety of flow rates, depth and widths. Further detailed design of the brook corridor, and planting scheme will be developed in consultation with CIEEM registered ecologists. The brook will be planted with water-margin species currently found there and in adjacent ditches. Excessive shading will be avoided. It is anticipated that the overall quality of the brook will be enhanced for water voles, otters, fish and aquatic invertebrates.

Good biosecurity practices will be adopted during all works on, in or within close proximity to any watercourses to prevent the spread of invasive non-native species. Signal Crayfish have been observed during these surveys and measures should be taken to avoid the spread of this species of the fungal disease that it can carry and which is lethal to native White Clawed Crayfish. A biosecurity method statement. will be produced.

6 REFERENCES

Environment Agency (1999). *Procedures for collecting and analysing macro-invertebrate samples.*

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

Extence, C.A., Balbi, D. M. And Chadd, R.P. (1999). *River flow indexing using benthic macroinvertebrates: a framework for setting hydro-ecological objectives. Regulated Rivers: Research & Management. 15: 543-574.*

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

Peay, S. (2003). Monitoring the White-Clawed Crayfish *Austropotamobius pallipes*. Conserving Natura 2000 Rivers Monitoring Series No. 1, English Nature, Peterborough.

APPENDIX A – INVERTEBRATE SURVEY RESULTS

Table A1 – Aquatic invertebrate results

Species	Description	BMWP Score	Conservation Status/CS Score	PSI Group	Flow Group	Sample Site															
						Milton Malsor								Junction 15A							
						US				DS				US				DS			
						Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)	Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)	Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)	Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)
COLEOPTERA																					
Elmidae		**5**																			
Elmidae larvae	Riffle Beetle			**B**	**2**									5*				5	A	1	8
Elmis aenea	Riffle Beetle		Very Common (1)	**B**	**2**									1	A	1	8				
ODONATA																					
Calopterygidae		**8**																			
Calopteryx splendens	Banded Demoiselle		Common (2)	**C**	**3**	1	A	1	7					1	A	1	7				
EPHEMEROPTERA																					
Baetidae		**4**																			
Baetis rhodani	Swimming Mayfly		Very Common (1)	**A**	**2**									1	A	2	8				
TRICHOPTERA																					
Limnephilidae		**7**																			
Micropterna lateralis	Cased Caddisfly		Common (2)	**B**	**4**	1	A	1	6	5	A	1	6								
*Limnephilus*sp (damaged)	Cased Caddisfly			**C**	**4**					5	A	1	6								
Hydropsychidae		**5**																			
Hydropsyche angustipennis	Caseless Caddisfly		Very Common (1)	**B**	**2**	10	B	2	9	50	B	2	9	2	A	1	8	5	A	1	8
Psychomyiidae		**8**																			
Lype reducta	Caseless Caddisfly		Frequent (3)	**D**	**2**	2	A	2	8												

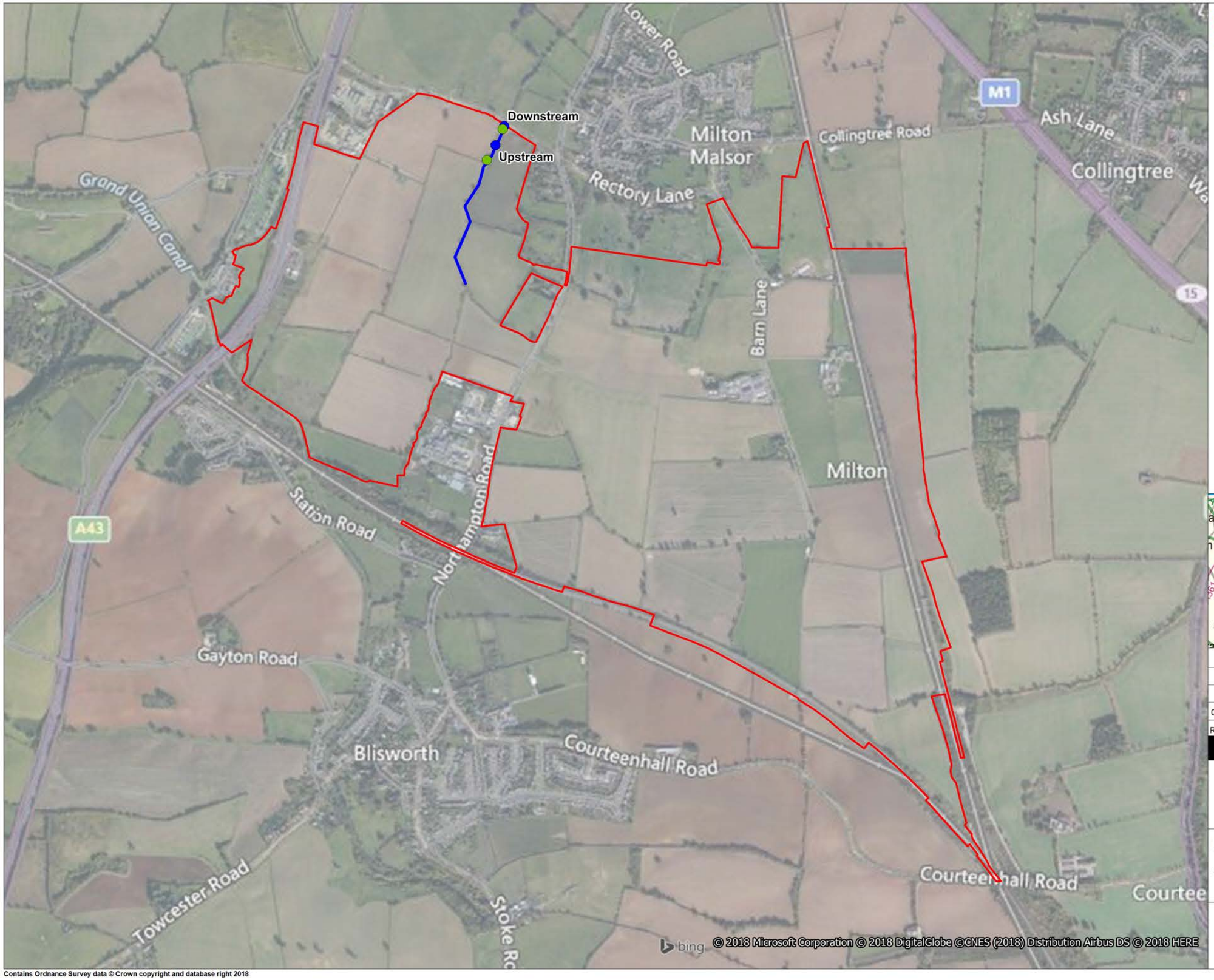
Species	Description	BMWP Score	Conservation Status/CS Score	PSI Group	Flow Group	Sample Site															
						Milton Malsor								Junction 15A							
						US				DS				US				DS			
						Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)	Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)	Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)	Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)
CRUSTACEA																					
Astacidae		**8**																			
Pacifastacus leinusculus	Signal Crayfish		Very Common (1)	**D**	**2**													1	A	2	8
Gammaridae		**6**																			
Gammarus pulex	Freshwater Shrimp		Very Common (1)	**B**	**2**	25	B	2	9	25	B	2	9	150	C	3	10	150	C	3	10
Asellidae		**3**																			
Asellus meridianus	Hoglouse		Frequent (3)	**D**	**4**	1	A	2	6					5	A	2	6				
Asellus aquaticus	Hoglouse		Very Common (1)	**D**	**4**									5	A	2	6				
NEUROPTERA																					
Sialidae		**4**																			
Sialis lutaria	Alderfly		Very Common (1)	**D**	**4**													1	A	2	6
DIPTERA																					
Chironomidae	Non-biting Midge	**2**	-	**-**	**-**	5	A	-	-	25	B	-	-	20	B	-	-	20	B	-	-
Stratiomyidae	Soldierfly	**NS**	-	**-**	**-**													1	A	-	-
Tipulidae	Cranefly	**5**	-	**B**	**4**	1	A	1	6					5	A	1	6				
Simuliidae	Blackfly	**5**	-	**A**	**2**					1	A	2	8								
HIRUNDINEA																					
Erpobdellidae		**3**																			
Erpobdella octoculata	Leech		Very Common (1)	**C**	**4**					1	A	1	6	1	A	1	6				
MOLLUSCA																					
Sphaeriidae		**3**																			
Pisidium sp	Pea Mussel		-	**D**	**4**	1	A	2	6	1	A	2	6								
Planorbiidae		**3**																			

Species	Description	BMWP Score	Conservation Status/CS Score	PSI Group	Flow Group	Sample Site															
						Milton Malsor								Junction 15A							
						US				DS				US				DS			
						Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)	Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)	Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)	Abundance	Abundance Category	Sediment Sensitivity Score	LIFE Flow Score (fs)
Gyraulus albus	White Ramshorn		Very Common (1)	**C**	**4**	5	A	1	6												
Hydrobiidae		**3**																			
Potamopyrgus antipodarum	Jenkins Spire Shell		Very Common (1)	**C**	**3**	20	B	2	7	5	A	1	7	5	A	1	7	1	A	1	7
Lymnaeidae		**3**																			
Radix balthica	Wandering Pond Snail		Very Common (1)	**D**	**4**	5	A	2	6	25	B	3	5								
OLIGOCHAETE																					
Oligochaete	Worm	**1**	-	**-**	**-**	1	A	-	-	5	A	-	-								
Taxon Richness						13				11				11				8			
BMWP Score						57				37				46				33			
Number of Scoring Families						13				10				10				7			
ASPT						4.38				3.70				4.60				4.71			
CS Sum						15				7				12				6			
CCI						5.00				2.33				4.00				1.00			
PSI Score						33.33				33.33				53.33				50.00			
LIFE Score						6.9				6.9				7.2				7.8			

APPENDIX B – FIGURES

Figure L1.1 – Sample Sites Location Plan

Figure L1.2 – Sample Sites Location Plan



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Rev	Date	Description	Drn	Chk	App
00	06.02.18	855950	SP	RG	RE

Rail Central

RSK

Figure L1.1

Aquatic Survey Locations

0 375

metres

Scale = 1:12,500 @ A3

N W E S

REV 00

File Name : U:\Ecology\855000s\855950 - Armtrack (Rail Central)\07 GIS

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Rev	Date	Description	Drn	Chk	App
00	06.02.18	855950	SP	RG	RE

Rail Central

RSK

Figure L1.2

Aquatic Survey Locations

0 250

metres

Scale = 1:7,500 @ A3

N W E S

REV 00

File Name : U:\Ecology\855000s\855950 - Armtrack (Rail Central)\07 GIS