XLINKS MOROCCO-UK POWER PROJECT

Preliminary Environmental Information Report

Volume 2, Appendix 1.10: Aquatic Invertebrate Monitoring of Watercourses to be Crossed

FOR ISSUE
April 2024

xlinks.co

Table of Contents

Tables

Figures

Annexes

Glossary

Term	Meaning
Alverdiscott Substation Connection Development	The development required at the existing Alverdiscott Substation site, which is envisaged to include development of a new 400 kV substation, and other extension modification works to be confirmed by National Grid Electricity Transmission.
Applicant	Xlinks 1 Limited.
Converter Site	The Converter Site is proposed to be located to the immediate west of the existing Alverdiscott Substation site in north Devon. The Converter Site would contain two converter stations (known as Bipole 1 and Bipole 2) and associated infrastructure, buildings and landscaping.
Converter station	Part of an electrical transmission and distribution system. Converter stations convert electricity from Direct Current (DC) to Alternating Current (AC), or vice versa.
Environmental Impact Assessment	The process of identifying and assessing the significant effects likely to arise from a project. This requires consideration of the likely changes to the environment, where these arise as a consequence of a project, through comparison with the existing and projected future baseline conditions.
Landfall	The proposed area in which the offshore cables make landfall in the United Kingdom (come on shore) and the transitional area between the offshore cabling and the onshore cabling. This term applies to the entire landfall area at Cornborough Range, Devon, between Mean Low Water Springs and the Transition Joint Bay inclusive of all construction works, including the offshore and onshore cable routes, and landfall compound(s).
Preliminary Environmental Information Report	A report that provides preliminary environmental information in accordance with the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. This is information that enables consultees to understand the likely significant environmental effects of a project, and which helps to inform consultation responses.
Proposed Development	The element of the Xlinks Morocco-UK Power Project within the UK, which includes the offshore cables (from the UK Exclusive Economic Zone to landfall), landfall site, onshore Direct Current and Alternating Current cables, converter stations, road upgrade works and, based on current assumptions, the Alverdiscott Substation Connection Development.
Proposed Development Draft Order Limits	The area within which all offshore and onshore components of the Proposed Development are proposed to be located, including areas required on a temporary basis during construction (such as construction compounds).
Xlinks Morocco-UK Power Project	The overall scheme from Morocco to the national grid, including all onshore and offshore elements of the transmission network and the generation site in Morocco (referred to as the ‘Project’).

Acronyms

Term	Meaning
ASPT	Average Score Per Taxon
BMWP	Biological Monitoring Working Party
CCI	Community Conservation Index
HVDC	High Voltage Direct Current
IMS	Industrial Methylated Spirits
PEIR	Preliminary Environmental Information Report
UK	United Kingdom
WFD	Water Framework Directive
WHPT	Whalley Hawkes Paisley Trigg

Units

Term	Meaning
cm	Centimetre
GWp	Gigawatts peak
km	Kilometre
km^2	Square kilometre
m	Metre

1 AQUATIC INVERTEBRATE MONITORING OF WATERCOURSES TO BE CROSSED

1.1 Introduction

Purpose and Scope of this Report

1.1.1 This document forms Volume 2, Appendix 1.10 of the Preliminary Environmental Information Report (PEIR) prepared for the UK elements of the Xlinks Morocco-UK Power Project (referred to hereafter as 'the Proposed Development'). The PEIR presents the preliminary findings of the Environmental Impact Assessment process for the Proposed Development.

1.1.2 This document presents the results of the aquatic invertebrate monitoring that was carried on watercourses to be crossed by the Proposed Development, which was undertaken in November 2022. The surveys and report have been undertaken by Lee Knight, a recognised invertebrate specialist based in Devon.

1.1.3 The design of the Proposed Development has changed since these surveys were undertaken. As such, updated surveys will be carried out (where required) prior to application to ensure that all elements of the revised Proposed Development site have been considered. The updated survey results will be reported as part of the Environmental Statement.

Proposed Development

1.1.4 The Proposed Development forms part of the wider Xlinks Morocco-UK Power Project (the 'Project') proposed by the Applicant to develop a sub-sea electricity connection between the UK and Morocco. The Project would be an electricity generation facility entirely powered by solar and wind energy combined with a battery storage facility. Located in Morocco's renewable energy rich region of Guelmim Oued Noun, the Applicant proposes to install 11.5 Gigawatts peak (GWp) generation capacity that would cover an approximate area of 1,500 km^2 and would be connected exclusively to the UK via High Voltage Direct Current (HVDC) sub-sea cables. The Project would include an offshore route of approximately 4,000 km, which would run through Moroccan, Spanish, Portuguese, and French Waters before arriving within the UK Exclusive Economic Zone (EEZ).

1.1.5 The Proposed Development, which is the focus of this PEIR, includes the UK onshore and offshore elements of the Project. The onshore elements of the Proposed Development are routed from the landfall at Cornborough Range, passing to the south of Bideford and arriving at the proposed Converter Site at Alverdiscott. The converter stations, situated within the Converter Site, would be connected to the national grid via the Alverdiscott Substation Connection Development and HVAC cables.

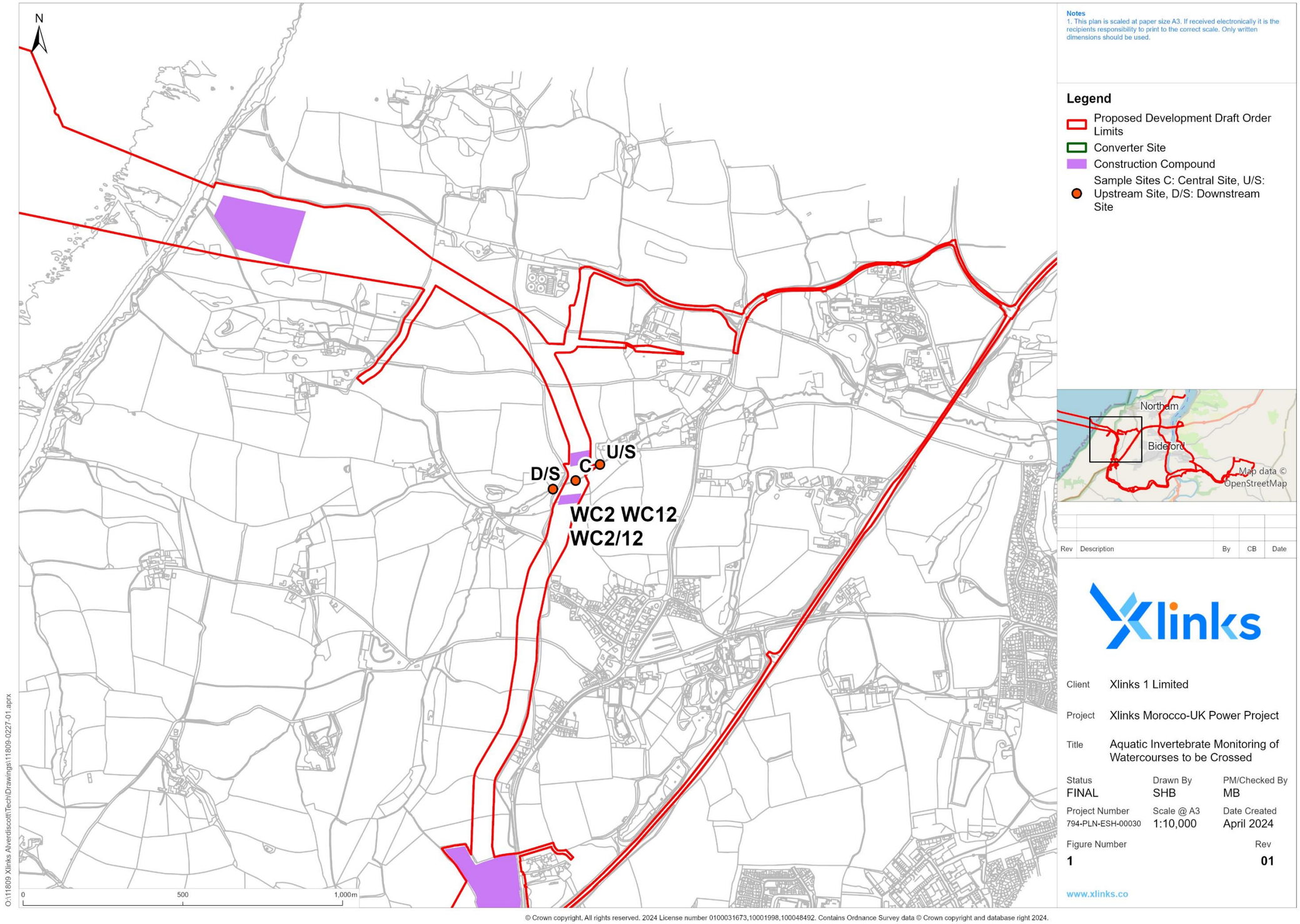
1.1.6 A similar cable route was proposed to connect the Alverdiscott sub-station to the Atlantic Array, a large-scale wind farm that was planned for construction in the Bristol Channel but was cancelled in 2013 due to various financial and technical reasons. As part of both the former and current projects, a suite of ecological

impact assessments were carried out along the proposed cable route and as the route crosses several small watercourses, surveys were required of the aquatic macro-invertebrate communities within them to assess their importance and determine the presence of any species of conservation value prior to works commencing. During the Atlantic Array Project, eleven small watercourses were identified as being either crossed by the cable route, or close to the construction area for new electricity distribution and converter stations, which might potentially be impacted by the planned works. These watercourses were investigated during October 2010 and May 2011. At the time of the 2010 survey, four of the watercourses were dry, thus seven were sampled for aquatic invertebrates. In May 2011, due to slight changes in the cable route, fewer watercourses would potentially be impacted, although several new ones were added to the list. A total of six watercourses were investigated of which two were dry and four were sampled. The results of these earlier surveys are reported in Knight (2010), Knight (2011) and RPS (2013).

1.1.7 The Proposed Development varies slightly from the previous proposed routes, but a desk study indicated the following watercourses that would be crossed by the cable or are close to the converter stations.

- Stream on Rickard's Down to the east of Combe Walker and Chaltaborough, into which two watercourses (WC) identified as WC2 and WC12 in previous surveys flow, referred to as WC2/12 in this report.
- Small ditch to the south of the A39, west of the Abbotsham Cross roundabout, herein referred to as WC17.
- Stream to the east of Lower Dunn Farm that flows northwards into Jennets Reservoir, identified as WC5 in previous surveys.
- Stream that rises to the west of Gammaton and flows westwards into the River Torridge at Hadlow, herein referred to as WC15.
- Stream south of Higher Huxhill that flows south eastwards along the boundary of the proposed converter station site into WC9, herein referred to as WC16.
- Headwater tributary of the Huntshaw water that rises east of Higher Kingdon Farm and will be crossed by the cable east of Lower Kingdon Farm, identified as WC9 in previous surveys.
- Tributary of WC9 which flows along the eastern boundary of the existing electricity sub-station, identified as WC10 in previous surveys.

1.1.8 The locations of the streams and sampling sites on them are illustrated in **Figure 1.1** to **Figure 1.3** below.



Notes
1. This plan is scaled at paper size A3. If received electronically it is the recipients responsibility to print to the correct scale. Only written dimensions should be used.

Legend

- Proposed Development Draft Order Limits
- Converter Site
- Construction Compound
- Sample Sites C: Central Site, U/S: Upstream Site, D/S: Downstream Site

Rev	Description	By	CB	Date

Client: Xlinks 1 Limited

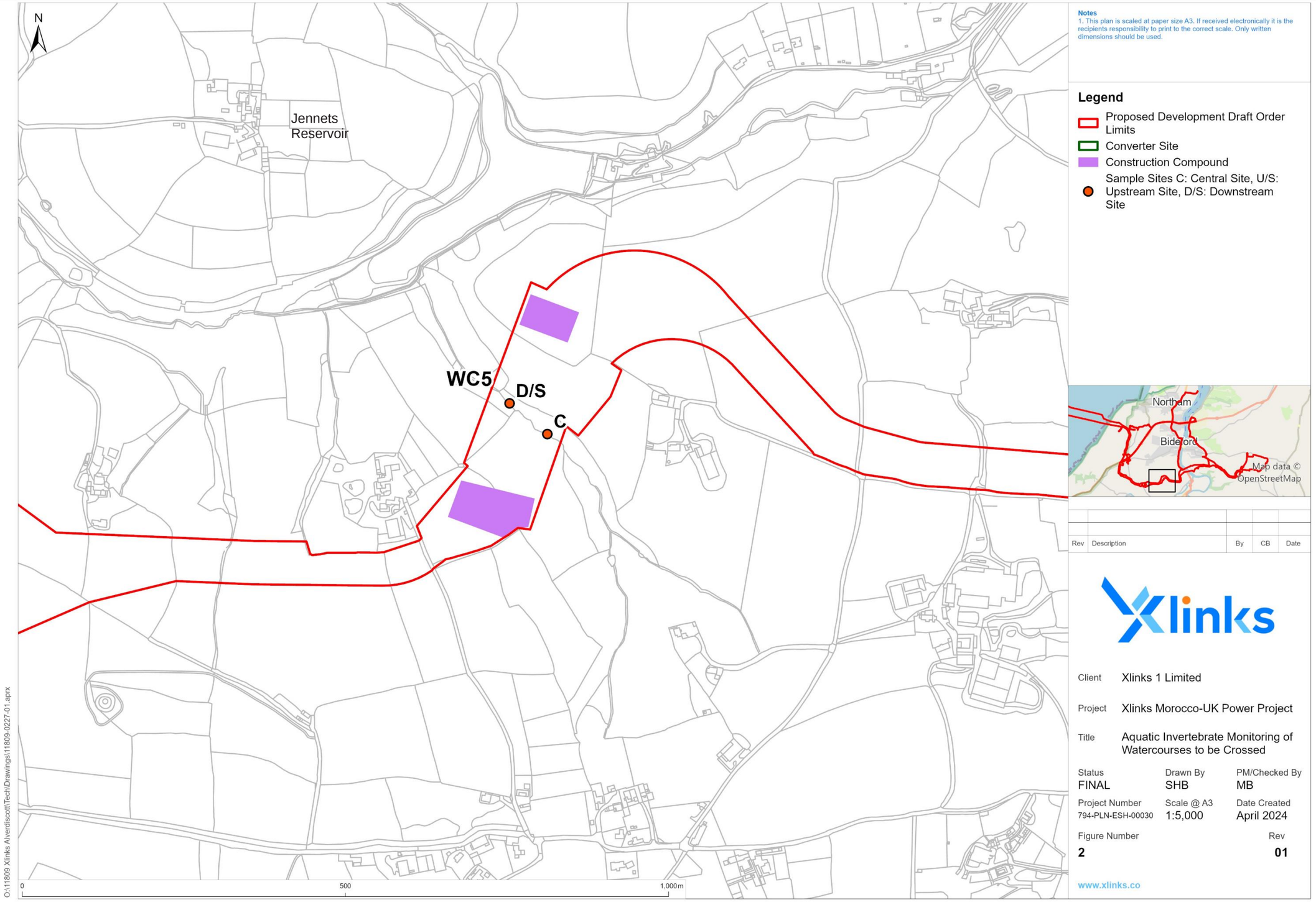
Project: Xlinks Morocco-UK Power Project

Title: Aquatic Invertebrate Monitoring of Watercourses to be Crossed

Status	Drawn By	PM/Checked By
FINAL	SHB	MB
Project Number	**Scale @ A3**	**Date Created**
794-PLN-ESH-00030	1:10,000	April 2024
Figure Number		**Rev**
1		01

www.xlinks.co

Figure 1.1: Location of aquatic invertebrate surveys for WC2, WC12 and WC2/12



Notes
1. This plan is scaled at paper size A3. If received electronically it is the recipients responsibility to print to the correct scale. Only written dimensions should be used.

Legend

- Proposed Development Draft Order Limits
- Converter Site
- Construction Compound
- Sample Sites C: Central Site, U/S: Upstream Site, D/S: Downstream Site

Rev	Description	By	CB	Date

Xlinks

Client: Xlinks 1 Limited

Project: Xlinks Morocco-UK Power Project

Title: Aquatic Invertebrate Monitoring of Watercourses to be Crossed

Status	Drawn By	PM/Checked By
FINAL	SHB	MB
Project Number	**Scale @ A3**	**Date Created**
794-PLN-ESH-00030	1:5,000	April 2024
Figure Number		**Rev**
2		**01**

www.xlinks.co

Figure 1.2: Location of aquatic invertebrate surveys for WC5

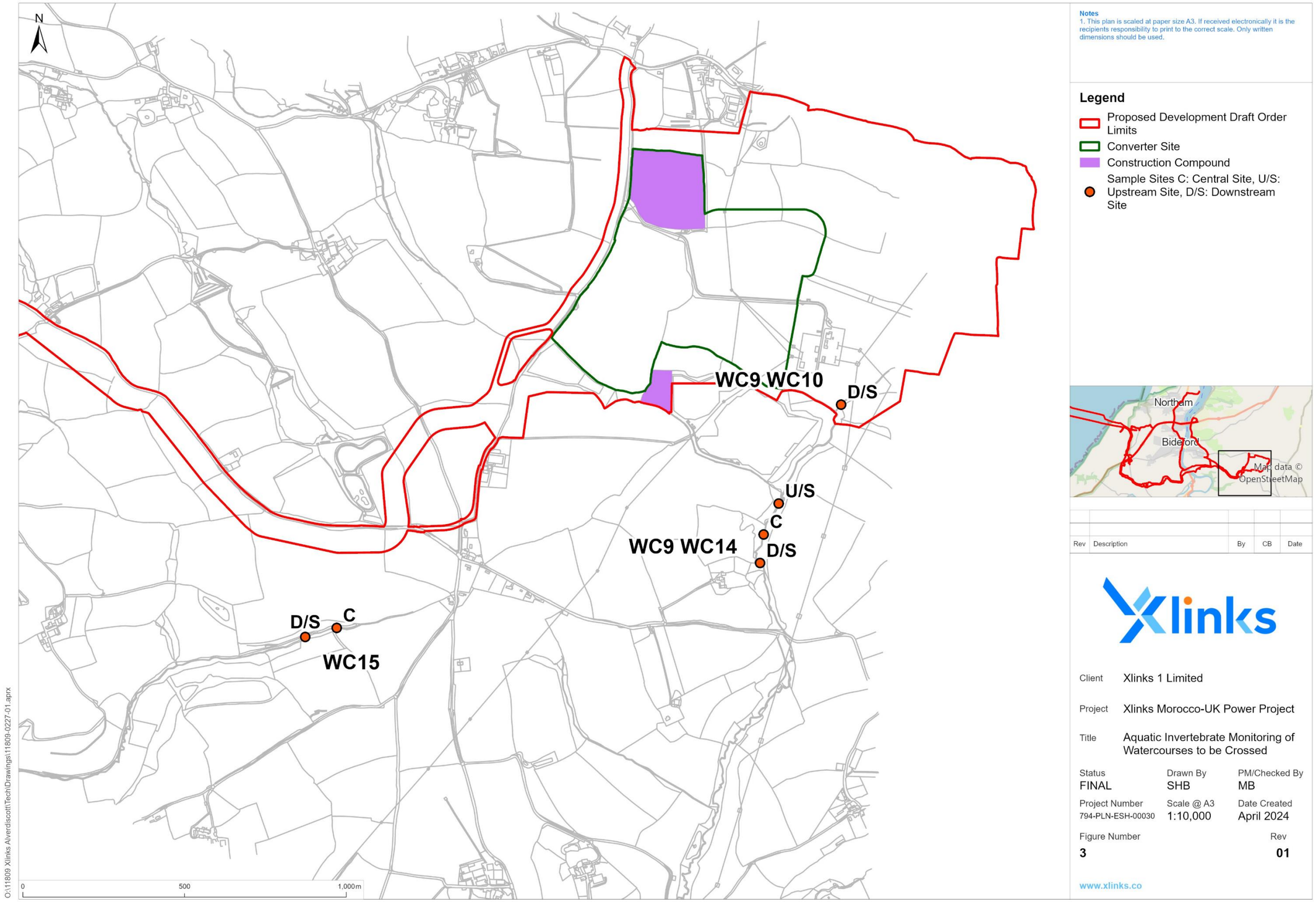


Figure 1.3: Location of aquatic invertebrate surveys for WC9, 10, 14 and 15

1.2 Materials and Methods

Field Survey

1.2.1 The survey of the watercourses took place on 12-13 September 2022. On each watercourse, it was proposed to select three sites for aquatic invertebrate sampling: one at the location of the proposed cable excavation (the central site) and two further sites, within approximately 50 m upstream and downstream of the central site. The central site would potentially be destroyed during the excavation of the cable route but the data from the survey would provide a baseline assessment of the communities present before works commenced. The other two sites would provide potential monitoring sites should this be required during the construction process, with the upstream site providing a control against which the downstream site could be compared.

1.2.2 Despite some rain in the weeks preceding the survey, a prolonged very dry summer meant that water levels in many of the watercourses were extremely low, such that it was only possible on two of the watercourses, WC9 and 2/12, to sample three sites.

1.2.3 The proposed cable corridor will cross the source of WC17, which was a small agricultural ditch laying within a deep channel beneath a dense hedgerow. Only a few very shallow, isolated pools were present in the channel and no sampling was undertaken.

1.2.4 At WC5, above the central site most of the flow in the channel originated from a land drain and upstream of this there was barely a trickle in the channel, limiting the survey to central and downstream sites only. A similar situation was also evident at WC15, where the channel was very narrow, with insufficient water for sampling above the central site.

1.2.5 WC16 consisted of a muddy trickle, with insufficient water for sampling. At WC10 most of the flow originated from a land drain, with just a trickle of water in the channel above, thus it was only possible to sample a downstream site, just upstream of the stream's confluence with WC9.

1.2.6 The locations of the watercourses and sampling sites on them are illustrated in **Figure 1.1** to **Figure 1.3** below. **Annex A** lists the environmental data for the sites, including descriptions of their locations, grid references, substrate composition and any flora present in the wetted channel. Site photographs are provided in **Annex B**.

1.2.7 Each of the sites were sampled using the standard protocol employed by the Environment Agency for sampling lotic watercourses (detailed in Environment Agency internal document No. 018_08 (2017), which has now superseded the more detailed BT001 (Murray-Bligh, 1999)). This protocol involved a timed period of three minutes of active net sampling (the time being apportioned to each habitat according to the proportion of the site that it covered), accompanied by a one-minute search.

1.2.8 The net sampling was carried out using a FBA pattern pond net, fitted with a 1 mm mesh collecting bag and involved a combination of kick sampling and sweeping the net through marginal vegetation. This was accompanied by manual investigation of submerged coarse woody debris and larger stones for attached organisms (e.g. the river limpet (*Ancylus fluviatilis*)) and searches of the water

surface for surface-dwelling animals (e.g. the whirligig beetle *Gyrinus substriatus*), for a timed period of one minute in total at each site.

1.2.9 After collection, the samples were preserved on-site, in a solution of 90% Industrial Methylated Spirits (IMS or Denatured Ethanol B), 5% water and 5% glycerol for transportation to the laboratory and subsequent analysis.

Sample Analysis and Data Evaluation

1.2.10 The analysis of the samples followed standard Environment Agency procedures (as outlined in Environment Agency internal document No. 024_08 (2014) and BT001). Taxa were identified to the lowest possible taxonomic level, with the exception of the taxonomically difficult groups: *Oligochaeta* (segmented worms) and *Chironomidae* (non-biting midge larvae). Other Diptera larvae were identified to the lowest level possible due to larval maturity and available identification keys.

1.2.11 In the previous cable route surveys Biological Monitoring Working Party (BMWP), N-Taxa (number of BMWP scoring taxa) and ASPT (Average Score Per Taxon) scores were calculated for each sample to provide an assessment of the ecological water quality at each site. The BWMP index has since been superseded by the WHPT (Whalley Hawkes Paisley Trigg) index, which is now used by the Environment Agency and the other UK environmental monitoring agencies for the classification of rivers according to the European Water Framework Directive (WFD, 2000/60/EC) (see **Annex D** for further details of the BMWP and WHPT indices). In order to provide some comparison with previous data, specifically relating to watercourses WC5, WC9 and WC10, both WHPT and BMWP indices were calculated for the data in the current survey.

1.2.12 The conservation value of the invertebrate communities at each site was assessed using a community-based classification developed by the Environment Agency (Chadd and Extence, 2004). The Community Conservation Index (CCI) empirically assesses the conservation value of a given site using the entire invertebrate community rather than undue emphasis on the presence of a few scarce species. An explanation of the terms used, along with the formula for calculating the index is given in **Annex E**. The conservation values for individual species used in this report are those cited by Chadd and Extence (2004).

Accurate Lifespan of Ecological Data

1.2.13 The majority of ecological data remain valid for only short periods due to the inherently transient nature of the subject. The survey results contained in this report are considered accurate for two years, assuming no significant considerable changes to the site conditions.

1.2.14 Site specific surveys used to inform Volume 2, Chapter 1: Onshore Ecology and Nature Conservation of the PEIR were undertaken between 2021 and 2024. CIEEMs Advice Note: On the lifespan of ecological reports and surveys (CIEEM, 2019) recommends that surveys exceeding three years in age are likely to require updating, whilst surveys undertaken between 18 months and three years prior to application may require site visits pre-construction to review the validity of survey findings. Therefore, in accordance with CIEEM guidance, site specific surveys undertaken over 18 months prior to the submission will be updated, where required (following a site review to confirm the validity of survey findings by a suitably qualified ecologist). Those surveys undertaken over three years will be supplemented by further surveys to be completed pre-submission.

1.3 Results

1.3.1 **Table 1.1** below lists the WHPT, BMWP and CCI indices for each of the sites on the five watercourses.

Table 1.1: WHPT, BMWP and CCI indices across the watercourses

Watercourse	WC2/12 Rickard's Down			WC5 lower Dunn Farm	
Sample Location	1: D/S	2: CENT.	3: U/S	1: D/S	2: CENT.
BMWP	26	19	58	82	63
N-TAXA	7	5	12	14	13
ASPT	3.71	3.8	4.83	5.86	4.85
WHPT	42.03	35.92	73.5	108.63	91.12
WHPT N-TAXA	9	8	14	17	17
WHPT ASPT	4.67	4.49	5.25	6.39	5.36
Average conservation score	1	1.33	1.56	1.8	1.86
Community score	1	1	3	3	3
Community conservation index	1	1.33	4.68	5.4	5.58
Conservation status	Low	Low	Low	Moderate	Moderate

Watercourse	WC9 Higher Kingdon			WC10 Sub-station	WC15 Gammaton	
Sample Location	1: D/S	2: CENT.	3: U/S	1: D/S	1: D/S	2: CENT.
BMWP	96	86	88	23	52	49
N-TAXA	16	15	16	5	11	10
ASPT	6	5.73	5.5	4.6	4.73	4.9
WHPT	105.06	115.14	106.78	26.7	63.36	65.16
WHPT N-TAXA	17	19	19	6	12	12
WHPT ASPT	6.18	6.06	5.62	4.45	5.28	5.43
Average conservation score	1.82	2.1	2.15	1	2.67	2.67
Community score	3	5	5	1	3	3
Community conservation index	5.46	10.5	10.75	1	8.01	8.01
Conservation status	Moderate	Fairly High	Fairly High	Low	Moderate	Moderate

1.3.2 Taxa lists for each of the five sampled watercourses are presented in **Annex C**, with summaries of the aquatic invertebrate communities below.

WC2/12: Rickard's Down Stream

1.3.3 The headwaters of this stream include the two watercourses referred to as WC2 and WC12 in the previous cable corridor surveys, both of which unite at Chaltaborough and then flow eastwards to Kenwith Castle, where the stream is joined by another tributary, before flowing through the Kenwith Valley to enter the Torridge Estuary between Bideford and Northam. The central sampling site was

located at SS 4230 2705, where the upper part of the surveyed reach flows through pasture, before entering woodland further downstream. Water levels in the channel were very low, with the wetted channel averaging just 1 m in width and a depth of 3 cm. It was evident that during wetter months the channel would be considerably wider and deeper. Vegetation was sparse with just a few stands of brooklime (*Veronica beccabunga*) and fool's watercress (*Apium nodiflorum*) at the central site. The substrate was a mixture of cobbles, pebbles and gravel, with the former dominant at the upstream and downstream sites and gravel at the central.

1.3.4 Both aquatic invertebrate numbers and diversity were low and considerably less than those recorded for WC2, further upstream, in 2010 and 2011. The species recorded were typical of such small, stony stream and the communities were dominated by *Gammarus* amphipods. As with all the small streams in this survey, many of which were likely to have been dry at the height of the summer, it was believed that the low diversity was due to the extremely low water levels, accompanied by difficulties in effectively sampling such shallow water. No uncommon species were recorded and the communities at all three sites were assessed as being of low conservation value.

WC 5: Lower Dunn Farm Stream

1.3.5 Previously sampled further upstream on its headwaters, this is one of several watercourses feeding into Jennets Reservoir to the south of Bideford. The stream lays within a small, wooded valley and water levels were very low, such that it was not possible to sample above the central site at SS 4430 2435.

1.3.6 The wetted channel was on average 0.5 to 0.75 m wide with just 2 cm of water, making netting difficult, and a substrate of predominately cobbles and pebbles. Channel vegetation was virtually absent and restricted to benthic diatoms and marginal patches of bryophytes above the current water level.

1.3.7 Invertebrate diversity was poor at both sites, with the communities dominated by chironomid larvae, *Gammarus* amphipods and the hydrobiid snail *Potamopyrgus antipodarum.* Several sensitive taxa were present suggesting that the poor diversity was more an indication of the drought conditions rather than water quality issues. The composition of the assemblages was similar to that recorded on the headwaters in 2010 and 2011, with no uncommon species and of moderate conservation interest.

WC 9: Higher Kingdon Stream

1.3.8 WC 9 is a headwater tributary of the Huntshaw Water, which flows into the River Torridge south of Weare Giffard. The stream rises in a small wood to the east of Higher Kingdon and flows eastwards, along the southern boundary of the existing electrical sub-station to join another stream (WC10) which flows along the eastern boundary of the station. The combined waters then flow southwards, to be joined by the flow from a second tributary (referred to as WC14 in previous surveys) and then on to the confluence with the Huntshaw Water at Fairoak.

1.3.9 In the current survey, WC9 was sampled downstream of the confluence of WC10, with the central site located at SS 4999 2453. At this point the stream flows through a wooded valley and is heavily shaded by the surrounding trees, such that in-channel vegetation was virtually absent, limited to a few stands of hemlock water-dropwort (*Oenanthe crocoata*) at the central site. The wetted channel width

was on average 2 m, with very low water levels on average 4 cm deep, and substrates of predominately cobbles and pebbles at the lower sites, and gravel at the upstream.

1.3.10 Diversity was similar to that recorded in the 2010 survey but lower than that of 2011, both conducted on the upper reaches, above the confluence of WC10. However, the communities recorded at WC9 were still the most diverse in the current survey. The assemblages were dominated by *Gammarus* and chironomid larvae. Taxa sensitive to organic pollution were present and again it was believed that the low diversity was more a result of the very low water levels, rather than water quality issues in the catchment. Conservation interest varied from moderate at the downstream site to fairly high at the other two locations.

1.3.11 Single larvae of the caddis species *Hydatophylax infumatus* were recorded at the central and upstream sites and were the only species of note within the communities. *Hydatophylax infumatus* feeds on decaying submerged wood and is a widespread species of streams and rivers, although never found frequently due to the cryptic habits of its adults and larvae. Formerly regarded as a Local Species (Wallace, 1991) it has since been given a status of Nationally Scarce in a more recent review (Wallace, 2016). Due to its rarer status, allocated since Chadd and Exetnce (2004), it is thus more likely that the communities at the central and upstream sites are of 'high' conservation interest.

1.3.12 Bullheads (*Cottus gobio*) were also recorded on the lower part of the stream during invertebrate sampling.

WC 10: Stream to east of sub-station

1.3.13 WC10 is a small headwater tributary of WC9 that rises to the southwest of Stony Cross and was sampled in autumn 2010, approximately 100 m upstream of its confluence with WC9. As with all the watercourses in the current survey water levels were very low, such that only a downstream site, just upstream of the confluence at SS 5022 2493 could be sampled. Approximately 30 m upstream of this location most of the flow in the channel comes from a land drain discharging into the watercourse and above this point the flow was just a muddy trickle. At the sampling site the wetted channel was 0.75 m wide with an average depth of 4 cm and a predominately gravel substrate.

1.3.14 Invertebrate diversity was very low, much less than that recoded previously, overwhelmingly dominated by *Gammarus*, and of low conservation value.

WC 15: Gammaton Stream

1.3.15 A small, heavily shaded stream within a wooded valley, with very low water levels in a channel 0.35 to 0.5 m wide with an average depth of 2 cm. Above the central site (at SS 4867 2426) the water was even shallower and impossible to sample. The substrate was predominately pebbles and gravel with in-channel vegetation limited to a few patches of the moss *Platyhypnidium riparoides* at the downstream site.

1.3.16 Aquatic invertebrate diversity was low, of moderate conservation interest, and the assemblages dominated by *Gammarus* and Chironomidae.

1.4 Conclusions

1.4.1 The watercourses surveyed had low aquatic invertebrate diversity, with assemblages dominated by *Gammarus* amphipods and chironomid larvae, and were mostly of low to moderate conservation interest.

1.4.2 The most diverse stream was WC9, which was slightly larger than the others in the survey and was sampled at locations further down the catchment than in the previous cable route appraisals. However, even here aquatic invertebrate diversity was somewhat restricted and lower than expected for a watercourse of this nature. The Nationally Scarce caddis *Hydatophylax infumatus* was recorded at the central and upstream sites. Although the CCI index indicated assemblages of moderate conservation interest at the upstream site and fairly high interest at the central and downstream sites, it was felt that in light of the elevation of the conservation status of *H. infumatus* from Local to Nationally Scarce, a designation of high conservation interest for the two lower sites was more appropriate.

1.4.3 Due to a very prolonged period of dry, hot weather in the preceding months, water levels in all the watercourses were very low, such that it was only possible to sample three sites on WC9 and 2/12, with flow in the upper channels of the others reduced to a trickle. Whilst restricted diversity is a naturally occurring phenomenon on such small headwater streams, the assemblages were still less diverse than to be expected for watercourses of this nature and, where previously surveyed in 2010 and 2011, the communities were of lower diversity than the historical data, which was collected from sampling sites further up the catchments than in the current survey. It was believed that the extremely low water levels were the limiting factor engendering the low diversity of the communities, rather than water quality issues on the catchments. It was likely that many of the streams had only just begun to flow again in the weeks preceding the survey and had probably been dry at the height of the summer. Thus, the survey was in fact documenting the steady re-colonisation of the watercourses by invertebrates from refugia either lower down the catchments or within the hyporheic zone beneath the stream beds. Should the watercourses be sampled during their typical follow regime then diversities within them would probably be much higher and more representative of that documented in previous surveys conducted as part of the Atlantic Array cable route appraisal in autumn 2010 and spring 2011.

1.5 References

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

Environment Agency (2017) *Freshwater macro-invertebrate sampling in rivers*. Internal Environment Agency document, Operational Instruction 018_08, Version 7.

Environment Agency (2014) *Freshwater macro-invertebrate analysis of riverine samples.* Internal Environment Agency document, Operational Instruction 024_08, Version 5.

Knight, L.R.F.D. (2010) *Aquatic invertebrate monitoring of watercourses to be crossed by the Atlantic Array underground electricity cable*. Unpublished report to RPS Planning & Development.

Knight, L.R.F.D. (2011) *Aquatic invertebrate monitoring of watercourses to be crossed by the Atlantic Array underground electricity cable*, North Devon. Unpublished report to RPS Planning & Development.

Murray-Bligh, J. (1999) *Procedures for collecting and analysing macro-invertebrate samples*. Internal Environment Agency document BT 001.

RPS (2013) *Atlantic Array Wind Farm: onshore cable route. Aquatic invertebrate report.* Unpublished report to RWE Npower Renewables Ltd.

Wallace, I.D. (1991) *A review of the Trichoptera of Great Britain - Research & survey in nature conservation, No. 32*. Nature Conservancy Council, Peterborough.

Wallace, I.D. (2016) *A review of the status of the caddis flies (Trichoptera) of Great Britain - Species Status No.27.* Natural England Commissioned Reports, Number191.

Walley, W.J. and Hawkes, H.A. (1996). A computer-based reappraisal of the Biological Monitoring Working Party scores using data from the 1990 river quality survey of England and Wales. *Water Research,* 30 (9): 2086-2094.

Walley, W.J. and Hawkes, H.A. (1997). A computer-based reappraisal of the Biological Monitoring Working Party score system incorporating abundance rating, site type and indicator value. *Water Research,* 31 (2): 201-21

Annex A: Sampling Site Environmental Data

ANNEX A: Sampling site environmental data

SITE	**WC2 / 12 D/S**	**WC2 / 12 Central**	**WC2 / 12 U/S**	**WC5 D/S**	**WC5 Central**
WATERCOURSE	Rickard's Down Stream	Rickard's Down Stream	Rickard's Down Stream	Lower Dunn Farm Stream	Lower Dunn Farm Stream
LOCATION	50m Downstream central site, 30m downstream boundary	20m Upstream boundary	75m Upstream central site, 50m upstream boundary and ford	60m Downstream central site, adjacent to large ash and game pen	40m Upstream boundary on LHB
NGR	SS 4234 2708	SS 4230 2705	SS 4221 2702	SS 4424 2437	SS 4430 2435
WIDTH (m)	1.9	0.75	1.1	0.75	0.5
AVERAGE DEPTH (cm)	3	3	5	3	1
SUBSTRATE (% cover)					
Silt	2	5	marginal / overlying	Overlying	Marginal / overlying
Clay	1	0	0	0	0
Sand	2	5	<1	<1	2
Gravel	15	50	5	10	28
Pebbles	45	25	35	40	50
Cobbles	35	20	60	50	20
FLOW	Moderate	Moderate	Moderate	Slow	Slow
SHADING	Heavy	Heavy	Heavy	Heavy	Heavy
MACROPHYTE COVER (%)	0	10	0	0	0
MACROPHYTE SPECIES	**	*Verronica Beccabunga, Apium nodiflorum*	**	**	**
BRYOPHYTE COVER (%)	0	0	0	0	0
BRYOPHYTE SPECIES	**	**	**	**	**
ALGAL COVER (%)	3	5	3	3	3
ALGAL TAXA	Benthic diatoms	Benthic diatoms	Benthic diatoms	Benthic diatoms	Benthic diatoms

SITE	**WC9 D/S**	**WC9 Central**	**WC9 U/S**	**WC10 D/S**	**WC15 D/S**	**WC15 Central**
WATERCOURSE	Higher Kingdon Stream	Higher Kingdon Stream	Higher Kingdon Stream	Stream to east of sub-station	Gammaton Stream	Gammaton Stream
LOCATION	70m Downstream central site, 10m downstream boundary on RHB	50m Downstream boundary on LHB	87m Upstream central site, 37m upstream boundary on RHB	5m Upstream confluence with WC9	50m Downstream central site, 40m downstream boundary on LHB	10m Upstream boundary on LHB
NGR	SS 4998 2447	SS 4999 2453	SS 5002 2559	SS 5022 2493	SS 4863 2425	SS 4867 2426
WIDTH (m)	2	2.6	1.35	0.75	0.35	0.5
AVERAGE DEPTH (cm)	4	3	6	3	2	2
SUBSTRATE (% cover)						
Silt	Marginal / overlying	Marginal / overlying	10	12	7	3
Clay	0	0	0	0	3	0
Sand	1	1	2	3	2	2
Gravel	9	35	65	65	55	50
Pebbles	50	50	20	10	20	25
Cobbles	40	14	3	10	13	20
FLOW	Moderate	Moderate	Moderate	Slow	Slow	Slow
SHADING	Heavy	Heavy	Heavy	Heavy	Heavy	Heavy
MACROPHYTE COVER (%)	0	<1	0	0	0	0
MACROPHYTE SPECIES	**	*Oenanthe crocoata*	**	**	**	**
BRYOPHYTE COVER (%)	0	0	0	0	<1	0
BRYOPHYTE SPECIES	**	**	**	**	*Platyhypnidium riparoides*	**
ALGAL COVER (%)	5	5	10	5	3	3
ALGAL TAXA	Benthic diatoms	Benthic diatoms	Benthic diatoms	Benthic diatoms	Benthic diatoms	Benthic diatoms

Annex B: Site Photographs

ANNEX B: Site photographs

WC2/12: Rickard's Down Stream, downstream site (left) and central site (right)

WC2/12: Rickard's Down Stream, upstream site

WC5: Lower Dunn Farm Stream, downstream site (left) and central site (right)

WC9: Higher Kingdon Stream, downstream site (left) and central site (right)

Left: WC9: Higher Kingdon Stream, upstream site. Right WC10: Stream to east of sub-station, downstream site

WC15: Gammaton Stream, downstream site (left) and central site (right)

Annex C: Aquatic Invertebrate Taxa Lists

ANNEX C: Aquatic invertebrate taxa lists

WC2/12: Rickard's Down Stream

	SAMPLE 1, D/S		SAMPLE 2, CENTRAL		SAMPLE 3, U/S	
TAXA	**Nos.**	**Relative Abundance**	**Nos.**	**Relative Abundance**	**Nos.**	**Relative Abundance**
TRICLADIDA						
PLANARIIDAE						
Polycelis felina					25	5.83
OLIGOCHAETA						
Oligochaeta spp.	9	13.64			34	7.93
HIRUDINEA						
ERPOBDELLIDAE						
Trocheta subviridis					3	0.70
GASTROPODA						
PLANORBIDAE						
Ancylus fluviatilis	1	1.52				
HYDROBIDAE						
Potamopyrgus antipodarum	5	7.58	10	16.39	6	1.40
BIVALVIA						
SPHAERIIDAE						
Pisidium sp.			1	1.64		0.00
CRUSTACEA						
ASELLIDAE						
Asellus aquaticus	4	6.06			6	1.40
GAMMARIDAE						
Gammarus pulex / fossarum	15	22.73	11	18.03	319	74.36
PLECOPTERA						
LEUCTRIDAE						
Leuctra fusca					2	0.47
Leuctra sp.					3	0.70
EPHEMEROPTERA						
EPHEMERIDAE						
Ephemera danica					1	0.23
DIPTERA						
CHIRONOMIDAE						
Chironomidae spp.	28	42.42	30	49.18	21	4.90
CERATOPOGONIDAE						
Palpomyia / Bezzia gp.	1	1.52	2	3.28	2	0.47
PTYCHOPTERIDAE						
Ptychoptera sp.	1	1.52				
TABANIDAE						
Chrysops sp.			1	1.64		
PSYCHODIDAE						
Pericoma sp.			5	8.20	1	0.23
COLEOPTERA						
ELMIDAE						
Elmis aenea					2	0.47
Oulimnius sp. (larva)					1	0.23
DYTISCIDAE						

Hydroporus tesselatus			1	1.64		
HYDRAENIDAE						
Hydraena gracilis					2	0.47
SCIRTIDAE						
Elodes sp. (larvae)	2	3.03			1	0.23
Nos. Identified Taxa	**9**		**8**		**15**	
Total Nos. of Invertebrates	**66**		**61**		**429**	
BMWP	**26**		**19**		**58**	
N-TAXA	**7**		**5**		**12**	
ASPT	**3.71**		**3.8**		**4.83**	
WHPT	**42.03**		**35.92**		**73.5**	
N-TAXA	**9**		**8**		**14**	
ASPT	**4.67**		**4.49**		**5.25**	
Average Conservation Score	**1**		**1.33**		**1.56**	
Community Score	**1**		**1**		**3**	
Community Conservation Index	**1**		**1.33**		**4.68**	
Conservation Status	**Low**		**Low**		**Low**	

WC5: Lower Dunn Farm Stream

	SAMPLE 1, D/S		**SAMPLE 2, CENTRAL**	
TAXA	**Nos.**	**Relative Abundance**	**Nos.**	**Relative Abundance**
TRICLADIDA				
PLANARIIDAE				
Polycelis felina	3	0.32	17	2.45
OLIGOCHAETA				
Oligochaeta spp.			7	1.01
GASTROPODA				
HYDROBIDAE				
Potamopyrgus antipodarum	124	13.07	75	10.79
BIVALVIA				
SPHAERIIDAE				
Pisidium casertanum	1	0.11		
Pisidium sp.	6	0.63	3	0.43
CRUSTACEA				
ASELLIDAE				
Asellus aquaticus	7	0.74		
GAMMARIDAE				
Gammarus pulex / fossarum	272	28.66	321	46.19
ANISOPTERA				
CORDULEGASTRIDAE				
Cordulegaster boltonii	1	0.11		
PLECOPTERA				
LEUCTRIDAE				
Leuctra sp.	2	0.21	3	0.43
NEMOURIDAE				
Nemurella picteti			1	0.14
EPHEMEROPTERA				
BAETIDAE				

Baetis muticus			1	0.14
TRICHOPTERA				
POLYCENTROPODIDAE				
Plectrocnemia conspersa	6	0.63	3	0.43
Plectrocnemia sp.	3	0.32	3	0.43
SERICOSTOMATIDAE				
Sericostoma personatum	2	0.21		
ODONTOCERIDAE				
Odontocerum albicorne	1	0.11		
DIPTERA				
CHIRONOMIDAE				
Chironomidae spp.	485	51.11	208	29.93
CERATOPOGONIDAE				
Palpomyia / Bezzia gp.	1	0.11	3	0.43
PTYCHOPTERIDAE				
Ptychoptera sp.	2	0.21	33	4.75
PEDICIIDAE				
Dicranota sp.	1	0.11	3	0.43
Pedicia sp.			1	0.14
LIMONIIDAE				
Eloeophila sp.			1	0.14
PSYCHODIDAE				
Pericoma sp.			1	0.14
DIXIDAE				
Dixa maculata / nubilipennis	1	0.11	3	0.43
COLEOPTERA				
GYRINIDAE				
Gyrinus substriatus	10	1.05		
DYTISCIDAE				
Hydroporus tesselatus			3	0.43
SCIRTIDAE				
Elodes sp. (larvae)	21	2.21	5	0.72
Nos. Identified Taxa	**17**		**19**	
Total Nos. of Invertebrates	**949**		**695**	
BMWP	**82**		**63**	
N-TAXA	**14**		**13**	
ASPT	**5.86**		**4.85**	
WHPT	**108.63**		**91.12**	
N-TAXA	**17**		**17**	
ASPT	**6.39**		**5.36**	
Average Conservation Score	**1.8**		**1.86**	
Community Score	**3**		**3**	
Community Conservation Index	**5.4**		**5.58**	
Conservation Status	**Moderate**		**Moderate**	

WC9: Higher Kingdon Stream

	SAMPLE 1, D/S		SAMPLE 2, CENTRAL		SAMPLE 3, U/S	
TAXA	**Nos.**	**Relative Abundance**	**Nos.**	**Relative Abundance**	**Nos.**	**Relative Abundance**
TRICLADIDA						
PLANARIIDAE						
Polycelis felina	2	0.85			4	1.19
OLIGOCHAETA						
Oligochaeta spp.	2	0.85	6	1.53	3	0.90
HIRUDINEA						
ERPOBDELLIDAE						
Trocheta subviridis	1	0.43				
GLOSSIPHONIIDAE						
Glossiphonia complanata					1	0.30
GASTROPODA						
PLANORBIDAE						
Ancylus fluviatilis			1	0.26		
HYDROBIDAE						
Potamopyrgus antipodarum	7	2.98	1	0.26	59	17.61
BIVALVIA						
SPHAERIIDAE						
Pisidium subtruncatum					1	0.30
Pisidium sp.					1	0.30
CRUSTACEA						
GAMMARIDAE						
Gammarus pulex / fossarum	73	31.06	253	64.54	49	14.63
ANISOPTERA						
CORDULEGASTRIDAE						
Cordulegaster boltonii					3	0.90
PLECOPTERA						
LEUCTRIDAE						
Leuctra fusca	27	11.49	10	2.55	8	2.39
Leuctra sp.	17	7.23	14	3.57	5	1.49
NEMOURIDAE						
Nemoura sp.	1	0.43				
EPHEMEROPTERA						
LEPTOPHLEBIIDAE						
Habrophlebia fusca	2	0.85				
BAETIDAE						
Baetis muticus			1	0.26		
HEPTAGENIIDAE						
Ecdyonurus torrentis	1	0.43				
Ecdyonurus sp.	6	2.55	2	0.51		
TRICHOPTERA						
POLYCENTROPODIDAE						
Plectrocnemia conspersa			1	0.26		
Plectrocnemia sp.	1	0.43				
SERICOSTOMATIDAE						
Sericostoma personatum	3	1.28			3	0.90
ODONTOCERIDAE						
Odontocerum albicorne			1	0.26	1	0.30

LIMNEPHILIDAE						
Hydatophylax infumatus			1	0.26	1	0.30
Limnephilidae sp.	2	0.85			5	1.49
DIPTERA						
CHIRONOMIDAE						
Chironomidae spp.	75	31.91	55	14.03	153	45.67
CERATOPOGONIDAE						
Palpomyia / Bezzia gp.			1	0.26	11	3.28
PTYCHOPTERIDAE						
Ptychoptera sp.			12	3.06		
EMPIDIDAE						
Hemerodromia sp. (pupa)			1	0.26		
Clinocerinae sp. (pupa)	1	0.43				
PEDICIIDAE						
Dicranota sp.					5	1.49
Pedicia sp.			1	0.26	2	0.60
CULICIDAE						
Anopheles claviger					1	0.30
TIPULIDAE						
Tipula maxima			1	0.26		
DIXIDAE						
Dixa nebulosa			1	0.26	1	0.30
Dixa maculata / nubilipennis			5	1.28		
COLEOPTERA						
ELMIDAE						
Elmis aenea	1	0.43	4	1.02	4	1.19
Limnius volckmari	1	0.43				
DYTISCIDAE						
Platambus maculatus	3	1.28	1	0.26	4	1.19
SCIRTIDAE						
Elodes sp. (larvae)	9	3.83	19	4.85	10	2.99
Nos. Identified Taxa	**18**		**21**		**20**	
Total Nos. of Invertebrates	**235**		**392**		**335**	
BMWP	**96**		**86**		**88**	
N-TAXA	**16**		**15**		**16**	
ASPT	**6**		**5.73**		**5.5**	
WHPT	**105.06**		**115.14**		**106.78**	
N-TAXA	**17**		**19**		**19**	
ASPT	**6.18**		**6.06**		**5.62**	
Average Conservation Score	**1.82**		**2.1**		**2.15**	
Community Score	**3**		**5**		**5**	
Community Conservation Index	**5.46**		**10.5**		**10.75**	
Conservation Status	**Moderate**		**Fairly High**		**Fairly High**	

WC10: Stream to east of electrical sub-station

	SAMPLE 1, D/S	
TAXA	**Nos.**	**Relative Abundance**
CRUSTACEA		

GAMMARIDAE		
Gammarus pulex / fossarum	454	74.79
DIPTERA		
CHIRONOMIDAE		
Chironomidae spp.	146	24.05
CERATOPOGONIDAE		
Palpomyia / Bezzia gp.	2	0.33
PEDICIIDAE		
Pedicia sp.	1	0.16
COLEOPTERA		
ELMIDAE		
Elmis aenea	1	0.16
SCIRTIDAE		
Elodes sp. (larvae)	3	0.49
Nos. Identified Taxa	**6**	
Total Nos. of Invertebrates	**607**	
BMWP	**23**	
N-TAXA	**5**	
ASPT	**4.6**	
WHPT	**26.7**	
N-TAXA	**6**	
ASPT	**4.45**	
Average Conservation Score	**1**	
Community Score	**1**	
Community Conservation Index	**1**	
Conservation Status	**Low**	

WC15: Gammaton Stream

	SAMPLE 1, D/S		SAMPLE 2, CENTRAL	
TAXA	**Nos.**	**Relative Abundance**	**Nos.**	**Relative Abundance**
TRICLADIDA				
PLANARIIDAE				
Polycelis felina	1	0.28	1	0.37
OLIGOCHAETA				
Oligochaeta spp.	1	0.28		
GASTROPODA				
HYDROBIDAE				
Potamopyrgus antipodarum			3	1.12
BIVALVIA				
SPHAERIIDAE				
Pisidium sp.	1	0.28	2	0.75
CRUSTACEA				
GAMMARIDAE				
Gammarus pulex / fossarum	143	39.50	135	50.56
ANISOPTERA				
CORDULEGASTRIDAE				
Cordulegaster boltonii	3	0.83	9	3.37
TRICHOPTERA				

POLYCENTROPODIDAE				
Plectrocnemia conspersa	5	1.38	2	0.75
Plectrocnemia sp.	2	0.55	1	0.37
HYDROPSYCHIDAE				
Diplectrona felix	1	0.28		
DIPTERA				
CHIRONOMIDAE				
Chironomidae spp.	179	49.45	103	38.58
PTYCHOPTERIDAE				
Ptychoptera sp.	15	4.14	1	0.37
PEDICIIDAE				
Dicranota sp.			4	1.50
DIXIDAE				
Dixa maculata / nubilipennis			1	0.37
COLEOPTERA				
DYTISCIDAE				
Hydroporus tesselatus	3	0.83	1	0.37
SCIRTIDAE				
Elodes sp. (larvae)	7	1.93	4	1.50
Nos. Identified Taxa	**12**		**112**	
Total Nos. of Invertebrates	**362**		**267**	
BMWP	**52**		**49**	
N-TAXA	**11**		**10**	
ASPT	**4.73**		**4.9**	
WHPT	**63.36**		**65.16**	
N-TAXA	**12**		**12**	
ASPT	**5.28**		**5.43**	
Average Conservation Score	**2.67**		**2.67**	
Community Score	**3**		**3**	
Community Conservation Index	**8.01**		**8.01**	
Conservation Status	**Moderate**		**Moderate**	

Annex D: WHPT and BMWP Indices

ANNEX D: WHPT and BMWP indices

Prior to 2015, the BMWP (Biological Monitoring Working Party) scoring system was used by the UK environmental agencies to provide an ecological classification of rivers and streams. This scoring system assigned a value of one to ten to certain invertebrate families, according to their degree of sensitivity to the effects of organic pollution, with the more sensitive families scoring the higher values. The BMWP scores for all the taxa in a sample are then totalled to provide an overall BMWP score for the sample. The ASPT (Average Score Per Taxon) is calculated by dividing the BMWP score by the number of taxa used to calculate it. This is arguably the most useful score for comparing between samples as it reduces the distorting effect of single / small numbers of very high or low-scoring taxa occurring at a sample site.

The BMWP system was in use from the late 1980s up to 2015 and by this time had long been in need of updating to better reflect current, better-informed information on the ecology and pollution tolerance of various aquatic invertebrate taxa. Under the initial BMWP system values were allocated to individual taxa based on expert judgement. Comprehensive information is now available from standardised river surveys undertaken across the UK by the Environment Agency, the Environment and Heritage Service for Northern Ireland and the Scottish Environmental Protection Agency. This data enabled Walley and Hawkes (1996, 1997) to carry out an analysis of the results and derive new values for each family and also to incorporate several families not previously included in the BMWP system. Combined with further refinement, this led to the development of the WHPT (Walley Hawkes Paisley Trigg) index, which is now being used by the UK regulatory agencies. This is calculated in a similar manner to the BMWP with WHPT N-TAXA and WHPT ASPT values also derived during the process. The main difference is that the WHPT values for each family can also be used to take into account that family's abundance within a sample of aquatic invertebrates, a factor that was noticeably lacking in the old BMWP system.

The numbers of individuals in each family are given a log abundance value based on the following:

Abundance Category	Numerical Abundance
AB1	1-9
AB2	10-99
AB3	100-999
AB4	>1000

A WHPT value is then assigned to each family according to its abundance in a sample; for example, for Asellidae based on presence only the WHPT score is: 2.8; AB1: 4; AB2: 2.3; AB3: 0.8 and AB4: -1.6, reflecting the fact that hoglice are an important natural component of the biota of many watercourses but when present in very high numbers are bio-indicators of organic pollution. WHPT values are assigned in this way to all families in a sample and then totalled, with the ASPT derived as in the BMWP system above.

Both the BMWP and WHPT scoring systems are designed for use with lotic sites and are only applicable to samples of invertebrates collected using the Environment Agency's standard methods. Although, primarily designed to detect the effects of organic pollution, both systems can also respond to the effects of toxic pollution and physical disturbance.

Annex E: Community Conservation Assessment Index (CCI)

ANNEX E: Community Conservation Assessment Index (CCI)

The Community Conservation Index (Chadd & Extence, 2004) was initially developed in 1995 by biologists in the NRA (National Rivers Authority) Anglian region and was reviewed in October 2004 after a ten year trial period. The CCI has advantages over other conservation assessment schemes, such as the species rarity score in that it takes into account the overall diversity of an invertebrate community and includes species that nationally might be uncommon but are not sufficiently scarce to warrant any conservation status. However, the scheme is already in need of up-dating as the conservation status of several species has changed in light of current knowledge. Chadd and Extence (2004) state that the scores can be adapted to local circumstances and changing designations but the scores from the original paper have been used in this report in order to avoid discrepancies and confusion.

Conservation Scores of between 1 and 10 have been assigned to each species of aquatic macro-invertebrate based on their rarity. Most of the individual species in a sample are allocated a score

The Community Score is based on the BMWP-score or the species in the sample with the highest conservation score: the Community Score for a site is based on whichever indicates the highest score.

Conservation scores used for the CCI (CS)

Conservation Score	Definition
10	Red Data Book Category (RDB)1, endangered
9	RDB2, vulnerable
8	RDB3, rare
7	Notable (but not RDB status) or regionally very notable
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)

Categories 10 - 5 are recognised national designations developed by JNCC.

Community scores used with the CCI (CoS)

Community Score	BMWP	Highest Conservation Score
15	>301	10
12	251 - 350	9
10	201 - 250	8
7	151 - 200	7
5	101 - 150	5 or 6
3	51 - 100	3 or 4
1	1 - 50	1 or 2
0	0	scoring species absent

The CCI for a site is the product of the Community Score and the average Conservation Score. It is calculated by dividing the sum of the individual species scores (CS) by the number of species (n) then multiplying the resulting product by the community score (CoS) described above:

$$CCI = (\sum CS \div n) \text{ X } CoS$$

This gives a numerical index from which the conservation value of a site is derived (see numerical ranges below)

0.0 to 5.0 – sites supporting only common 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 species richness. MODERATE CONSERVATION VALUE

10.0 to 15.0 – sites supporting at least one uncommon species, or several species of restricted distribution 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