Environmental Scientific Services

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River Mease Restoration Monitoring:
Annual report 2017

ECRC Research Report Number 180

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Cover photo: Gilwiskaw Brook – Site B

Contents

List of Tables

List of Figures

1. Overview

Twelve monthly water sample collections and annual invertebrate, habitat and macrophyte surveys have taken place to date. The water chemistry baseline data suggest Site C has the highest nutrient concentrations; habitat and invertebrate data suggest Site A (upstream control) and Site B are largely similar; with macrophyte data suggesting relatively poor habitat. Collated Environment Agency statutory water quality monitoring data for 2016 provide further baseline information (Table 3).

1.1. Annual action summary

- 24/11/15: start-up meeting
- 19/01/16: site selection and initial water sample collection
- 23/02/16: second water sample collection
- 23/03/16: third water sample collection
- 23/03/16: first invertebrate sample collection and habitat survey
- 19/04/16: fourth water sample collection
- 16/05/16: fifth water sample collection
- 16/06/16: sixth water sample collection
- 28/07/16: seventh water sample collection
- 22/08/16: eighth water sample collection
- 22/08/16: first macrophyte survey: Sites A & B
- 22/09/16: ninth water sample collection
- 26/010/16: tenth water sample collection
- 23/11/16: eleventh water sample collection
- 20/12/16: twelfth water sample collection
- 10/01/17: EA statutory monitoring data collated (Table 3)

2. Site information summary

Table 1 Site locations of 50m reaches, see also Figure 1.

Description	Grid Reference	Postcode	Site reference
A parking	SK 35860 14167	LE65 1WD	Control Site
A foot bridge	SK 36001 14191		
A upstream	SK 36000 14177		
A downstream	SK 35987 14131		
B parking	SK 36556 12701	LE67 2TE	GIL003
B gap in hedge	SK 36295 12652		
B upstream	SK 36150 12427		
B downstream	SK 36137 12381		
C parking	SK 32885 10163	DE12 7AJ	MEA001
C long route	SK 33132 10481		
C shortcut	SK 33317 10142		
C upstream	SK 33718 10061		
C downstream	SK 33672 10069		
D parking	SK 32343 11663	DE12 7DU	MEA005
D upstream	SK 32018 11915		
D downstream	SK 31974 11909		
E parking	SK 30258 12692	DE12 8AE	MEA007
E route	SK 30306 12466		
E route	SK 30287 12634		
E upstream	SK 30360 12435		
E downstream	SK 30365 12390		

Figure 1 Site locations.

3. Methods

Upstream and downstream water samples were collected at each site and combined to give mean concentrations of total phosphorus, orthophosphate, total oxidised nitrogen, suspended solids, dissolved oxygen and temperature (*note total phosphorus has been collected since July 2016). Further data collected by the Environment Agency have been collated to complement our data. Physical and biotic assessments were undertaken at Site A (upstream control) and Site B (designated for restoration): substrate proportions (i.e. %silt relative to other substrate), wood and plant percentage volume infested (PVI) were estimated at each invertebrate survey point (n = 12, i.e. 6 samples per reach).

3.1. Biotic characterisation

A bespoke 152.4mm diameter Hess sampler with 335 microns mesh was used to collect invertebrates. Unlike a kick net survey, Hess samples are quantitative meaning population densities can be estimated. A row of teeth at the base of the Hess and robust handles enabled it to cut through branches when used within woody structures. Samples were immersed immediately in 70% IMS to preserve contents for identification in the laboratory. Invertebrates were identified to species in most cases using a dissecting microscope with 40-100x magnification and counted to give the density per sample.

3.2. Macrophyte survey

Sites A and B were surveyed for aquatic macrophytes. Each 50 m reach was subdivided into 10 x 5 m sections and at each section a percentage cover was estimated for all plants found growing within a) the channel under normal flow conditions (i.e. aquatic plants) and b) on the bank (defined by the area between the waterline and bank-full). Additional records were made of substrate, shading, and general bank character. Plant identification was performed in the field were possible, and, where necessary, in the laboratory from voucher specimens.

3.3. Statistical methods

The principal aim of this report is to develop a baseline for the Gilwiskaw Brook and River Mease ecosystems. First we show how water chemistry differs between sites and over time. We use Tukey contrasts on linear models to test for water chemistry differences between sites, after accounting for seasonal effects. We then focus in on whether abiotic and biotic conditions between the control (Site B) and pre-restored (Site B) reaches differ. We use principal components analysis (PCA) and non-metric multidimensional scaling (NMDS) with the Bray–Curtis dissimilarity index to assess differences in environmental parameters and invertebrate composition, respectively.

Estimates of species richness were made using recently developed methodology published as the R package iNEXT (Chao *et al.* 2014). This approach provides information on the sampling efficiency (i.e. estimates what percentage of the community we are capturing) and provides a robust means of comparing samples where different sample sizes occur. In NMDS and species richness estimates, groups such as oligochaetes and chironomids were removed due to large within group diversity which can distort such analyses. “Reach” was a fixed term and “sample” was a random term in general linear mixed effects models (GLMM) used to assess differences in invertebrate density and biomass.

4. Results

There were seasonal trends in water chemistry variables, such as summer and winter peaks in suspended solid concentration (Figure 2 and see Table 4 in Appendix I). Concentrations of orthophosphate and total oxidised nitrogen were highest at Site C, and dissolved oxygen was lowest at Sites C and E. By comparing our data with those collected by the Environment Agency we were able to reveal that the elevated nutrient concentrations at Site C were driven by those coming from the R. Mease upstream of the confluence with G. brook (Table 3).

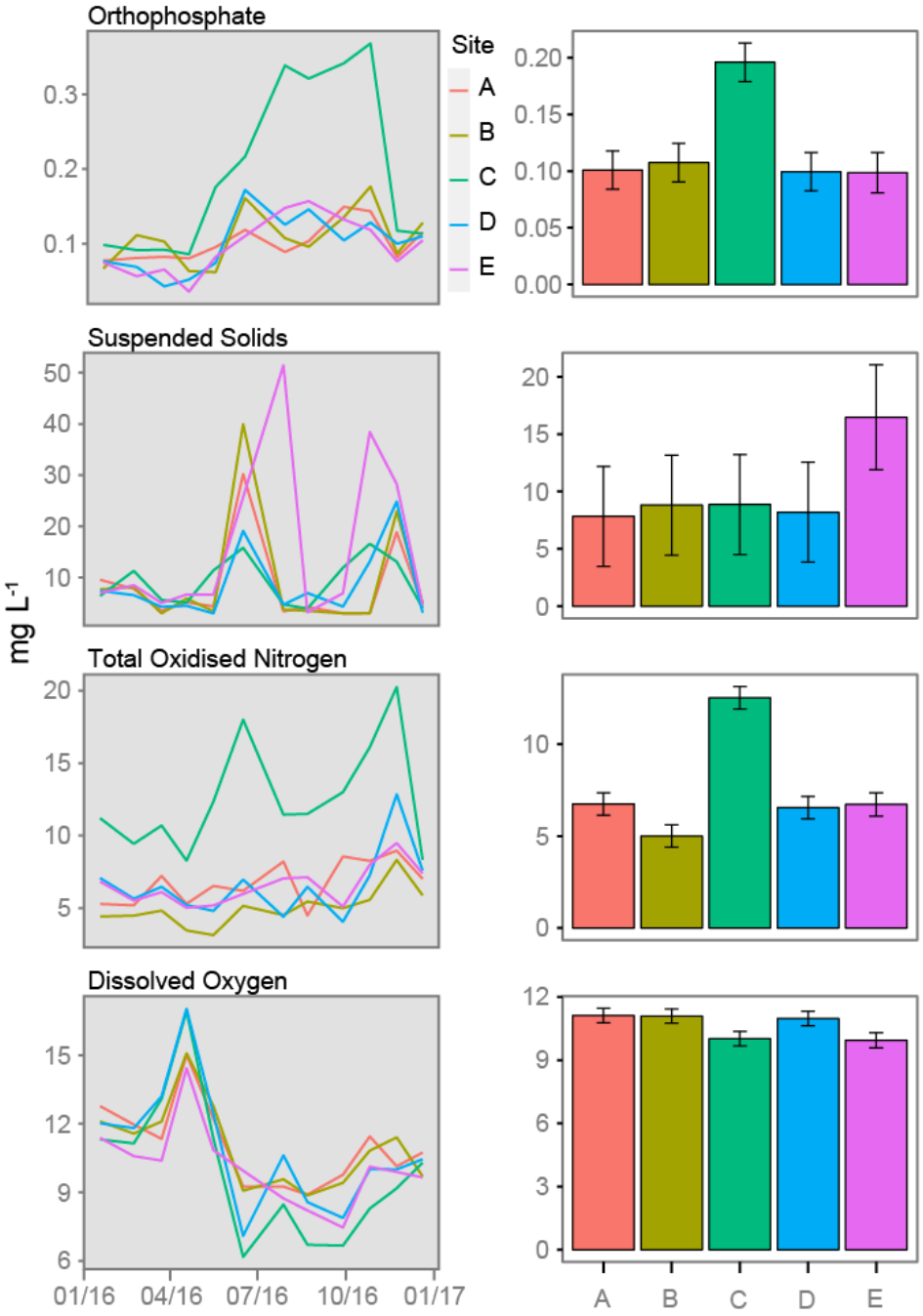


Figure 2 Left column: time series mean water chemistry data across sites. Right column: between site differences in water chemistry, error bars represent 95% confidence intervals.

Table 2 Annual mean water chemistry data for 2016. TON = total oxidised nitrogen which is the sum of nitrate (NO_3^-) and nitrite (NO_2^-).

	A	B	C	D	E
Dissolved oxygen (mg L^{-1})	11.07	11.04	9.97	10.93	10.15
Nitrite (mg L^{-1})	0.03	0.02	0.06	0.02	0.04
TON (mg L^{-1})	6.77	5.03	12.55	6.57	6.62
Ortho-phosphate (mg L^{-1})	0.1	0.11	0.2	0.1	0.1
Total phosphorus (mg L^{-1})	0.14	0.16	0.32	0.18	0.2
Suspended solids (mg L^{-1})	8.13	9.11	9.16	8.49	15.16
Temperature °C	10.05	11.14	10.21	10.56	10.32

Table 3 Annual mean water chemistry data for 2016 collected by the Environment Agency. Column titles indicate location of sampling stations in relation to our sampling design, US = upstream; DS = downstream; $^+$ = G. brook upstream of R. Mease confluence; * = R. Mease upstream of G. brook confluence. TON = total oxidised nitrogen which is the sum of nitrate (NO_3^-) and nitrite (NO_2^-)..

	A US	A DS	B DS	C US$^+$	C US*	E_DS
Dissolved oxygen (mg L-1)	11.03	10.02	10.78	9.66	9.6	10.14
TON (mg L-1)	8.09	3.61	4.85	5.83	10.04	5.77
Ortho-phosphate (mg L-1)	0.17	0.17	0.15	0.1	0.17	0.12
Temperature °C	12.83	15.58	10.36	10.15	10.48	9.65
Conductivity (µS-cm)	691.83	748.4	670.43	862	964.25	819.12
pH	8.12	7.98	7.99	7.98	7.83	7.93

There were no significant differences in habitat variables between Site A or B, but there was a significant difference in invertebrate community composition (Figure 3a, b, see Table 5 in Appendix II). This compositional difference was likely due to presence of *Ancylus fluviatilis, Asellus aquaticus, Clinocera* spp. only in Site A, and *Caenis lactuosa, Halesus radiatus* and *Polycentropus flavomaculatus* only recoded in site B, among other taxa. There were no significant differences in invertebrate species richness, abundance and biomass between sites (Figure 3c, d, e).

Baseline macrophyte data show there to be very low species richness within the river channel at sites A and B. With the exception of *Lemna minor* (Duck weed), which was recorded in the slack water areas of Site A, the submerged flora comprised only of bryophytes, and these were mainly restricted to areas which are periodically exposed (at low flow). Site A is heavily shaded by tree growth, thus limiting the development of marginal vegetation. The species summaries are given below and full data presented in Appendix III.

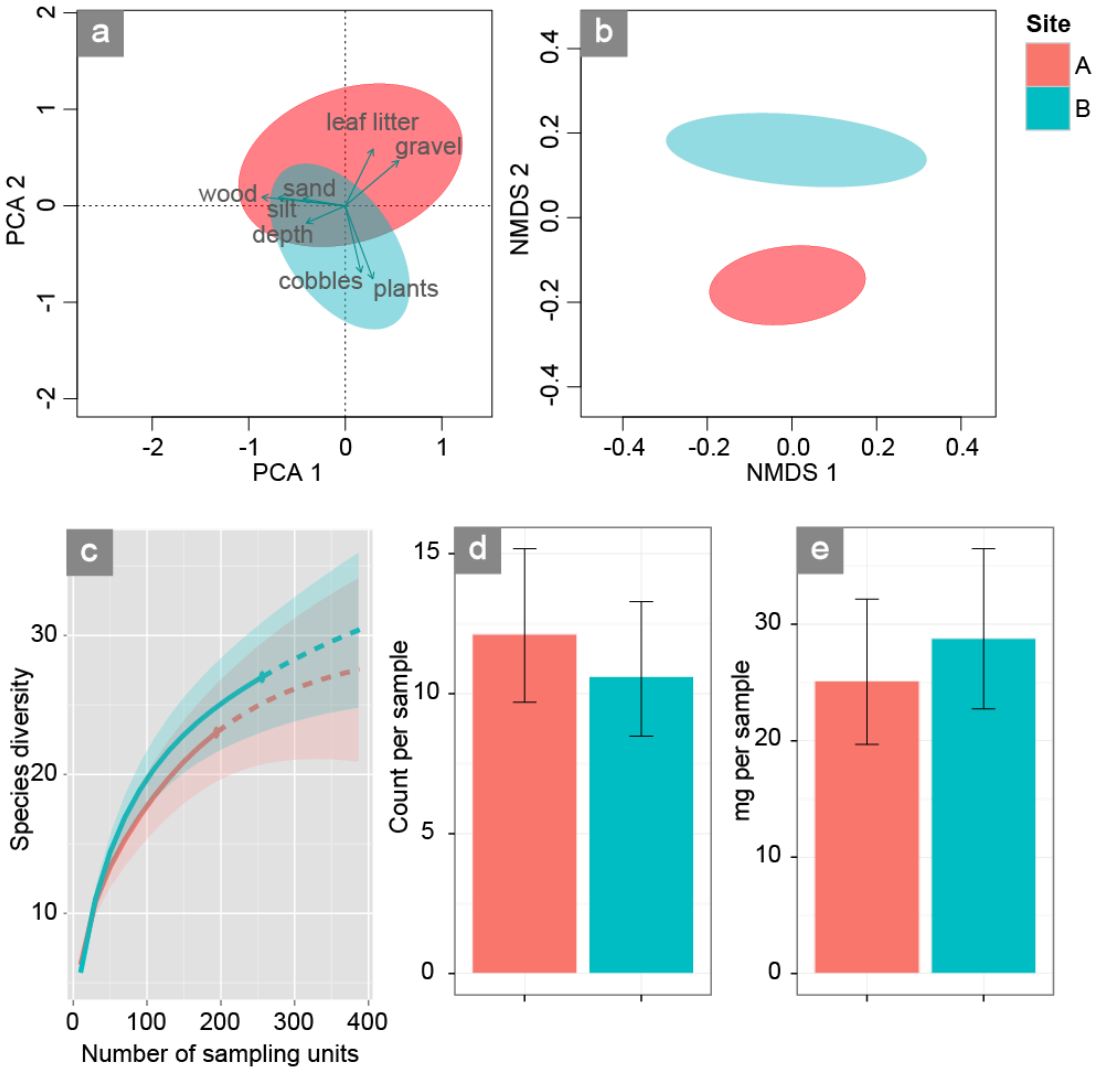


Figure 3 a) PCA of habitat data, ellipses represent standard error; b) NMDS of species data, ellipses represent standard error; c) species richness estimation, shading represents 95% confidence intervals, dotted lines indicate extrapolation from observed diversity (solid line) towards a standardised sample size (i.e. 388); d) differences in invertebrate abundance and e) biomass per sample, error bars represent 95% confidence intervals..

4.1. Macrophytes: Site A - SK3600014177 - SK3598714131

This section is heavily shaded (>90%) by overhanging trees on both banks. With the exception of occasional fronds of *Lemna minor* (common duckweed) held up in the margins, there were no higher plants growing within the channel. Bryophytes were relatively common just above the waterline and occasional within the channel.
The banks are steep sloping (45 degrees to vertical) and dominated by tall trees – mainly alder and sycamore with an understory of hawthorn, holly and elder with brambles (*Rubus fruticosa* agg.) beneath.

Species summary – Channel (overall for 50 m reach)

Name	Abundance	Cover
Lemna minor	*Rare*	*<1%*
Pellia epiphylla (thallose liverwort)	Rare	<1%
Fissidens viridulus (moss)	Rare	<1%
Oxyrrhynchium hians (moss)	Rare	<1%
Filamentous green algae	Frequent	<20%

Substrate: Pebbles (65%), Cobbles (20%), Gravel (10%), Fines (5%).

Species summary – Bank (overall for 50 m reach)

Name	Abundance	Cover
Pellia epiphylla (thallose liverwort)	Frequent	<25%
Fissidens viridulus (moss)	Occasional	<5%
Leptodictyum riparium (moss)	Occasional	<5%
Oxyrrhynchium hians (moss)	Occasional	<5%
Alnus glutinosa	Abundant	<50%
Carex pendula	*Frequent*	*<25%*
Crataegus monogyna	*Frequent*	*<25%*
Crocosmia sp*.	Rare	*<1%*
Ilex aquifolium	*Occasional*	*<5%*
Lamium album	*Rare*	*<1%*
Phalaris arundinacea	*Occasional*	*<5%*
Rubus fruticosa agg.	*Frequent*	*<25%*
Sambucus nigra	*Rare*	*<2%*
Stachys sylvestris	*Rare*	*<1%*
Urtica dioica	*Occasional*	*<5%*

*Non-native species – garden escape

4.2. Macrophytes: Site B - SK3615012427 - SK 3613712381

This section lies in a deeply incised channel (approx. 2 m below field height) with partial shade by overhanging trees/shrubs on both banks. There were no higher plants growing within the channel. Bryophytes were relatively common just above the waterline and occasional within the channel.

The banks are steep sloping (60 degrees to vertical) and dominated by tall grasses on the east bank and mainly brambles and tall herbs on the west bank.

Species summary – Channel (overall for 50 m reach)

Name	Abundance	Cover
Pellia epiphylla (thallose liverwort)	Rare	<1%
Brachythecium rutabulum	Rare	<1%
Filamentous green algae	Dominant	>65%
Vaucheria sp. (algae)	Dominant	>10%

Substrate: Pebbles (30%), Cobbles (20%), Gravel (20%), Fines (20%) Boulders (10%).

Species summary – Bank (overall for 50 m reach)

Name	Abundance	Cover
Pellia epiphylla	Occasional	<5%
Brachythecium rutabulum	Rare	<2%
Fissidens viridulus	Rare	<2%
Agrostis stolonifera	Occasional	<5%
Angelica sylvestris	Rare	<1%
Carex pendula	Occasional	<5%
Cirsium palustre	Rare	<1%
Crataegus monogyna	Rare	<2%
Epilobium hirsutum	Frequent	<15%
Filipendula ulmaria	Rare	<1%
*Impatiens glandulifera**	Rare	<1%
Juncus effusus	Rare	<1%
Juncus inflexus	Rare	<2%
Phalaris arundinacea	Dominant	>50%
Scrophularia auriculata	Occasional	<5%
Stachys palustris	Occasional	<5%

The moss *Brachythecium rutabulum* recorded in the channel was mainly confined to the tops of larger boulders and stones, suggesting it is exposed at low flow.

*Himalayan Balsam – a non-native invasive species. Care should be taken not to spread this species during any management action. We would advise manual control during spring and summer.

5. References

Chao A., Gotelli N.J., Hsieh T.C., Sander E.L., Ma K.H., Colwell R.K., *et al*. (2014) Rarefaction and extrapolation with Hill numbers: a framework for sampling and estimation in species diversity studies. *Ecological Monographs* **84**, 45–67.

6. Appendix I – Water Chemistry

Table 4 Monthly water chemistry data. TON = total oxidised nitrogen which is the sum of nitrate (NO_3^-) and nitrite (NO_2^-).

19/01/16	Site A	Site B	Site C	Site D	Site E
Dissolved oxygen (mg L^{-1})	12.77	12.10	11.32	12.02	11.38
Nitrite (mg L^{-1})	0.02	0.02	0.05	0.04	0.05
TON (mg L^{-1})	5.30	4.43	11.20	7.08	6.83
Ortho-phosphate (mg L^{-1})	0.08	0.07	0.10	0.08	0.08
Suspended solids (mg L^{-1})	9.55	7.70	6.43	7.40	7.00
Temperature °C	4.40	5.50	5.00	4.70	4.60
23/02/16					
Dissolved oxygen (mg L^{-1})	11.97	11.57	11.14	11.81	10.59
Nitrite (mg L^{-1})	0.01	0.02	0.04	0.02	0.03
TON (mg L^{-1})	5.20	4.49	9.44	5.66	5.53
Ortho-phosphate (mg L^{-1})	0.08	0.11	0.09	0.07	0.06
Suspended solids (mg L^{-1})	7.80	8.16	11.29	6.56	8.50
Temperature °C	5.85	6.40	5.75	6.35	6.50
23/02/16					
Dissolved oxygen (mg L^{-1})	11.34	12.10	13.09	13.20	10.39
Nitrite (mg L^{-1})	0.03	0.01	0.08	0.02	0.06
TON (mg L^{-1})	7.22	4.84	10.70	6.47	6.11
Ortho-phosphate (mg L^{-1})	0.08	0.10	0.09	0.04	0.07
Suspended solids (mg L^{-1})	3.48	3.00	5.62	4.28	5.03
Temperature °C	7.85	8.90	7.70	7.65	7.70
18/04/16					
Dissolved oxygen (mg L^{-1})	15.02	15.09	16.94	17.04	14.43
Nitrite (mg L^{-1})	0.02	0.02	0.02	0.01	0.03
TON (mg L^{-1})	5.30	3.47	8.28	5.22	5.03
Ortho-phosphate (mg L^{-1})	0.08	0.06	0.09	0.05	0.04
Suspended solids (mg L^{-1})	5.12	5.90	5.10	4.47	6.68
Temperature °C	8.90	9.70	8.30	8.70	9.45
16/05/16					
Dissolved oxygen (mg L^{-1})	12.21	12.78	11.34	12.45	10.84
Nitrite (mg L^{-1})	0.03	0.01	0.16	0.03	0.05
TON (mg L^{-1})	6.54	3.15	12.35	4.81	5.19
Ortho-phosphate (mg L^{-1})	0.10	0.06	0.18	0.07	0.08
Suspended solids (mg L^{-1})	4.37	3.41	11.38	3.00	6.67
Temperature °C	10.85	12.60	11.72	12.35	13.20

16/06/16					
Dissolved oxygen (mg L^{-1})	9.25	9.07	6.18	7.10	flooded
Nitrite (mg L^{-1})	0.03	0.03	0.09	0.05	flooded
TON (mg L^{-1})	6.20	5.16	18.00	6.97	flooded
Ortho-phosphate (mg L^{-1})	0.12	0.16	0.22	0.17	flooded
Suspended solids (mg L^{-1})	30.20	39.95	15.80	19.10	flooded
Temperature °C	13.70	13.90	13.70	14.25	flooded
28/07/16					
Dissolved oxygen (mg L^{-1})	9.25	9.57	8.46	10.62	8.73
Nitrite (mg L^{-1})	0.04	0.01	0.04	0.01	0.05
TON (mg L^{-1})	8.21	4.53	11.45	4.42	7.05
Ortho-phosphate (mg L^{-1})	0.09	0.11	0.34	0.13	0.15
Total phosphorus (mg L^{-1})	0.11	0.13	0.39	0.24	0.31
Suspended solids (mg L^{-1})	3.38	3.74	4.75	4.69	51.45
Temperature °C	16.55	16.65	15.05	16.4	16.9
22/08/16					
Dissolved oxygen (mg L^{-1})	15.5	17.25	16.4	17.2	17.3
Nitrite (mg L^{-1})	0.03	0.01	0.04	0.01	0.03
TON (mg L^{-1})	4.5	5.46	11.5	6.47	7.13
Ortho-phosphate (mg L^{-1})	0.1	0.1	0.32	0.15	0.16
Total phosphorus (mg L^{-1})	0.13	0.13	0.37	0.21	0.21
Suspended solids (mg L^{-1})	4.25	3.49	3.92	6.97	3.19
Temperature °C	8.89	8.87	6.7	8.57	8.21
28/09/16					
Dissolved oxygen (mg L^{-1})	9.77	9.41	6.67	7.88	7.46
Nitrite (mg L^{-1})	0.04	0.01	0.04	0.00	0.04
TON (mg L^{-1})	8.56	5.00	13.00	4.07	5.11
Ortho-phosphate (mg L^{-1})	0.15	0.14	0.34	0.10	0.13
Total phosphorus (mg L^{-1})	0.16	0.15	0.39	0.15	0.16
Suspended solids (mg L^{-1})	3.00	3.00	11.90	4.33	6.92
Temperature °C	12.50	14.40	13.50	14.00	14.00
26/10/16					
Dissolved oxygen (mg L^{-1})	11.45	10.82	8.29	10.01	10.12
Nitrite (mg L^{-1})	0.04	0.01	0.11	0.01	0.03
TON (mg L^{-1})	8.26	5.58	16.10	7.27	8.00
Ortho-phosphate (mg L^{-1})	0.14	0.18	0.37	0.13	0.12
Total phosphorus (mg L^{-1})	0.16	0.20	0.46	0.17	0.24
Suspended solids (mg L^{-1})	3.02	3.00	16.57	13.10	38.40
Temperature °C	9.85	11.70	10.25	10.10	10.00

23/11/16					
Dissolved oxygen (mg L^{-1})	10.14	11.40	9.18	10.00	9.89
Nitrite (mg L^{-1})	0.02	0.03	0.03	0.03	0.03
TON (mg L^{-1})	8.97	8.32	20.25	12.85	9.49
Ortho-phosphate (mg L^{-1})	0.08	0.09	0.12	0.10	0.08
Total phosphorus (mg L^{-1})	0.15	0.17	0.17	0.18	0.17
Suspended solids (mg L^{-1})	18.85	22.90	13.10	24.85	28.25
Temperature °C	7.90	8.60	8.00	8.00	7.40
20/12/16					
Dissolved oxygen (mg L^{-1})	10.74	9.70	10.30	10.45	9.65
Nitrite (mg L^{-1})	0.03	0.01	0.03	0.03	0.06
TON (mg L^{-1})	7.03	5.89	8.34	7.60	7.40
Ortho-phosphate (mg L^{-1})	0.12	0.13	0.11	0.11	0.10
Total phosphorus (mg L^{-1})	0.14	0.18	0.14	0.14	0.13
Suspended solids (mg L^{-1})	4.55	5.05	4.05	3.15	4.70
Temperature °C	6.70	8.05	7.10	7.05	6.50

7. Appendix II – Invertebrates

Table 5 Total invertebrate counts from six samples per site collected in March.

Taxa	Site A	Site B
Agapetus fuscipes	14	15
Ancylus fluviatilis	34	0
Asellus aquaticus	1	0
Athripsodes cinereus	9	4
Baetis rhodani	29	8
Bezzia solstitalis	9	9
Bithynia tentaculata	23	97
Caenis lactuosa	0	4
Centroptilum luteolum	0	7
Chironomid	296	359
Clinocera sp1	1	0
Clinocera sp2	1	0
Clinocera stagnalis	2	0
Elmis aenea	40	42
Gammarus pulex	12	1
Glossiphonia complanata	1	1
Habrophlebia fusca	2	4
Halesus radiatus	0	1
Hydracarina	1	2
Hydrobius fuscipes	1	0
Hydropsyche contubernalis	0	2
Hydropsyche pellucidula	2	8
Hydropsyche siltalai	3	3
Hydroptila sp	0	1
Lepidostoma hirtum	1	4
Limnius volchmari	0	2
Lype reducta	0	1
Mystacides sp	0	1
Oligochaeta	468	278
Oulimnius sp	2	25
Physa fontinalis	0	2
Pisidium	4	10
Polycentropus flavomaculatus	0	6
Rhyacophila dorsalis	1	0
Serratella ignita	2	0
Simulium ornatum	0	1
Simulium pseudequinum	3	3
Tanypod	1	6
Tinodes waeneri	1	3
Tipula sp	0	1
x.Hydroptilidae	0	2

Taxa	Site A	Site B
x.Plecoptera indet	1	0

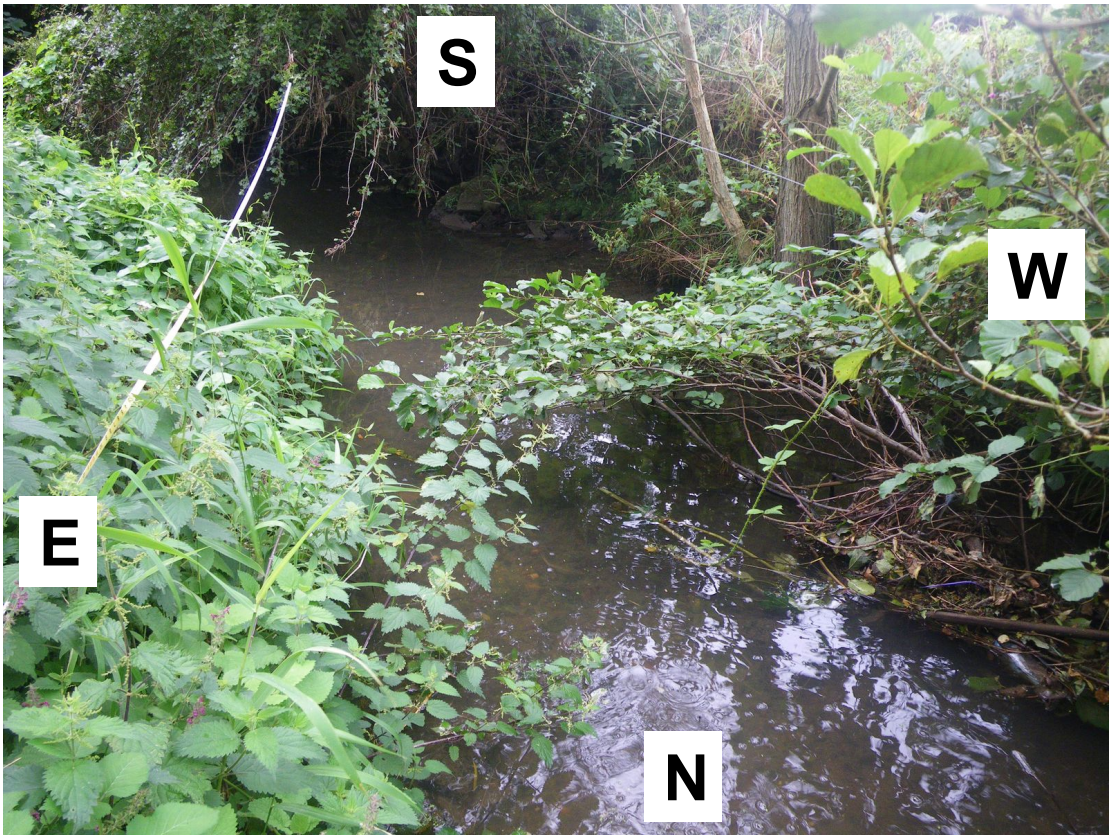
8. Appendix III – Macrophytes

Site A

Sites surveyed in an upstream direction.
Start. SK3598714131 End: SK6000114177

Reach 1: 0 – 5 m

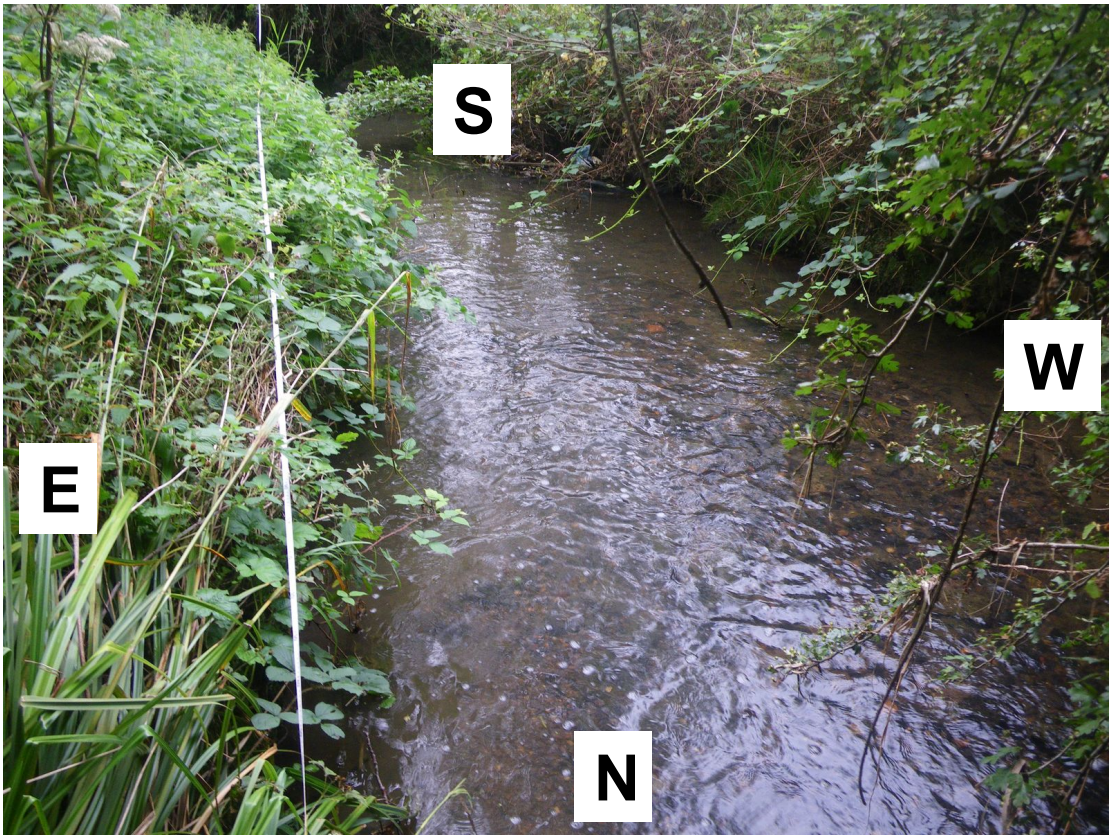
Boulders:	-	Gravel:	10%	Shade:	60%
Cobbles:	10%	Sand:	-	Filamentous algae:	50%
Pebbles:	75%	Silt:	5%	Tree roots:	-



East Bank	%	Channel	%	West Bank	%
Pellia epiphylla	25	*Oxyrrhynchium hians*	5	*Salix* sp.	50
Fissidens viridulus	10	*Lemna minor*	1	*Alnus glutinosa*	10
Stachy sylvestris	5			*Rubus fruticosa agg.*	5
Phalaris arundinacea	*5*			*Pellia epiphylla*	40
Crocosmia sp.	1				
Urtica dioica	20				
Lamium album	10				

Reach 2: 5 – 10 m

Boulders:	-	Gravel:	15%	Shade:	20%
Cobbles:	10%	Sand:	-	Filamentous algae:	30%
Pebbles:	70%	Silt:	5%	Tree roots:	-



East Bank	%	Channel	%	West Bank	%
Pellia epiphylla	20	*Oxyrrhynchium hians*	1	*Alnus glutinosa*	10
Fissidens viridulus	10	*Lemna minor*	1	*Carex pendula*	5
Leptodictyum riparium	2			*Rubus fruticosa* agg.	5
Carex pendula	5			*Pellia epiphylla*	30
Stachy sylvestris	1			*Fissidens viridulus*	10
Phalaris arundinacea	5			*Leptodictyum riparium*	5
Rubus fruticosa agg.	20				
Urtica dioica	10				
Lamium album	5				
Angelica syvestris	2				

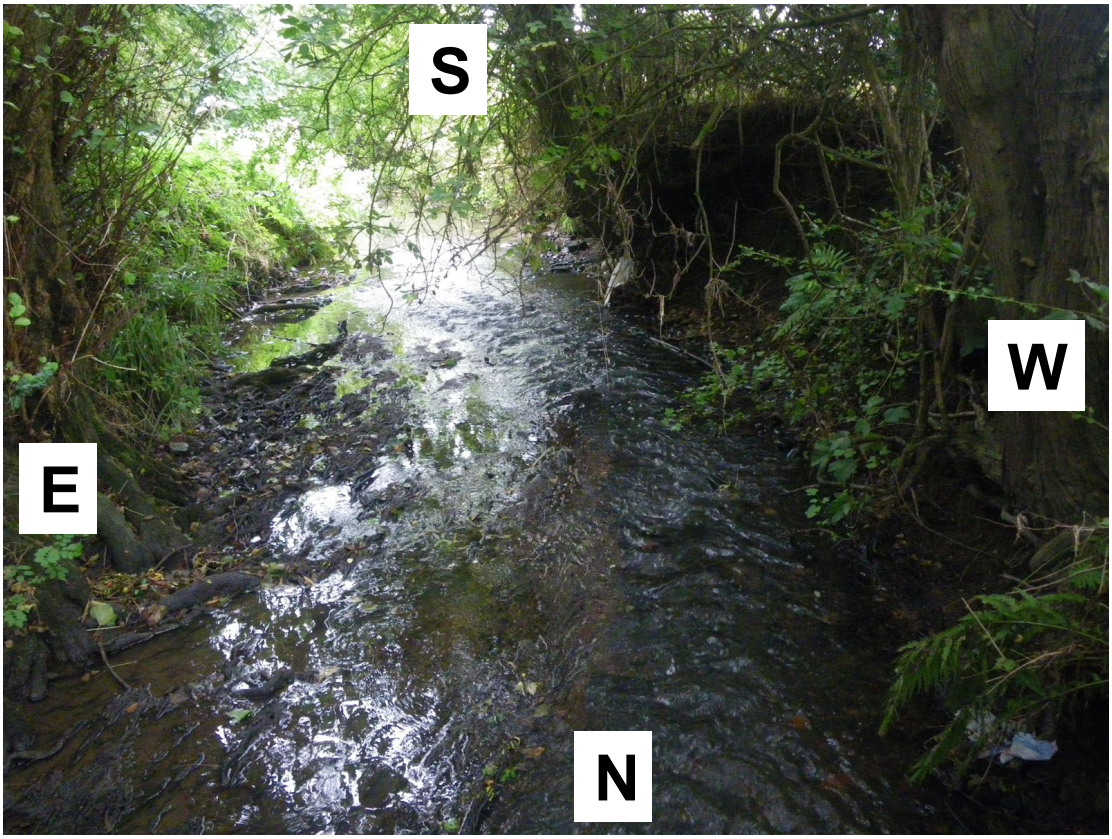
Reach 3: 10 – 15 m

Boulders:	-	Gravel:	10%	Shade:	100%
Cobbles:	5%	Sand:	5%	Filamentous algae:	10%
Pebbles:	70%	Silt:	10%	Tree roots:	20%

East Bank	%	Channel	%	West Bank	%
Pellia epiphylla	5	*Pellia epiphylla*	1	*Crataegus monogyna*	75
Fissidens viridulus	20	*Lemna minor*	1	*Rubus fruticosa* agg.	5
Carex pendula	5			*Pellia epiphylla*	5
Rubus fruticosa agg.	5			*Fissidens viridulus*	10
Urtica dioica	2				

Reach 4: 15 – 20 m

Boulders:	-	Gravel:	15%	Shade:	100%
Cobbles:	10%	Sand:	5%	Filamentous algae:	10%
Pebbles:	30%	Silt:	5%	Tree roots:	35%



East Bank	%	Channel	%	West Bank	%
Alnus glutinosa	50	*Pellia epiphylla*	1	*Crataegus monogyna*	40
Pellia epiphylla		*Lemna minor*	1	*Rubus fruticosa* agg.	5
Leptodictyum riparium	1			*Pellia epiphylla*	5
Carex pendula				*Fissidens viridulus*	1
Rubus fruticosa agg.	5			*Sambucus nigra*	20
Urtica dioica	5				

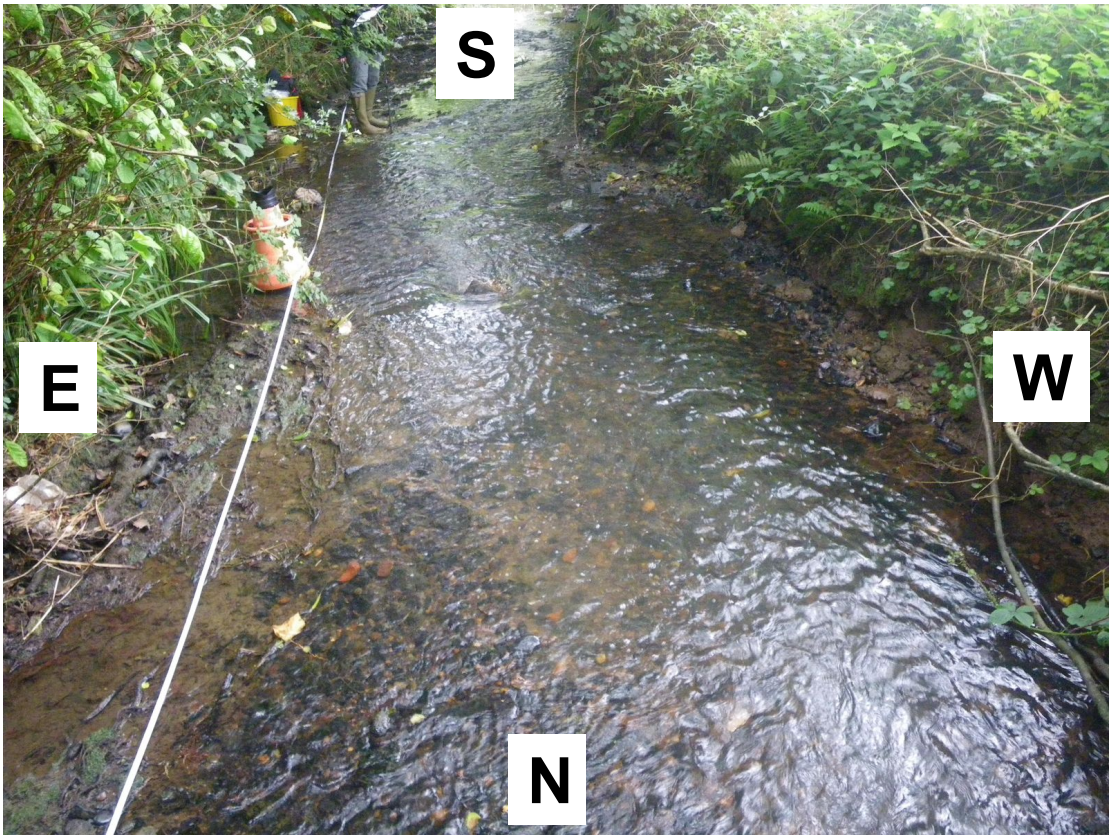
Reach 5: 20 – 25 m

Boulders:	-	Gravel:	15%	Shade:	90%
Cobbles:	10%	Sand:	5%	Filamentous algae:	10%
Pebbles:	30%	Silt:	5%	Tree roots:	35%

East Bank	%	Channel	%	West Bank	%
Alnus glutinosa	25	*Pellia epiphylla*	2	*Rubus fruticosa* agg.	15
Pellia epiphylla	25	*Lemna minor*	1	*Pellia epiphylla*	2
Leptodictyum riparium	5			*Leptodictyum riparium*	10
Carex pendula	20			*Oxyrrhynchium hians*	10
Rubus fruticosa agg.	5				

Reach 6: 25 – 30 m

Boulders:	-	Gravel:	15%	Shade:	90%
Cobbles:	5%	Sand:	5%	Filamentous algae:	10%
Pebbles:	35%	Silt:	5%	Tree roots:	25%



East Bank	%	Channel	%	West Bank	%
Alnus glutinosa	50	*Pellia epiphylla*	5	*Rubus fruticosa* agg.	10
Pellia epiphylla	20	*Lemna minor*	1	*Pellia epiphylla*	1
Rubus fruticosa agg.	5	*Oxyrrhynchium hians*	1	*Leptodictyum riparium*	5
Phalaris arundinacea	5			*Oxyrrhynchium hians*	15
				Urtica dioica	20

Reach 7: 30 – 35 m

Boulders:	-	Gravel:	15%	Shade:	100%
Cobbles:	5%	Sand:	5%	Filamentous algae:	10%
Pebbles:	35%	Silt:	5%	Tree roots:	25%

East Bank	%	Channel	%	West Bank	%
Alnus glutinosa	50	*Pellia epiphylla*	5	*Crataegus monogyna*	20
Pellia epiphylla	50	*Lemna minor*	1	*Ilex aquifolium*	15
Rubus fruticosa agg.	5			*Sambucus nigra*	15
Urtica dioica	2			*Pellia epiphylla*	1
				Oxyrrhynchium hians	15
				Rubus fruticosa agg.	5
				Urtica dioica	5

Reach 8: 35 – 40 m

Boulders:	-	Gravel:	10%	Shade:	100%
Cobbles:	15%	Sand:	5%	Filamentous algae:	10%
Pebbles:	60%	Silt:	5%	Tree roots:	5%

East Bank	%	Channel	%	West Bank	%
Alnus glutinosa	20	No plants		*Crataegus monogyna*	40
Ilex aquifolium	10			*Ilex aquifolium*	10
Pellia epiphylla	20			*Pellia epiphylla*	1
Leptodictyum riparium	5			*Oxyrrhynchium hians*	10
Oxyrrhynchium hians	5			*Rubus fruticosa* agg.	5
Rubus fruticosa agg.	10			*Urtica dioica*	1
Urtica dioica	5				

Reach 9: 40 – 45 m

Boulders:	-	Gravel:	10%	Shade:	75%
Cobbles:	20%	Sand:	5%	Filamentous algae:	20%
Pebbles:	60%	Silt:	5%	Tree roots:	-

East Bank	%	Channel	%	West Bank	%
Alnus glutinosa	10	*Lemna minor*	1	*Crataegus monogyna*	20
Phalaris arundinacea	5	*Pellia epiphylla*	2	*Carex pendula*	10
Pellia epiphylla	5	*Oxyrrhynchium hians*	2	*Pellia epiphylla*	1
Leptodictyum riparium	2	*Fissidens viridulus*	2	*Leptodictyum riparium*	1
Fissidens viridulus	1		1	*Rubus fruticosa* agg.	5
Rubus fruticosa agg.	15			*Urtica dioica*	1
Urtica dioica	20			*Oxyrrhynchium hians*	10

Reach 10: 45 – 50 m

Boulders:	-	Gravel:	10%	Shade:	95%
Cobbles:	15%	Sand:	5%	Filamentous algae:	10%
Pebbles:	45%	Silt:	5%	Tree roots:	20%

East Bank	%	Channel	%	West Bank	%
Alnus glutinosa	10	*Lemna minor*	2	*Alnus glutinosa*	85
Phalaris arundinacea	10	*Pellia epiphylla*	2	*Pellia epiphylla*	25
Pellia epiphylla	5	*Oxyrrhynchium hians*	2	*Leptodictyum riparium*	2
Leptodictyum riparium	2				
Fissidens viridulus	2				
Rubus fruticosa agg.	10				
Urtica dioica	10				

Site B

Sites surveyed in an upstream direction.
Start. SK3615012427 End: SK3613712381

Reach 1: 0 – 5 m

Boulders:	20%	Gravel:	10%	Shade:	15%
Cobbles:	50%	Sand:	-	Filamentous algae:	40%
Pebbles:	20%	Silt:	-	Tree roots:	-

East Bank	%	Channel	%	West Bank	%
Pellia epiphylla	1	*Vaucheria* sp.	30	*Rubus fruticosa* agg.	70
Brachythecium rutabulum	10	*Brachythecium rutabulum*	1	*Brachythecium rutabulum*	1
Phalaris arundinacea	75			Alnus Glutinosa	10
Epilobium hirsutum	5			*Pellia epiphylla*	40
Urtica dioica	5				
Angelica sylvestris	1				

Reach 2: 5 – 10 m

Boulders:	40%	Gravel:	5%	Shade:	20%
Cobbles:	40%	Sand:	-	Filamentous algae:	30%
Pebbles:	15%	Silt:	-	Tree roots:	-

East Bank	%	Channel	%	West Bank	%
Phalaris arundinacea	75	*Vaucheria* sp.	30	*Fissidens viridulus*	1
Epilobium hirsutum	10	*Brachythecium rutabulum*	5	*Brachythecium rutabulum*	5
Impatiens glandulifera	1			*Epilobium hirsutum*	20
				Urtica dioica	15
				Impatiens glandulifera	1
				Rubus fruticosa agg.	10
				Stachys palustris	30
				Scrophularia auriculata	20

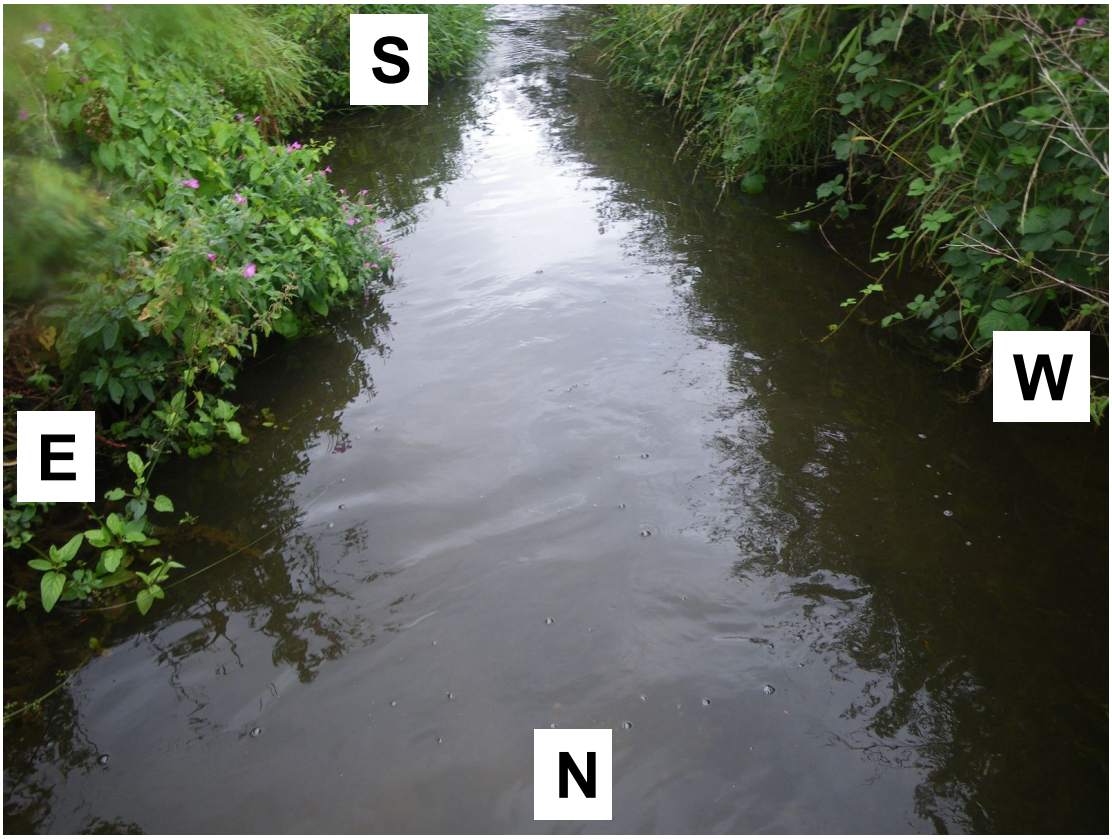
Reach 3: 10 – 15 m

Boulders:	10%	Gravel:	10%	Shade:	75%
Cobbles:	40%	Sand:	10%	Filamentous algae:	80%
Pebbles:	30%	Silt:	-	Tree roots:	-

East Bank	%	Channel	%	West Bank	%
Phalaris arundinacea	60	*Vaucheria* sp.	5	*Agrostis stolonifera*	5
Epilobium hirsutum	10			*Carex pendula*	20
Carex pendula	1			*Epilobium hirsutum*	10
Urtica dioica	10			*Cirsium palustre*	30
				Rubus fruticosa agg.	10
				Urtica dioica	10

Reach 4: 15 – 20 m

Boulders:	1%	Gravel:	25%	Shade:	20%
Cobbles:	10%	Sand:	4%	Filamentous algae:	80%
Pebbles:	50%	Silt:	10%	Tree roots:	-



East Bank	%	Channel	%	West Bank	%
Pellia epiphylla	10	No plants		*Stachys palustris*	1
Agrostis stolonifera	10			*Carex pendula*	5
Phalaris arundinacea	5			*Epilobium hirsutum*	40
Carex pendula	10			*Pellia epiphylla*	10
Epilobium hirsutum	20			*Rubus fruticosa* agg.	20
Scrophularia auriculata	5			*Urtica dioica*	10
Urtica dioica	10			*Juncus inflexus*	10
				Phalaris arundinacea	5

Reach 5: 20 – 25 m

Boulders:	-	Gravel:	45%	Shade:	35%
Cobbles:	5%	Sand:	-	Filamentous algae:	70%
Pebbles:	30%	Silt:	20%	Tree roots:	-

East Bank	%	Channel	%	West Bank	%
Pellia epiphylla	5	No plants		*Stachys palustris*	5
Leptodictyum riparium	2			*Carex pendula*	1
Juncus effusus	1			*Epilobium hirsutum*	75
Phalaris arundinacea	50			*Pellia epiphylla*	10
Carex pendula	10			*Rubus fruticosa* agg.	20
Epilobium hirsutum	10			*Urtica dioica*	5
Scrophularia auriculata	1			*Agrostis stolonifera*	10
Crataegus monogyna	5				
Urtica dioica	10				

Reach 6: 25 – 30 m

Boulders:	-	Gravel:	45%	Shade:	50%
Cobbles:	5%	Sand:	-	Filamentous algae:	80%
Pebbles:	30%	Silt:	20%	Tree roots:	-

East Bank	%	Channel	%	West Bank	%
Phalaris arundinacea	100	*Vaucheria* sp.	5	*Pellia epiphylla*	5
Epilobium hirsutum	10			*Leptodictyum riparium*	2
Impatiens glandulifera	1			*Stachys palustris*	10
Filipendula ulmaria	1			*Epilobium hirsutum*	40
Carex pendula	10			*Rubus fruticosa* agg.	15
Crataegus monogyna	10			*Urtica dioica*	5
Urtica dioica	5			*Scrophularia auriculata*	5
				Agrostis stolonifera	5

Reach 7: 30 – 35 m

Boulders:	-	Gravel:	40%	Shade:	30%
Cobbles:	5%	Sand:	-	Filamentous algae:	80%
Pebbles:	40%	Silt:	15%	Tree roots:	-

East Bank	%	Channel	%	West Bank	%
Phalaris arundinacea	75	*Vaucheria* sp.	5	*Pellia epiphylla*	5
Epilobium hirsutum	25			*Leptodictyum riparium*	1
Filipendula ulmaria	1			*Carex pendula*	10
Urtica dioica	5			*Epilobium hirsutum*	60
Rubus fruticosa agg.	5			*Stachys palustris*	20
				Agrostis stolonifera	5
				Urtica dioica	5
				Rubus fruticosa agg.	10

Reach 8: 35 – 40 m

Boulders:	-	Gravel:	50%	Shade:	25%
Cobbles:	5%	Sand:	-	Filamentous algae:	72%
Pebbles:	30%	Silt:	15%	Tree roots:	-

East Bank	%	Channel	%	West Bank	%
Phalaris arundinacea	100	*Vaucheria* sp.	2	*Pellia epiphylla*	2
Epilobium hirsutum	30			*Epilobium hirsutum*	25
Urtica dioica	5			*Stachys palustris*	40
Rubus fruticosa agg.	5			*Urtica dioica*	10
				Rubus fruticosa agg.	15
				Impatiens glandulifera	1

Reach 9: 40 – 45 m

Boulders:	-	Gravel:	35%	Shade:	40%
Cobbles:	-	Sand:	-	Filamentous algae:	80%
Pebbles:	25%	Silt:	40%	Tree roots:	-

East Bank	%	Channel	%	West Bank	%
Pellia epiphylla	5	*Vaucheria* sp.	2	*Pellia epiphylla*	5
Phalaris arundinacea	45			*Leptodictyum riparium*	5
Epilobium hirsutum	25			*Phalaris arundinacea*	75
Angelica sylvestris	2			*Epilobium hirsutum*	20
Rubus fruticosa agg.	5			*Stachys palustris*	10
Salix sp.	20			*Urtica dioica*	5
Urtica dioica	10			*Rubus fruticosa* agg.	5

Reach 10: 45 – 50 m

Boulders:	-	Gravel:	65%	Shade:	60%
Cobbles:	-	Sand:	-	Filamentous algae:	60%
Pebbles:	25%	Silt:	10%	Tree roots:	-

East Bank	%	Channel	%	West Bank	%
Phalaris arundinacea	40	*Vaucheria* sp.	2	*Pellia epiphylla*	5
Epilobium hirsutum	60			*Phalaris arundinacea*	80
Rubus fruticosa agg.	5			*Epilobium hirsutum*	25
Urtica dioica	10			*Stachys palustris*	10
				Urtica dioica	10
				Rubus fruticosa agg.	5