Environment Agency

Evidence

Ecological indicators for abandoned mines

Report: SC090024/R2

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Miranda Kavanagh

Director of Evidence

Executive summary

Abandoned metal mines are significant and unregulated sources of pollution to our rivers and seas discharging priority hazardous and other polluting substances, notably cadmium (Cd), lead (Pb), copper (Cu), zinc (Zn) and iron (Fe). The first Water Framework Directive (WFD) surface water classification in England and Wales identified 133 waterbodies failing to meet environmental quality standards (EQS) for metals (Cd, Pb, Ni, Zn, Cu) in metal mining areas. The majority of significant EQS failures for Pb and Cd across England and Wales (that is, EQS failures occurring with more than 95 per cent statistical certainty) are in rivers draining abandoned metal mines. Four hundred and seventy waterbodies have been identified as "impacted" or "probably impacted" by abandoned non-coal mines across England and Wales. The Environment Agency has developed a joint approach with the Department for Environment, Food and Rural Affairs (Defra) to manage pollution from abandoned non-coal mines for the WFD. Three priority areas have been identified in the first river basin management planning cycle (2009-2015):

1. Develop new low-cost sustainable treatment technologies for metal mines (mitigation of pollution from abandoned mines).
2. Understand how to implement water quality targets to protect ecosystems impacted by abandoned mines over many decades (ecological indicators)., and
3. Carry out catchment investigations in priority water bodies to identify the main sources of metals, appraise options to manage the pollution including costs and benefits, and implement remediation (clean-up).

This project focussed on the second work area – ecological indicators for abandoned mines. The project was funded by Defra and managed by the Environment Agency as part of the overarching project, *Managing mining pollution for the Water Framework Directive* (*MAGIC*) (SC090024).

The project outlined in this report aimed to clarify whether conventional EQS are suitably protective of aquatic life (such as invertebrates, fish, diatoms, macrophytes), or if higher metal concentrations than the EQS can be acceptable in mining-impacted catchments without risk to aquatic life and, if so, how this is accommodated within the WFD to enable the status of the water body to be correctly classified.

The overall project aim was to *investigate the ecological impact of metals in rivers and produce guidance on setting water quality targets for aquatic ecosystems that are impacted by long-term mining pollution.*

Additional objectives were to provide guidance on:

1. The course of action when biological and chemical measurements differ, that is, when EQS for metals are breached but the biological community is in a good condition.
2. How to implement water quality targets for metals that represent good chemical and ecological status in mining-impacted rivers.
3. The evidence required to enable the appropriate refinement of water quality targets in mining-impacted rivers. For example, whether site biological data are required.

To achieve these objectives a combination of desk and field-based work was undertaken. The "tiered risk-based framework" for incorporating biotic ligand models (metal bioavailability models) and ambient background concentrations (ABCs) for metals risk assessment under the WFD was used as the basis for the project. The initial phase of the project (described in section 2 of this report) was focussed on the identification of sub-sets of waterbodies that share similar WFD compliance characteristics. For example, scenario 3, has poor chemical status but good[1] ecological status. This "screening assessment" applied both simple bioavailability screening tools and default Ambient Background Concentrations for zinc and was used to identify candidate waterbodies that offered the greatest scope for developing robust guidance for the implementation of alternative approaches to assess the status of mining impacted waters after undertaking a field programme to provide a range of water physico-chemistry, metal mixtures and EQS compliance scenarios.

A prioritised list of waterbodies was agreed with the Environment Agency project board and field surveys to obtain additional site-specific chemical and ecological data were undertaken, which included the collection of waterbody specific background concentrations for zinc and the suite of physico-chemical input parameters required to run full biotic ligand models for Cu and Zn. These field data, in combination with existing Environment Agency data for these waterbodies, were then analysed to determine the relative efficacy, transparency and legitimacy of candidate alternative approaches for applying EQS in mine impacted waterbodies during WFD classification in order to minimise instances of chemical and biological mis-match.

A pre-screening exercise removed waterbodies where there are pressures other than metals or acidity. This decreased the number of waterbodies taken forward to the screening assessment from 470 to 240. The screening assessment resulted in a modest improvement in the overall surface water classification of the 240 mining impacted waterbodies considered in this report. The number of waterbodies at "good or better" surface water status (based on a combination of chemistry and ecology) increased slightly from 47 to 53. More significantly, the number of waterbodies reaching good chemical status was increased from 105 to 116.

However, potentially of most interest in this dataset is the reduction in the number of waterbodies at which "significant" metal EQS failures are reported. Significant EQS failures are those that occur at a confidence of at least 95 per cent and are most likely to require a regulatory intervention. Overall, significant failures occur at 130 (54 per cent) waterbodies with conventional EQS, which is reduced to 87 (36 per cent) of waterbodies after applying the bioavailability screening tools.

Based on the findings of the screening assessment, a limited "confirmatory" field programme was undertaken to further explore some of the compliance scenarios. Only a limited number of waterbodies (four) could be included in this field programme because of the high costs of undertaking fieldwork and performing the necessary chemical and biological characterisation. However, each of the waterbodies investigated was selected after careful consideration to ensure that they represented "typical" scenarios for which the findings would be most readily transferable to other waterbodies.

Ambient Background Concentrations for zinc (and other metals) were estimated in individual waterbodies by direct sampling in the headwaters of the waterbodies. This approach requires that ABC sites in headwaters are not affected by any anthropogenic source of metals to the environment (for example, any abandoned mining feature such as an adit or spoil heap). Candidate sites for ABC sampling were identified in each waterbody using a GIS in combination with information on known mining-related features in waterbodies.

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[1] Despite the fact the compliance of specific pollutants with their EQS is a component of ecological status, throughout this project the term chemical status refers to compliance of chemical determinands against EQS and ecological status refers to compliance of biological quality elements against their respective EQR class boundaries.

The project also developed a methodology for deriving site-specific quality targets for zinc, based on the macroinvertebrate community observed, or predicted to occur at a site. The quality targets also take account of zinc bioavailability. The rationale for the development of such targets is that they are more closely related to the WFD ecological protection goals than toxicologically based EQS (either conventional or bioavailability-adjusted) and may reduce the frequency of chemical and biological mis-matches during classification. Whilst not of equivalent regulatory standing to either conventional or bioavailability-based EQS, site-specific quality targets based on ecology could potentially be adopted as “alternative” objectives or targets for waterbodies.

The conclusions of the project were as follows:

1. Accounting for the bioavailability of copper in waterbodies affected by abandoned non-coal mines using simple screening tools reduces the face-value EQS failure rate by approximately 66 per cent, and the “significant” EQS failure rate by more than 70 per cent.

2. Accounting for the bioavailability of Zn and Ni as well as Cu using simple screening tools does not affect the overall burden of EQS failure across waterbodies impacted by abandoned non-coal mines, but reduces the proportion of mining impacted waterbodies affected by one or more “significant” EQS failures from 54 to 36 per cent.

3. An assessment of the risk posed by mixtures of metals can be readily conducted on compliance data expressed as “confidence of failure”. However, the lack of metals data in the majority of waterbodies included in the WFD surface water classification limited the useful application of this approach.

4. Collection of site-specific physicochemical data can be used to refine the predictions of bioavailability screening tools made using conservative defaults, and are likely to result in improved compliance (particularly for the copper EQS).

5. The full BLM for copper provides less precautionary estimates of site-specific PNECs than the simple Cu bioavailability screening tool and could be readily applied by the Environment Agency to refine EQS compliance where risks remain after application of the bioavailability screening tool.

6. Waterbody-specific Ambient Background Concentrations (ABC) for zinc can be estimated by sampling in the headwaters of waterbodies, but care must be taken to ensure that these estimates are reliable.

7. Site-specific quality targets for zinc, based on the macroinvertebrate ecology predicted or observed at a site, can be derived and can result in improved compliance compared to the use of both conventional and bioavailability-based EQS. In addition to zinc, the approach is likely to be applicable to other metals and possibly other types of chemical stressors (for example, pesticides). However, the methodology for deriving site-specific quality targets requires additional development and validation before they can be robustly applied during surface water classification.

8. Guidance for Environment Agency staff on the appropriate application of bioavailability-based tools in waterbodies affected by abandoned non-coal mines has been produced (Appendix H).

Acknowledgements

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1 Introduction

1.1 Background

Abandoned metal mines are significant and unregulated sources of pollution of our rivers and seas discharging priority hazardous and other polluting substances, notably cadmium (Cd), lead (Pb), copper (Cu), zinc (Zn) and iron (Fe). Parys Mountain copper mine on Anglesey is the single largest contributor of copper and zinc to the Irish Sea, discharging 24 tonnes of zinc and 10 tonnes of copper each year, more than the River Mersey. The Restronguet Creek in Cornwall discharges 52 tonnes of zinc, 12 tonnes of copper and 60kg of cadmium each year, more than the River Severn. In Wales, the 50 metal mines deemed to be the worst polluters discharge 200 tonnes of zinc, 32 tonnes of copper, 15 tonnes of lead and 600 kg of cadmium annually (Environment Agency, 2008b).

The first Water Framework Directive (WFD) surface water classification in England and Wales identified 133 waterbodies failing to meet environmental quality standards (EQS) for metals (Cd, Pb, Ni, Zn, Cu) in metal mining areas. The majority of significant EQS failures for Pb and Cd across England and Wales (that is those EQS failures occurring with greater than 95 per cent statistical certainty) are in rivers draining abandoned metal mines. Four hundred and seventy waterbodies have been identified as "impacted" or "probably impacted" by abandoned non-coal mines across England and Wales (NoCAM project; Environment Agency 2012a-m).

The Environment Agency has developed a joint approach with Defra to manage pollution from abandoned non-coal mines for the WFD. Three priority work areas have been identified in the first river basin cycle (2009-2015):

1. Develop new low-cost sustainable treatment technologies for metal mines ("mitigation of pollution from abandoned mines");
2. Understand how to implement water quality targets to protect ecosystems impacted by abandoned mines over many decades ("ecological indicators"), and
3. Carry out catchment investigations in priority water bodies to identify the main sources of metals, appraise management options including costs and benefits, and implement remediation.

This project is focussed on the second work area – ecological indicators for abandoned mines. The project is funded by Defra and managed by the Environment Agency as part of project SC090024: *M*an*agi*ng mining pollution for the Water Framework Directive (MAGIC).

This project aims to clarify whether conventional EQS are suitably protective of aquatic life (for example, invertebrates, fish, diatoms, macrophytes), or if higher metal concentrations than the EQS can be acceptable in mining-impacted catchments without risk to aquatic life and, if so, how this is accommodated within the WFD to enable the status of the water body to be correctly classified.

1.2 Metal EQS and the WFD

The EQS for WFD priority substances (PS) and priority hazardous substances (PHS) are defined in a WFD Daughter Directive (2008/105/EC[2]). Compliance with these EQS (which are harmonised across the EU are a requirement of Good Chemical Status for surface waters. EQS for cadmium (Cd), nickel (Ni) and lead (Pb) are included on this list. In addition, Annex VIII of the WFD requires that Member States identify other pollutants that are discharged to water in "significant quantities". These are called Annex VIII substances or "specific pollutants"[3]. The WFD requires that Member States develop their own standards for specific pollutants and in the UK this currently includes metalloids and metals, such as arsenic (As), copper (Cu), iron (Fe) and zinc (Zn). Additional metals, such as silver (Ag) and manganese (Mn) are being assessed as to whether they should be specific pollutants (Helen Wilkinson, Environment Agency, Pers com). Compliance with the EQSs for specific pollutants is technically a component of ecological status rather than chemical status. However, the outcome in terms of surface water classification is similar – where EQS are failed the waterbody cannot be classed as meeting the requirements for good surface water status. This is known as the "one out, all out" principle. Biological quality elements are treated similarly. A schematic of the surface water classification process is presented in Figure 1.1.

Many existing metal EQS are hardness banded. However, it is clear from recent research that hardness, when considered in isolation, does not adequately account for metal bioavailability and therefore toxicity (Denmark 2007, ECI 2007, The Netherlands 2008). Many mine impacted streams have waters that are relatively soft. When compliance is assessed using existing EQS, especially for Cu and Zn, the most sensitive EQS from the lowest hardness band would be required to be used and the waters would be unlikely to comply. Annex I, part B, of the WFD Daughter Directive on priority substances (EC 2008) suggests that Member States may account for both natural backgrounds and/or physico-chemical conditions of the water that may affect bioavailability when assessing monitoring results against a metal EQS. The most-relevant metrics with which to assess the environmental risk should therefore account for metal bioavailability.

EQS for metals, as derived using WFD specific guidance (EC 2010), can be relatively precautionary as they are intended to be sufficiently protective under conditions of low exposure and high bioavailability. Compliance under the WFD is being driven by the concentration of chemicals in the water column and for metals these are measured as dissolved concentrations. Sediment monitoring in freshwater systems in the UK is limited and sediment monitoring to comply with the WFD in the UK is generally considered to be unlikely (John Batty, Defra, pers. comm.).

There are several speciation-based tools, such as biotic ligand models (BLMs) that can account for bioavailability in freshwaters. Through the use of site-specific physico-chemical data, these models estimate the fraction of the measured metal in the water sample that is biologically relevant and, therefore, able to exert toxic effects. There are a variety of other analytical approaches for assessing metal toxicity (for example, Unsworth *et al.* 2006), but they generally have a limited ability to take account of competitive effects at the 'biotic ligand'. They are, at present, not able to account fully for bioavailability in the same way as the BLM approaches. In addition, the available analytical techniques tend to be highly specialised and are not generally suitable for routine regulatory use.

The challenge of developing technically robust, implementable methods for assessing the potential risks of metals in the aquatic environment is considerable, but has been

[2] http://ec.europa.eu/environment/water/water-dangersub/index.htm#chemical_pollution

[3] Section 1.2.6 in Annex V of the Water Framework Directive

addressed, in part, by research initiated by the metals industry to fulfil regulatory needs under the Existing Substances Regulation (793/93/EEC) and more recently by the Environment Agency (Environment Agency 2009a-d,f). This research has focussed on the following areas:

1. Accounting for bioavailability using tools like BLMs. These models use site-specific physicochemical data to estimate the fraction of the dissolved metal that is biologically relevant and, therefore, able to exert toxic effects;
2. Consideration of “ambient background concentrations” (ABC) and the development of methods to estimate regional and waterbody specific default values and incorporate these into risk characterisation, and
3. Using biological data to support EQS development. Several methods have recently been used to estimate EQS from field-based data (Crane et al. 2007, Linton et al. 2007). This can effectively be used as validation of EQS derived from laboratory-based data. In some circumstances relatively sophisticated chemical predictors of ecotoxicity can be overprotective in the field, that is the ecology is not affected when the chemical measures suggest that it should be (NiPERA 2009).

These developments have recently been incorporated into European guidance for setting EQSs for the WFD and performing environmental risk assessments under the regulation on Registration, Evaluation, Authorisation and restriction of Chemicals (REACH, EC 1907/2006; EC 2009, ECHA 2008). Nevertheless, the question remains as to how applicable these developments are in implementing water quality targets to protect ecosystems impacted by abandoned mines.

The underlying theory of the BLM is not new (Pagenkopf 1983). The BLM, through the use of chemical equilibrium modelling, addresses the competition between the free metal ion and other naturally occurring cations, together with complexation by abiotic ligands, for binding with a biotic ligand – the site of toxic action. These relationships are shown in the schematic in Figure 1.2 with the free metal ion represented by Me^{2+}, the naturally occurring cations by Na^{+}, H^{+}, Mg^{2+} and Ca^{2+} and the abiotic ligands by POC, DOC, CO_3^{2-}, etc.; the site of toxic action is represented by the fish gill. Extensive technical reviews of the development of the BLM have been published (for example, Paquin *et al.* 2002). BLMs require information on many physicochemical input parameters to undertake estimates of bioavailability for particular water chemistry.

Building on this research, the Environment Agency is already considering bioavailability and ambient background concentrations in new EQS for copper, zinc and manganese. Bioavailability correction will be undertaken using Biotic Ligand Models (BLMs), or simplified “screening models” based on BLMs that require fewer input parameters.

Whilst this project was being carried out, the Environment Agency and Defra have been developing the bioavailability-based approach for assessing metals in England and Wales. Defra will be consulting on the approach during 2012 which may be slightly different than that taken in this report.

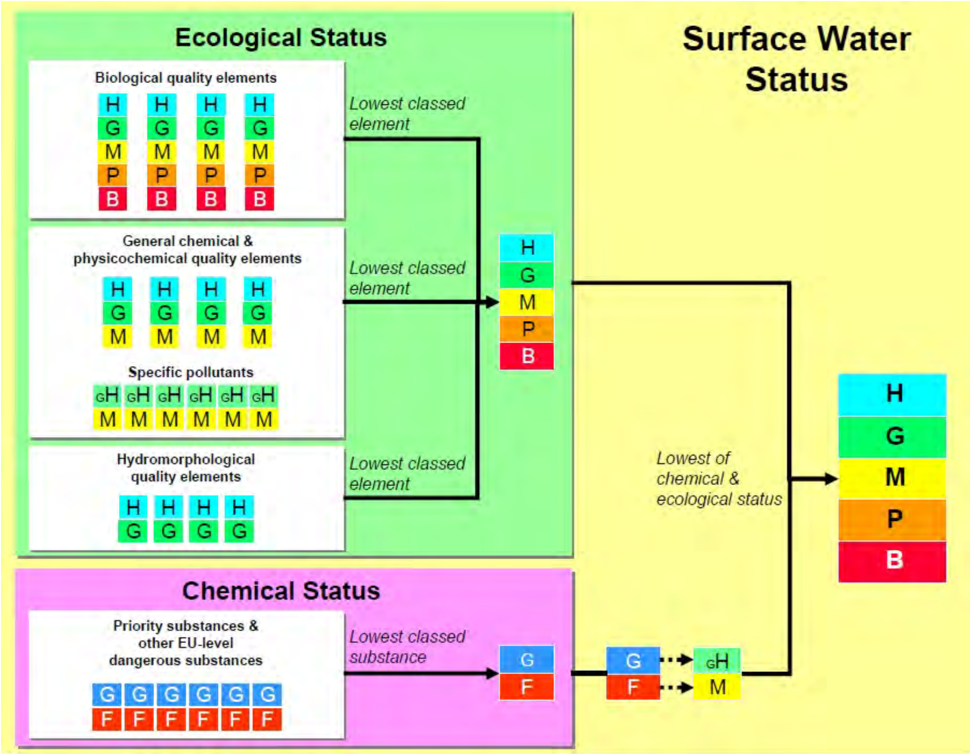

Figure 1.1 Schematic representation of how results of different elements are combined to classify ecological status, chemical status and surface water status. Reproduced from UK TAG (2007). H: High, G: Good, M: Moderate, P: Poor, B: Bad, GH: Good or better, F: Fail

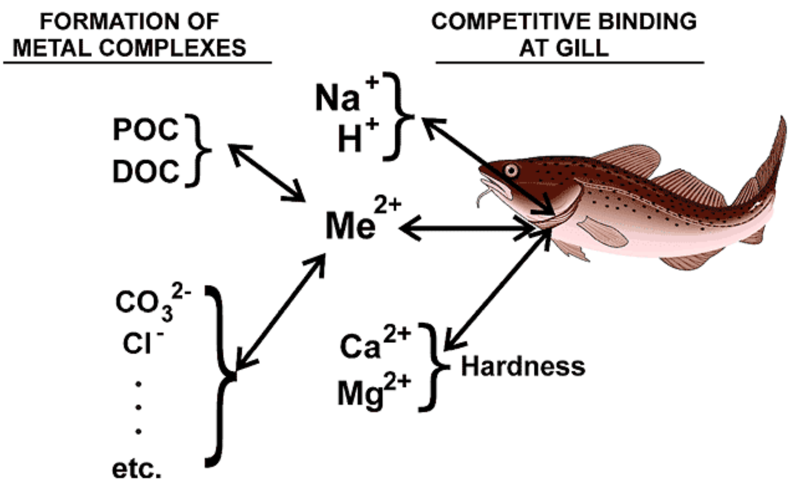

Figure 1.2 Simplified schematic of the biotic ligand model; Me^{2+} is the free metal ion, POC and DOC are particulate and dissolved organic carbon, respectively (source: http://www.hydroqual.com)

1.3 Detoxification and adaptation

Organisms have a wide variety of mechanisms for managing excess levels of many metals, including detoxification by metallothioneins (Hobson and Birge 1989) and formation of granules. Some exposed populations of insects have been shown to remove much of their body burden of some trace metals through the shedding of exoskeletons during growth or metamorphosis (Groenendijk et al. 1999). Whilst some studies appear to have shown statistically significant effects of acclimation and adaptation (for example, Crane and Maltby 1991, Bossuyt and Jannsen 2005) the observed effects are generally relatively small, and are not usually considered to be of importance for risk assessment. Adaptation of emerging insects, which may comprise a significant fraction of the assessable fauna at a site, is unlikely given that they may not be the offspring of organisms from the same site. A recent Environment Agency literature review suggested that "adaptation and acclimation ………..could justify changes in the EQS" (Environment Agency 2009e). However, such changes would need to be supported by considerable site specific data.

1.4 Project aims and objectives

The overall project aim is to *investigate the ecological impact of metals in rivers and produce guidance on setting water quality targets for aquatic ecosystems that are impacted by long-term mining pollution.*

Additional, specific project objectives are:

1. To provide guidance on the course of action when biological and chemical measurements differ, that is, EQS for metals are breached but the biological community is in a good condition;
2. To provide guidance on how to implement water quality targets for metals that represent good chemical and ecological status in mining-impacted rivers; and
3. To provide guidance to the Environment Agency on the evidence required to enable the appropriate refinement of water quality targets in mining-impacted rivers. For example, whether site biological data are required.

1.5 Approach

To achieve these objectives a combination of desk and field-based work was undertaken. The "tiered risk-based framework" for incorporating biotic ligand models and ambient background concentrations for metals risk assessment under the WFD (Environment Agency 2009a) was used as a basis for the project (Figure 1.3)[4].

The initial phase of the project (described in section 2 of this report) was focussed on the identification of sub-sets of waterbodies that share similar WFD compliance characteristics (for example, chemical status was poor, but ecological status was good[5]). This "screening assessment" applied both simple bioavailability and ABC

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[4] Subsequent to the start of this project the "tiered risk-based framework" has been revised by EA Evidence, most notably the current version of the framework does not require the application of full BLMs as a defined step. Work to finalise the framework is ongoing.

[5] Despite the fact the compliance of specific pollutants with their EQS is a component of ecological status, throughout this project the term chemical status refers to compliance of chemical determinands against EQS and ecological status refers to compliance of biological quality elements against their respective EQR class boundaries.

methodologies and was used to identify candidate waterbodies that offered the greatest scope for developing robust guidance for the implementation of alternative approaches to assess the status of mining impacted waters (for example, to provide a range of water physico-chemistry, metal mixtures and EQS compliance scenarios). A prioritised list of waterbodies was agreed with the Environment Agency project board and field surveys to obtain additional site-specific chemical and ecological data were undertaken, which included the collection of waterbody specific background concentrations for zinc and the suite of physico-chemical input parameters required to run the full Biotic Ligand Model for Cu and Zn. These field data, in combination with existing Environment Agency data for these waterbodies, were then analysed to determine the relative efficacy, transparency and legitimacy of each of the approaches for applying EQS in mine impacted waterbodies during WFD classification (described in section 3 of this report).

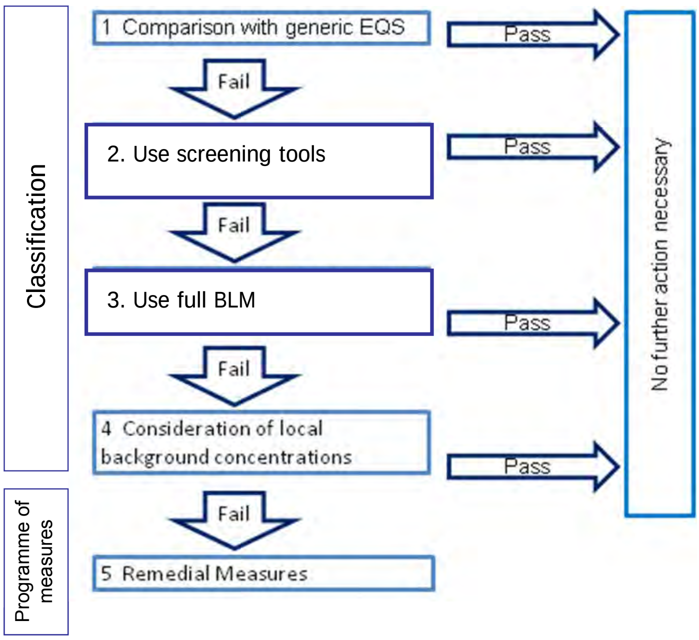

Figure 1.3 Tiered, risk-based framework for incorporating biotic ligand models and ambient background concentrations to fulfil the needs of the WFD (Environment Agency 2009a)[6].

[6] Subsequent to the start of this project the "tiered risk-based framework" has been revised by EA Evidence, most notably the current version of the framework does not require the application of full BLMs as a defined step. Work to finalise the framework is ongoing.

2 Screening Assessment

2.1 Aims and objectives

This section of the report details the application of simple bioavailability “screening tools” for Cu, Ni and Zn to chemical monitoring data used in the first WFD surface water classification for the 470 waterbodies in England and Wales that were previously identified as either “impacted” or “potentially impacted” by abandoned non-coal mines in the NoCAM[7] project (Environment Agency 2012a-m). The overall aims of the assessment were to:

- Describe the effect of the application of simple bioavailability screening tools for Cu, Ni and Zn on the WFD Surface Water Classification of the NoCAM waterbodies, and
- Identify groups of NoCAM waterbodies with similar compliance characteristics (chemical and biological) in order to identify suitable sites for further assessment, including a field programme.

Bioavailability screening-tools are simple, user-friendly versions of BLMs with the purpose of providing a rapid assessment tool that fits into Environment Agency monitoring and assessment systems. Bioavailability screening tools are *not* intended to replace the existing (full) BLM for a metal, but to deliver a method requiring quick, low resource input, high data throughput and rapid interpretation of monitoring data. They require much less input data than full BLMs to make estimates of metal bioavailability.

Bioavailability Screening Tools were available for zinc (v10), copper (v10) and nickel (v2). The EA screening tool for Manganese was not available at the time this assessment was undertaken (and Mn was also not a component of WFD classification). Each of these tools requires data on ambient water pH, dissolved organic carbon (DOC) and calcium concentrations to estimate bioavailability. Where site-specific data on pH, DOC and calcium concentrations were not available the assessment used either hydrometric area or waterbody default input values. Default values have been derived for some of the waterbodies and hydrometric areas in Great Britain based on a low (usually 5th) percentile of the available monitoring data. These defaults provide an input for bioavailability screening tools, but are likely to result in a precautionary assessment. In addition to bioavailability, Ambient Background Concentrations (ABCs) for zinc were also applied (see section 2.5). The specific objectives of the screening assessment were as follows:

- Where metal EQS are failed, to derive site-specific EQS using screening tools, based on either site-specific data (if these are already available) or default physicochemical input parameters and ABCs ($EQS_{chem\text{-}default}$);
- Where $EQS_{chem\text{-}default}$ are failed, to calculate the change in physicochemical conditions required to meet an $EQS_{chem\text{--}default}$ (for example, how much dissolved organic carbon (DOC) is needed to mitigate toxicity), and therefore establish for which waterbodies the collection of site-specific data may feasibly improve compliance by allowing the derivation of a site-specific EQS using measured physicochemistry ($EQS_{chem\text{-}measured}$);

[7] NoCAM: Non-Coal Abandoned Mines

- To establish for which sites, irrespective of collection of site-specific monitoring data, there is little chance of meeting any reasonable compliance metric for metals (“priority for intervention” waterbodies);
- To provide an early indication of situations where there is currently a mismatch between chemical and biological quality as determined by existing and proposed WFD compliance metrics; and
- To consider any potential effects of metal mixtures in the assessment of compliance.

2.2 Pre-screening of NoCAM waterbodies

A comparison of the list of NoCAM waterbodies to the WFD surface water classification database identified that not all NoCAM waterbodies would be suitable for inclusion in the screening assessment. This was because they did not have the minimum level of information necessary, or they were at risk from stressors beyond those associated with abandoned non-coal mines. It was decided to exclude these waterbodies from the screening assessment to simplify subsequent waterbody prioritisation and data interpretation based on a waterbody meeting at least one of the following four criteria:

1. The waterbody did not have a WFD surface water classification;
2. The waterbody was identified as failing to achieve good chemical status because of pesticide, nutrient, industrial chemical or physico-chemical EQS failure (apart from pH);
3. There were no metals monitoring data reported within the waterbody during the period used for WFD classification (2006-2008); or
4. There were no input parameters (site-specific or default) available for the bioavailability screening tools.

Waterbodies failing to achieve good status as a consequence of pH were not removed from the screening assessment as this was considered to be legitimate impact of abandoned non-coal mine sites.

2.3 WFD classification monitoring data

Monitoring data for all chemical/physicochemical quality elements (with the exception of dissolved zinc, see below) were taken from the first (2009) WFD surface water classification database. The 2009 classification used chemical monitoring data from 2006-2008 (summarised as mean, standard deviation and number of samples). The list of chemical/physicochemical quality elements included in the classification is given in Table 2.1 and comprises both WFD Annex X priority substances and WFD Annex VIII specific pollutants.

As the zinc screening tool (and the zinc BLM upon which it is based) was developed using measurements of dissolved zinc and the 2009 WFD surface water classification was undertaken using monitoring data for total zinc, additional data on dissolved zinc were sought from a large dataset provided by the Environment Agency’s Data and Information Management Team for the purposes of this project (Tim Doran, Environment Agency, pers com). These data were constrained to the same monitoring sites used in the WFD surface water classification and, as with the 2009 WFD classification, were limited to samples from 2006-2008. These data were additionally “crossed-checked” against a 2006-2008 dataset of dissolved zinc monitoring data supplied to wca environment from the Environment Agency to undertake a national

EQS compliance assessment for zinc. On inspection, the datasets were generally comparable. However, where a discrepancy occurred the lower value was used in the screening assessment. Once dissolved zinc data were collated it became apparent that they had been determined relatively infrequently compared to total zinc and would have significantly limited the scope of the screening-level assessment were they to be used exclusively. Therefore, in order to maximise the scope of the screening assessment, total zinc concentrations were substituted as screening tool input in an additional Zn compliance assessment. As total zinc concentrations should theoretically always be greater than dissolved concentrations this should always be precautionary and is consistent with the application of a tiered risk assessment framework.

Table 2.1 Priority substances, specific pollutants, general chemical and physicochemical quality elements used in the 2009 WFD surface water classification of rivers.

Priority Substances

Quality element		EQS (µg l^{-1} AA)
Anthracene		0.1
Atrazine		0.6
Benzene		10
Cadmium*		
Hardness mg l^{-1} $CaCO_3$	0 – 50	0.08
	50 – 100	0.09
	100 – 200	0.15
	> 200	0.25
Carbon tetrachloride		12
Chlorfenvinphos		0.1
DDT (total)		0.025
Para Para DDT		0.01
1-2 Dichloroethane		10
Dichloromethane		20
Diuron		0.2
aldrin, dieldrin, endrin and isodrin		∑ 0.01
Fluoranthene		0.1
Hexachlorobenzene		0.01
Hexachlorobutadiene		0.1
HCH (sum of isomers)		0.02

Specific Pollutants

Quality element		EQS (µg l^{-1} AA)
2-4 D		0.3
Arsenic*		50
Cyanide (free)		1
Copper*		
Hardness mg l^{-1} $CaCO_3$	0 – 50	1
	50 – 100	6
	100 – 250	10
	> 250	28
Cypermethrin		0.0001
Diazinon		0.01
Dimethoate		0.48
Iron*		1
Linuron		0.5
Mecoprop		18
Permethrin[2]		0.01
Phenol		7.7
Toluene		50
Total available chlorine		2
Zinc*		
Hardness mg l^{-1} $CaCO_3$	0 – 50	8
	50 – 100	50
	100 – 250	75

Physicochemical elements

Quality element		EQS H	EQS G	EQS M	EQS P
Ammonia (µg l^{-1})		H	G	M	P
WB Type	1,2,4 & 6	0.2	0.3	0.75	1.1
	3,5 & 7	0.3	0.6	1.1	2.5
pH					
Status	High	6 as 5th percentile – 9 as the 95th percentile			
	Good	5.2 as 90th percentile			
Phosphorus[4] (µg l^{-1})		H	G	M	P
WB Type	1n	30	50	150	500
	2n	20	40	150	500
	3n, 4n	50	120	250	1000
Temperature[5] (°C)		H	G	M	P
WB Type	Salmonid	20	23	28	30
	Cyprinid	25	28	30	32
Dissolved Oxygen (% ASV)[6]		H	G	M	P
WB Type	1,2,4 & 6	80	75	64	50
	3,5 & 7	70	60	54	45

Priority Substances		Specific Pollutants		Physicochemical elements	
Quality element	**EQS ($\mu g\ l^{-1}$ AA)**	**Quality element**	**EQS ($\mu g\ l^{-1}$ AA)**	**Quality element**	**EQS**
Isoproturon	0.3	> 250	125		
Lead*	7.2				
Mercury*	0.05				
Napthalene	2.4				
Nickel*	20				
Nonylphenol	0.3				
Octylphenol	0.1				
Pentachlorophenol	0.4				
Benzo(a)pyrene	0.05				
Benzo(b)fluoranthene	∑ 0.03				
Benzo(k)fluoranthene					
Benzo(g,h,i)-perylene	∑ 0.002				
Indeno(1,2,3-cd)-pyrene					
Simazine	1				
Tetrachloroethylene	10				
Trichloroethylene	10				
Tributyl tin	0.0002				
Trichlorobenzenes	0.4				
Trichloromethane	2.5				
Trifluralin	0.03				

*: Metals/metalloids included in mixtures assessment. AA: annual average

1: EQS are taken from Defra/WAG direction to the EA on classification - http://www.defra.gov.uk/environment/quality/water/wfd/documents/river-basin-typology-standards.pdf

2: Compliance is assessed against the 95th percentile of annual monitoring data rather an as an annual average

3: Compliance is assessed against the 90th percentile of annual monitoring data

4: Compliance is assessed against an annual average of annual monitoring data

5: Compliance is assessed against a 98th percentile of annual monitoring data

6: Compliance is assessed against the 10th percentile of annual monitoring data

2.4 "Screening tool" physicochemical input parameters

Screening tool input values for median DOC, mean calcium, and mean pH values for each monitoring site in the NoCAM waterbodies (where available) were calculated from data provided from the Environment Agency's Data and Information Management Team (Tim Doran, Environment Ageny, pers comm).

Where matched site-specific DOC, Ca and pH data were not available for all the monitoring points in a waterbody used for WFD surface water classification then default input values were substituted in screening tool calculations. A series of "waterbody" and "hydrometric area" defaults have been developed by wca environment in previous projects (Environment Agency 2009b) but they are not available for all the NoCAM waterbodies. Where both waterbody and hydrometric area defaults were available for a particular waterbody then waterbody defaults were preferred because they were more likely to reflect conditions within the waterbody then defaults derived at a larger spatial scale.

2.5 Zn ambient background concentrations (ABCs)

Ambient background concentrations (ABCs) for zinc were used in the screening assessment (Table 2.2). The proposed bioavailability based EQS for Zn has been derived using an "added-risk" approach as toxicologically relevant concentrations of zinc can occur at levels below background at some sites. The added risk approach allows the ABC at a site to be accounted for during EQS compliance assessment. None of the other metals EQS have been derived using the added risk approach. ABCs for Zn are variable dependent upon factors such as underlying geology. The ABCs used for the screening assessment were derived on a hydrometric area basis as the 5^{th} percentile of available monitoring data (Environment Agency 2009b). As such, they may not genuinely reflect geological conditions on a local scale, but are useful nonetheless during the initial stages of a risk assessment.

Table 2.2 Ambient background concentrations for Zn

Hydrometric Area	Region	ABC(µg l^{-1})
Tyne	North East	1.1
Wear		1.5
Tees		1.1
Ouse, Humber		2.5
Trent	Midlands	2.5
Great Ouse	Anglian	2.5
Lee	Thames	1.25
Thames		2.5
Avon	South West	2.5
Piddle, Frome		2.5
Tamar		1.9
Fal		1.25

Hydrometric Area	Region	ABC(µg l^{-1})
Camel		1.25
Torridge, Taw		2
Tone, Parrett		2.5
Frome, Bristol, Avon		2.5
Severn		13.4
Severn	Midlands	2.5
Wye	Wales	2.1
Usk		3.4
Taff		2.5
Tawe, Neath		0.5
Loughor		0.5
Tywi		2.5
Cleddau		1.5
Teifi		4.1
Angelsey		1.2
Dovey		3.7
Glaslyn		2.8
Clwyd, Conwy		0.5
Dee		2.5
Weaver	North West	2.5
Mersey		2.5
Ribble		2.5

2.6 Assessing compliance with EQS

The screening assessment was undertaken using an equivalent compliance methodology to that used for the WFD classification (UKTAG 2007, Environment Agency 2008a). The screening assessment methodology differs from WFD methodology only with respect that all chemical and physicochemical compliance (Annex X, Annex VIII and water physicochemistry) was considered to be a component of “chemical status”, rather than Annex X chemical compliance being considered as chemical status and Annex VIII chemical compliance and physicochemical compliance being considered a component of “ecological status”. This was so that the consequences of the application of the screening tools could be appraised most appropriately, and that genuine mismatches between chemical and biological classification could be readily identified. Where “chemical” status is referred to in subsequent sections of this report this is intended to describe overall compliance of Annex X, Annex VIII and physicochemical EQS rather than simply compliance of Annex X substances.

WFD compliance assessment uses a “confidence of failure” statistic, calculated for each chemical quality element at each monitoring site (as per ISO 5667-20:2008). Where there are multiple monitoring sites within a waterbody a “median confidence of failure” is calculated incorporating data from all the monitoring sites with data within a particular waterbody. Chemicals with a median confidence of failure ≤0.5 are “compliant” with their relevant EQS (see Table 2.1) and classified as achieving "good or better" chemical status for that particular element in a waterbody. Median confidence of failure reported between 0.5 and 0.75 is described as a "marginal failure", greater than or equal to 0.75 but less than 0.95 is a "reasonable failure" and greater than or equal to 0.95 is a "significant Failure". Marginal, reasonable and significant EQS failures all result in classification of a chemical element in a particular waterbody as at "less than good" status. Remedial intervention ("programmes of measures") is most likely to be required in instances of "confirmed" EQS failure (Jon Gulson, Environment Agency, pers com). Not all chemical quality elements are monitored within each waterbody. Where a quality element is not measured (chemical or ecological) it is assumed to be at good status.

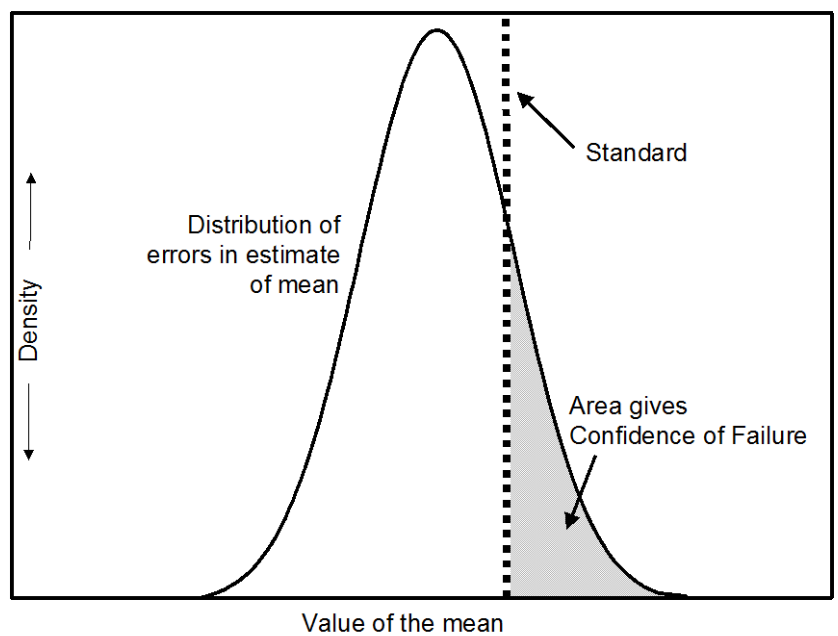

Figure 2.1 Confidence of failure (reproduced from ISO 5667-20:2008). The confidence of failure is the area under the curve to the right of the standard.

2.7 Assessing metal mixtures

Ecological assemblages are exposed to a complex mixture of chemical, physicochemical and environmental stressors. The potential impact of mixtures of metals on compliance was assessed in the screening assessment by a modified application of the cumulative criterion units (CCU) approach (Clements et al. 2000). As compliance under the WFD is based on a confidence (probability) of failure rather than a simple risk characterisation ratio (PEC[8]/EQS ratio) then the cumulative hazard of mixtures of chemicals, including metals, can be assessed as follows:

1. Convert individual "confidence of failure" to "confidence of compliance" (by subtracting from one);

[8] PEC: Predicted Environmental Concentration

2. Calculate a "cumulative confidence of compliance" by multiplying the individual confidence of compliance probabilities of the mixture components together, and
3. Subtract cumulative confidence of compliance from one to give "cumulative confidence of failure" for a waterbody.

An example calculation is given in Table 2.3. This approach is consistent with the mixtures theory of "Independent action", which describes the response of an organism to a mixture of chemicals that have dissimilar modes of action (Kortenkamp and Faust 2009). The approach described above has the additional benefit of using a similar measure of compliance outcome as the rest of the screening assessment. The overall effect of a mixture of arsenic, cadmium, bioavailable copper, iron, lead, bioavailable nickel and bioavailable zinc (total) was included in the screening assessment.

Table 2.3 Assessing metal mixtures – example calculation

	Quality element (individual probability)								**Cumulative Probability**[1]
	Cd	Pb	Hg	Ni	As	Cu	Fe	Zn	
Probability of "failure"	2.7×10^{-8}	0.18	0.12	2.2×10^{-9}	3.1×10^{-3}	0.1	0.1	0.05	0.47 (Pass)
Correspond. probability of "compliance"	0.99	0.82	0.88	0.99	0.99	0.9	0.9	0.95	0.53

1: cumulative probability is calculated as the product of individual quality element probabilities

2.8 Results of the screening assessment

Two hundred and thirty of the 470 NoCAM waterbodies were excluded from the screening assessment. Table 2.4 describes how many waterbodies were excluded from the assessment as each of the criteria were progressively applied. Whilst these criteria lead to a significant number of the NoCAM waterbodies not being subject to the screening tools it was felt that not removing these waterbodies would have confounded the wider project objectives, specifically when sites were being selected for further investigation . Details of each of the NoCAM water bodies and the rationale for inclusion or exclusion are given in Appendix A.

Table 2.4 Criteria used to exclude NoCAM waterbodies from the screening

Rationale for removal	Number of waterbodies remaining
No surface water classification	443
Failure of pesticide, nutrient and industrial chemical quality elements	354

No metal quality element monitoring	257
No default input parameters available for screening tool	240

Despite being used for classification, the coverage of chemical determinands across the different waterbodies in the dataset is inconsistent. Table 2.5 reports the coverage of monitoring for the various metal quality elements across the screening assessment dataset. The Environment Agency undertakes its monitoring according to risk. Individual quality elements (chemical or biological) are only monitored where they are perceived to be at some risk of failure. Where individual quality elements are not monitored they are assumed to be a Good status. Whilst this is consistent with cost-effective monitoring the subsequent analysis (particularly the assessment of mixtures) would have benefited from a more comprehensive monitoring dataset.

2.8.1 Effect of accounting for bioavailability and ABCs on classification

Applying screening tools resulted in a modest improvement in the overall surface water classification of the 240 waterbodies included in the assessment (Table 2.5). The number of waterbodies at “good or better” surface water status (based on a combination of chemistry and ecology) increased slightly from 47 to 53. More significantly, the number of waterbodies reaching good chemical status was increased from 105 to 116.

Potentially of most interest in this dataset is the reduction in the number of waterbodies at which “significant” metal EQS failures are reported. Significant EQS failures are those that occur at a confidence of greater than or equal to 95 per cent and are most likely to require a regulatory intervention. Overall, significant failures occur at 130 (54 per cent) waterbodies with conventional EQS, which is reduced to 87 (36 per cent) of waterbodies after applying the bioavailability screening tools.

When the outcome of the screening assessment is analysed on an individual metal basis (Table 2.6, Figure 2.2) it is clear that the overall assessment is dominated by copper and zinc, since these are the two metals that are monitored in the majority of waterbodies (principally because of freshwater fish directive monitoring obligations). Non-compliance with the other metals appears to be less significant, but as these metals are included in the classification of far fewer waterbodies their impact across the NoCAM waterbodies as a whole remains uncertain.

Accounting for copper bioavailability using screening tools consistently reduces the incidence of EQS failure. However, whilst effective on an individual waterbody level, the zinc screening tool did not appear to be effective in reducing the overall burden of zinc EQS non-compliance, or “significant” zinc EQS non-compliance across the screening dataset (“Significant” EQS failure for zinc was actually increased slightly under the bioavailability based zinc EQS). Where concurrent data are available for both total and dissolved zinc in a waterbody there is no apparent difference in compliance outcome after the application of bioavailability-based EQS, with the exception of a single waterbody that passed the conventional EQS but failed a bioavailability based compliance assessment based on total zinc.

Application of a bioavailability-based EQS does not universally result in an improved compliance outcome. Sites that pass a conventional EQS do, on occasion, fail a bioavailability-based EQS (both those based on site-specific input parameters and defaults). Accounting for the bioavailability of copper, nickel and zinc resulted in 15, 3 and 24 waterbodies failing to meet a bioavailability based EQS that met a conventional EQS, respectively. Across all the screening tools this scenario was observed in 6 to 10 per cent of waterbodies, although in the case of copper these instances were more than outweighed by increased rates of compliance across the remainder of the dataset (Figures 2.3 – 2.6). Similar to the results of the zinc assessment, compliance with a bioavailability-based EQS for nickel was also less favourable than the conventional priority substance EQS. Rather than a problem with the screening tool calculations used in the assessment, this occurrence is due to relatively high level of the hardness banded EQS for nickel relative to the revised bioavailability-based EQS for nickel. The existing priority substance EQS for nickel is currently being revised at a European level and is expected to be revised broadly in line with the generic Ni EQS used in the screening tool for this assessment (3.0 µg l^{-1}).

Where zinc ABCs is applied in addition to bioavailability-based EQS they improve the compliance outcome for eight waterbodies (approximately 3 per cent) compared to a bioavailability-only compliance assessment.

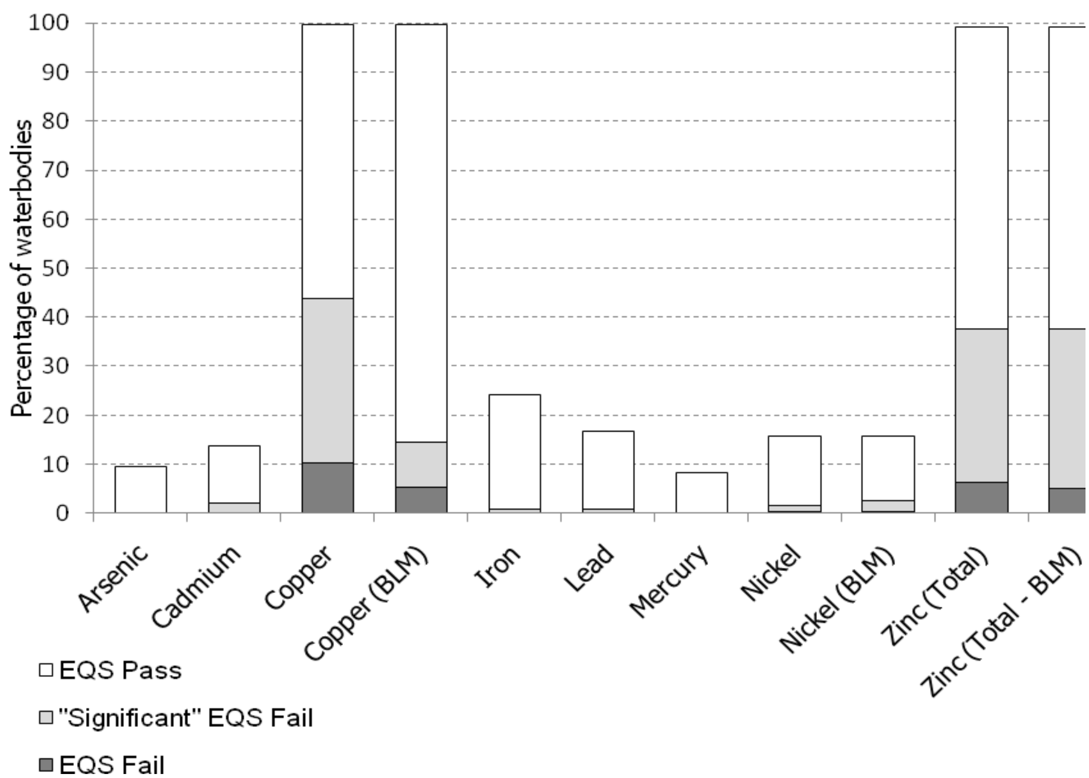

Figure 2.2 Compliance of individual metals across the screening assessment. Copper, nickel and zinc have compliance with and without accounting for bioavailability.

Table 2.5 Summary of chemical and biological status of waterbodies pre and post application of bioavailability screening tools.

Chemical Status \ Biological Status	High	Good	Moderate	Poor	Bad	Total
Conventional EQS						
Good	17	30	32	16	10	**105**
Less than Good	17	44	32	20	22	**135**
Bioavailability-based EQS						
Good	14	39	32	17	14	**116**
Less than Good	20	35	32	19	18	**124**

Table 2.6 Coverage of metal monitoring data across the screening dataset.

Quality element	N° (%) of waterbodies with data	Conventional EQS		Bioavailability-based EQS	
		N° (%) failing EQS	N° (%) "significantly" failing EQS	N° (%) failing EQS	N° (%) "significantly" failing EQS
Copper	239 (99.6)	105 (44)	80 (33)	35 (15)	22 (9)
Total zinc	238 (99.2)	90 (38)	75 (31)	90 (38)	78 (32.5)
Iron	58 (24.2)	2 (1)	2 (1)	-	-
Lead	40 (16.7)	2 (1)	2 (1)	-	-
Nickel	38 (15.8)	4 (2)	3 (1)	6 (3)	5 (2)
Cadmium	33 (13.8)	5 (2)	5 (2)	-	-
Arsenic	26 (10.8)	0 (0)	0 (0)	-	-
Dissolved zinc	24 (10.0)	-	-	6 (3)	6 (3)
Mercury	20 (8.3)	0 (0)	0 (0)	-	-

The zinc compliance assessment incorporates the use of hydrometric area ABCs

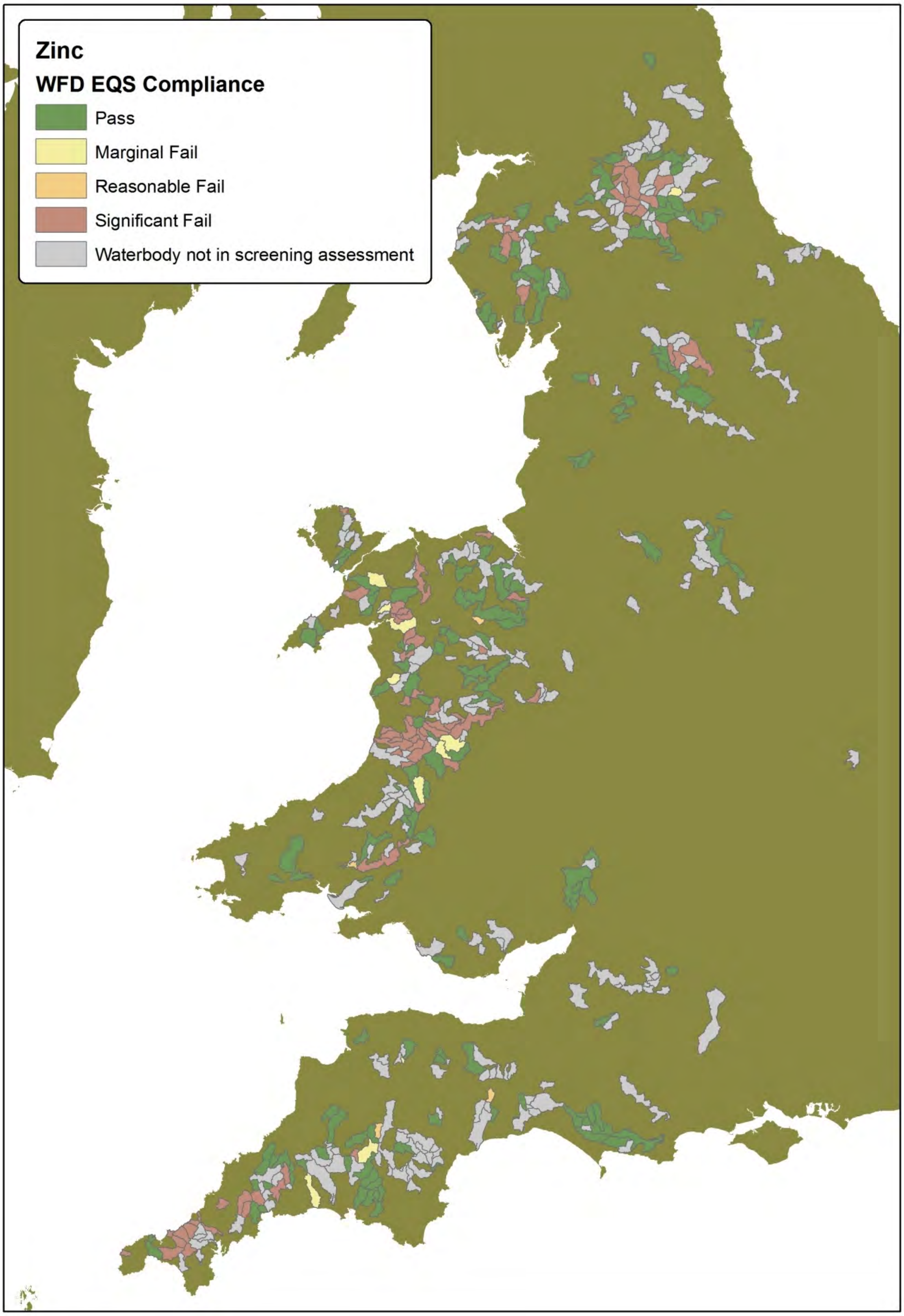

Figure 2.3 Compliance with WFD Annex VIII EQS for zinc

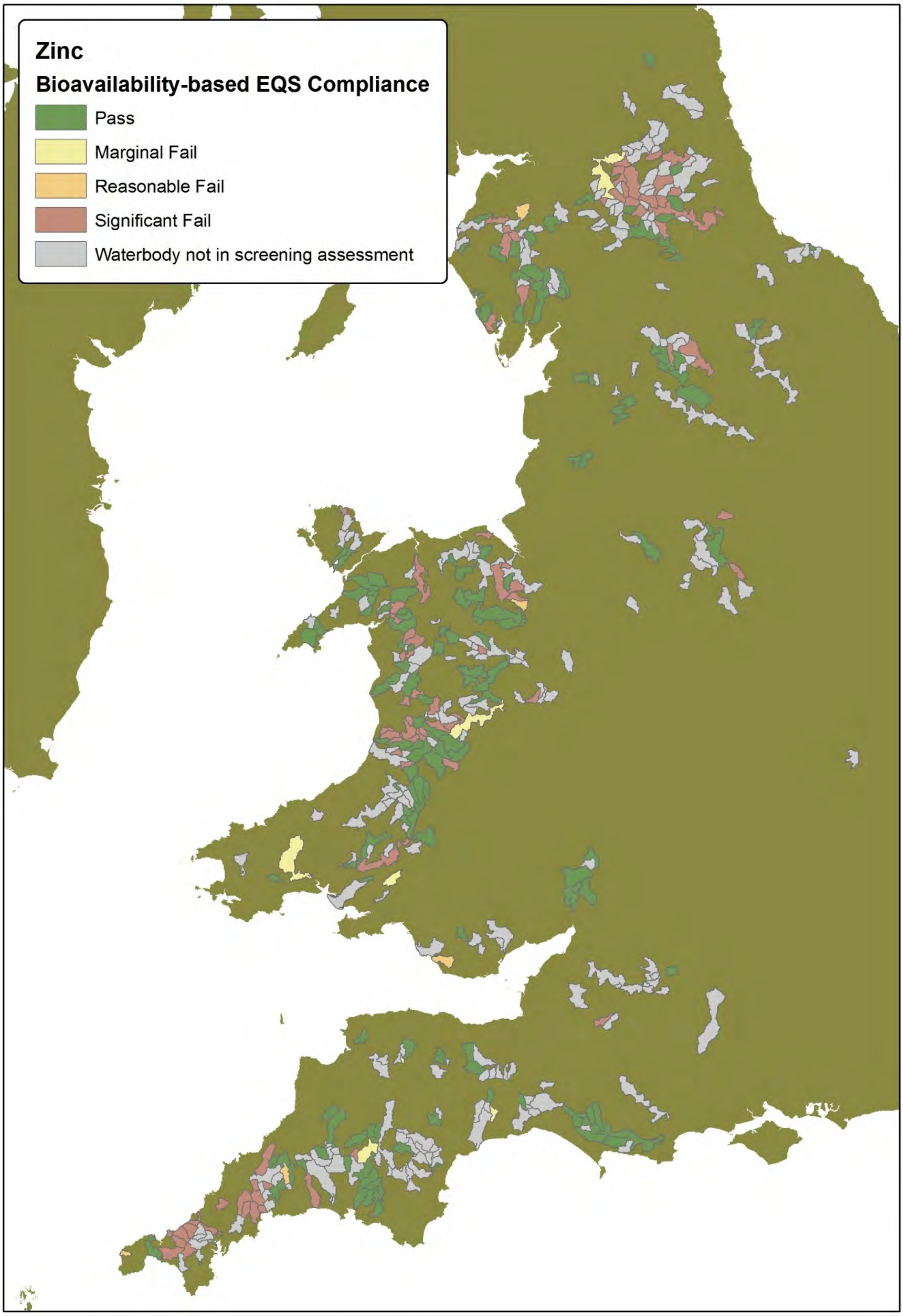

Figure 2.4 Compliance with proposed bioavailability-based EQS for zinc

Figure 2.5 Compliance WFD Annex VIII EQS for copper

Figure 2.6 Compliance with bioavailability-based EQS for copper

2.8.2 Mixture effects

Table 2.7 details the number of metals used by the Environment Agency for WFD surface water classification in each waterbody. In approximately 75 per cent of waterbodies surface water classification was based on two metals (most usually copper and zinc), whilst only 15 per cent of waterbodies were classified using monitoring data for four or more metals. This preponderance of data for copper and zinc is because of the requirements of the freshwater fish directive, which required monitoring of copper and zinc in designated fisheries.

Two waterbodies are identified in the screening assessment as being at risk from metal mixtures where none was predicted for individual metals: The River Derwent from River Ashop to River Wye (GB104028057880, Humber RBD) and the River Teign (GB108046008430, South West RBD). Both were classified as “marginal” failures (confidence of failure between 0.5 and 0.75). The Derwent waterbody was classified as having good biological status (macroinvertebrates and fish), whilst the River Teign was classified as at not good biological status because of effects on diatoms. The absence of evidence for more widespread risks of mixtures is more likely to be a consequence of the limited coverage of metals data across the waterbodies, rather than a genuine absence of cumulative metals risks in waterbodies affected by abandoned non-coal mines. The Teign waterbody was one of a handful of waterbodies whose classification was based on monitoring data for eight metals. Additional data, specifically from additional waterbodies with good chemistry but biology at less than good status, would be required to assess the potential impacts of mixtures on ecological status more comprehensively.

Table 2.7 Number of metals monitored per waterbody for classification

Number of metals used for classification	N° (%) of waterbodies	Cumulative N° (%) of waterbodies
1	2 (0.8)	2 (0.8)
2	176 (73.3)	178 (74.2)
3	19 (7.1)	197 (82.1)
4	5 (2.1)	202 (84.2)
5	10 (4.2)	212 (88.3)
6	5 (2.1)	217 (90.4)
7	3 (1.3)	220 (91.7)
8	20 (8.3)	240 (100.0)

2.9 Additional compliance assessments for cadmium

Of the 240 waterbodies included in the screening assessment only 33 (approximately 14 per cent) had sufficient information on dissolved cadmium for it to be included as a chemical quality element in the WFD classification (monitoring data from 2006-2008 with a minimum of eight replicate samples per monitoring site). In response to a request from the project board, two other dissolved cadmium datasets were analysed to determine if there were additional data on cadmium available that could be used to give a more complete picture of cadmium’s influence on the surface water status of waterbodies affected by abandoned non-coal mines than that given in the first WFD classification. The two additional datasets were as follows:

- NoCAM dataset (WIMS[9] data on dissolved cadmium sampled between 1999-2004)
- Current dataset (WIMS data on dissolved cadmium sampled between 2006-2010)

Dissolved cadmium data from each sample point was summarised as a mean, standard deviation and number of samples. In line with the WFD classification, each dataset was then filtered to remove sample points that were not included in the 2009 classification (as these did not have a hardness banding that could be used to set the hardness-banded EQS) or

[9] WIMS: Environment Agency’s Water Information Management System.

which were comprised of fewer than nine samples. Site-specific confidence of failure and median confidence of failure for each of the 240 NoCAM waterbodies was then calculated (where possible). Table 2.8 compares the outcome of the compliance assessment using the original WFD database to the additional datasets. The WIMS database of samples from 2006-2010 allowed the greatest number (41) of the 240 NoCAM waterbodies to be classified. However this is only marginally larger than the 33 sites that were assessed under the WFD classification. The original NoCAM database contained relatively little dissolved cadmium data and, consequently, only 10 waterbodies could be classified. However, approximately half of these were not included in either the WFD classification or the 2006-2008 databases. Overall, a total of 45 of the 240 NoCAM waterbodies prioritised for the screening assessment could be classified compared to 33 in the WFD classification. Of the 45 waterbodies with dissolved cadmium data 11, approximately a quarter, were significant EQS failures. These additional data were not used for the prioritisation of waterbodies for the field programme.

Table 2.8 Additional compliance assessment of 240 NoCAM waterbodies using additional cadmium data.

WBID	Name	Catchment	Confidence of failure			
			NoCAM (1999-2004)	WFD Class. (2006-2008)	WIMS (2006-2010)	Overall
GB103023074700	West Allen from Wellhope Burn to Allen	Tyne	1.000			**1.000**
GB103023074770	Derwent from Nookton Burn to Burnhope Burn	Tyne	1.000			**1.000**
GB108049000570	Red River (Lower)	West Cornwall and the Fal	1.000	1.000	1.000	**1.000**
GB108049000600	Red River (Upper)	West Cornwall and the Fal	1.000	1.000	1.000	**1.000**
GB109054044840	Afon Cerist - conf Afon Trannon to conf R Severn	Severn Uplands	1.000		1.000	**1.000**
GB109054049310	R Severn - conf Afon Dulas to conf R Camlad	Severn Uplands	1.000	0.996	1.000	**1.000**
GB110062043550	Meurig - headwaters to confluence with Teifi	South West Wales	-	-	1.000	**1.000**
GB110063041570	Rheidol - confluence with Castell to tidal limit	South West Wales	1.000	1.000	1.000	**1.000**
GB110063041610	Clarach - headwaters to conf with Bow Street Brook	South West Wales	-	-	1.000	**1.000**
GB110063041720	Ystwyth - headwaters to conf with Cwmnewydion	South West Wales	1.000	-	1.000	**1.000**
GB110102059230	Goch Amlwch	North West Wales	0.983	1.000	1.000	**1.00**
GB103024077530	Rookhope Burn from source to wear	Wear	0.942			**0.942**
GB109054049410	Afon Rhiw (conf N and S arm) to conf R Severn	Severn Uplands		0.042	0.293	**0.293**
GB108046008430	River Teign	South Devon		0.000	0.015	**0.015**
GB108048002280	St. Austell River	West Cornwall and the Fal			0.002	**0.002**
GB103023075801	Tyne from Watersmeet to tidal limit	Tyne		0.000	0.000	**0.000**
GB108044009690	Frome Dorset (Lower) & Furzebrook Stream	Dorset		0.000	0.000	**0.000**
GB108047004040	Lower River Plym	Tamar		0.000	0.000	**0.000**
GB108048001420	Lower River Fowey	North Cornwall, Seaton, Looe and Fowey		0.000	0.000	**0.000**
GB108048002310	Par River (Upper)	West Cornwall and the Fal		0.000	0.000	**0.000**
GB109053022050	R Marden - source to conf Abberd Bk	Bristol Avon & North Somerset Streams			0.000	**0.000**

WBID	Name	Catchment	Confidence of failure			
			NoCAM (1999-2004)	WFD Class. (2006-2008)	WIMS (2006-2010)	Overall
GB109054032640	Cannop Bk - source to R Severn Estuary	Severn Vale		0.000	0.000	**0.000**
GB109055037111	R Wye - conf Walford Bk to Bigsweir Br	Wye		0.000	0.000	**0.000**
GB110060029290	Tywi - confluence with Cothi to spring tidal limit	Loughor to Taf	-	0.000	0.000	**0.000**
GB110060029590	Tywi - Bishop's Pond to conf with Gwili and TL	Loughor to Taf	-	0.000	0.000	**0.000**
GB110060036280	Taf - headwaters to confluence with Cynin	Loughor to Taf	-	0.000	0.000	**0.000**
GB110062043540	Teifi - headwaters to confluence with Meurig	South West Wales	-	-	0.000	**0.000**
GB110063041630	Bow Street Brook - headwaters to conf with Clarach	South West Wales	-	-	0.000	**0.000**
GB110064048390	Dyfi - tidal limit to Afon Twymyn	North West Wales	-	0.000	0.000	**0.000**
GB110064048440	Dysynni - lower	North West Wales	-	0.000	0.000	**0.000**
GB110064048710	Mawddach - lower	North West Wales	-	0.000	0.000	**0.000**
GB110064048750	Eden - lower	North West Wales	-	-	0.000	**0.000**
GB110064048800	Wnion - lower	North West Wales	-	0.000	0.000	**0.000**
GB110065053600	Dwyryd - lower	North West Wales	-	0.000	0.000	**0.000**
GB110065053750	Prysor	North West Wales	-	0.000	-	**0.000**
GB110065054190	Gwyrfai	North West Wales	-	0.000	0.000	**0.000**
GB110066060030	Conwy - tidal limit to Merddwr	Conwy and Clwyd	-	0.000	0.000	**0.000**
GB111067051810	Alyn - upper river above Rhydymwyn	Middle Dee	-	0.000	0.000	**0.000**
GB111067052171	Alyn - Rhydymwyn to Leadmill	Middle Dee	-	0.000	0.000	**0.000**
GB112070064951	River Yarrow US Big Lodge Water	Douglas	-	0.000	0.000	**0.000**
GB112070064952	River Yarrow DS Big Lodge Water	Douglas	-	0.000	0.000	**0.000**
GB112073071140	River Rothay	Kent/Leven	-	0.000	0.000	**0.000**
GB112073071420	River Leven	Kent/Leven	-	0.000	0.000	**0.000**
GB112074070030	River Keekle (upper)	South West Lakes	-	0.000	0.000	**0.000**
GB112075073561	River Derwent US Bassenthwaite Lake	Derwent (NW)	-	0.000	0.000	**0.000**
Number (%) of NoCAM waterbodies with data			10 (4.2)	33 (13.8)	41 (17.1)	**45 (18.8)**
Number (%) of NoCAM waterbodies with "significant" confidence of failure			9 (3.8)	5 (2.1)	9 (3.8)	**11 (4.6)**

2.10 WFD compliance scenarios

Waterbody compliance can be divided into seven scenarios. These scenarios are described below with some further detail (*in italics*) of the potential scope of field work to further investigate/validate the findings of the screening assessment within a particular compliance scenario. The details of the individual waterbodies that are consistent with these scenarios are listed in Appendix B. A GIS shapefile for each of the scenarios has also been produced.

1. **Those achieving good chemical status and good biological status after application of the screening tools, where chemical status before application of the screening tools was less than good.** Twenty-three waterbodies are consistent with this scenario (Table 3.5).

    a. *Where default screening tool input parameters have been used these may require validation using site-specific monitoring data.*

    b. *Where ABC for zinc have improved compliance these may require validation using local ABC monitoring data.*

2. **Those achieving good chemical status after application of screening tools but failing to meet good ecological status.** Sixty-three waterbodies are consistent with this scenario (Table 3.6).

    a. *Are chemical monitoring data sufficient to characterise waterbody pressures, including mixture effects?*

    b. *If so, are ecological monitoring data fit for purpose. Explore alternative means of assessing the ecological community (for example, local reference sites).*

3. **Those failing good chemical status after application of screening tools but achieving good ecological status.** Forty six waterbodies are consistent with this scenario (Table 3.7). However, of these, 23 are classified as "priority for intervention" waterbodies as they would not be expected to comply with a bioavailability based EQS even under optimistic 95th percentile UK DOC conditions.

    a. *Were screening tool defaults used? Site-specific measurements of screening tool input parameters may improve compliance.*

    b. *Apply full Biotic Ligand Model (BLM) and explore potential to derive site-specific targets based on the ecology observed or predicted at a site. Full BLM predictions of bioavailability may be less conservative that screening tool predictions.*

    c. *Explore potential for local ABC, as replacement for hydrometric area ABC.*

4. **Those failing to achieve both good chemical status and good ecological status.** Fifty waterbodies are consistent with this scenario (Table 3.8). Of these, 26 are classified as "priority for intervention" waterbodies and are excluded from further investigation in the field programme.

    a. *Were screening tool defaults used? Site-specific measurements of screening tool input parameters may improve compliance.*

    b. *Apply full Biotic Ligand Model (BLM) and explore potential to derive site-specific targets based on the ecology observed or predicted at a site. Full BLM predictions of bioavailability may be less conservative that screening tool predictions.*

    c. *Ecological monitoring data fit for purpose*? *Explore alternative means of assessing the ecological community (local reference sites).*

5. **Those passing chemical and biological status without application of screening tools.** These waterbodies are not considered to be a priority for the field programme (Table 3.9).

6. **Those failing chemical status due to pH quality element but with good ecology.** These waterbodies may or may not also fail metal quality element EQS and are not considered to be a priority for the field programme. (Table 3.10).

7. **Those failing chemical status due to pH quality element but with poor ecology.** These waterbodies may or may not also fail metal quality element EQS and are not considered to be a priority for the field programme (Table 3.11).

In addition to “priority for intervention” waterbodies, which would not be expected to pass a bioavailability-based standard, it was also possible to identify waterbodies that were considered to be likely candidates to pass a bioavailability-based EQS after further refinement of physico-chemical input data, or application of a full Biotic Ligand Model (BLM), in later stages of this project. Where relevant, these waterbodies are classified as “optimistic”.

3 Field Programme

3.1 Selection of waterbodies for the field programme

Based on the findings of the screening assessment, a limited "confirmatory" field programme was undertaken to further explore some of the compliance scenarios outlined in section 2.10. In consultation with the project steering group, waterbodies that were classified as scenario 1, 3 and 4 were considered to be the most potentially useful to investigate further in terms of the aims and objectives of the project. The following sections detail the objectives and scope of the field programmes conducted under each of the scenarios. The three scenarios investigated may be considered as the negative control (scenario 1), positive control (scenario 4) and experimental sites (scenario 3). Only a limited number of waterbodies (four) could be included in the field programme because of the high costs of undertaking fieldwork and performing the necessary chemical and biological characterisation. However, each of the waterbodies investigated was selected after careful consideration to ensure that they represented "typical" case-studies for which the findings would be most readily transferable to other waterbodies.

3.1.1 Objectives and scope for Scenario 1 field programme.

Waterbodies in Scenario 1 (Table 3.1) had good ecological status but were failing to meet good chemical status as a result of either face value comparison with Cu, Zn or Ni EQS prior to the application of bioavailability screening tools. Application of bioavailability screening tools resulted in the waterbody achieving good chemical status, and consequently good surface water status.

The objectives of the field programme in relation to Scenario 1 were:

1. Where ecological quality element datasets were not complete, undertake additional ecological monitoring to ensure that where good ecological quality is stated for a waterbody this was based on monitoring data rather than an assumption of good ecological status;

2. Confirm the results of the bioavailability screening tool by application of the full Biotic Ligand Model bioavailability correction for Cu, Zn and Ni. This required the collection of additional site-specific physicochemical data (for example, DOC, major ion and major anion concentrations), where these data were not already available;

3. Undertake additional metals monitoring to more completely understand the metals compliance situation in a particular waterbody (the majority of waterbodies measure only Cu and Zn);

4. Collection of data from all current WIMS sample points within a waterbody (as WFD compliance is assessed on a waterbody basis, rather than site by site), and

5. Estimate waterbody-specific Ambient Background Concentrations (ABCs) for zinc.

A single waterbody from this scenario was included in the final field programme. The criteria developed for short-listing candidates for the field programme from the 23 others in scenario 1 were as follows:

- **The waterbody should have been identified as "impacted", rather than "probably impacted" in the NoCAM project.** This is to ensure that an abandoned non-coal mine pressure had been identified within a waterbody (and details of its location were available).

- **Comprehensive ecological classification data should already be available.** This provided reasonable confidence that a waterbody was at good ecological status before additional work was undertaken. Only a single waterbody in Scenario 1 (Dee - Ceiriog To Alwen) had a “complete” set of ecological quality element data (macroinvertebrates, diatoms, fish and macrophytes), although four (R Severn - source to conf Afon Dulas, Lower River Fowey, Lower River Plym, Tywi - Confluence with Cothi to spring tidal limit) had data on three out of the four ecological quality elements.
- **Multiple metals data used for classification.** The metal aspect of chemical classification for many waterbodies was based on compliance with the EQS for Zn and Cu only. It was preferable that any waterbody used in the field programme had more comprehensive metals monitoring data available (including Ni, Cd, and Fe). This provided reasonable confidence that the waterbody was at good chemical status, rather than assumed to be at good chemical status.
- **Multiple metals failing EQS before application of the bioavailability Screening Tool.** Waterbodies failing more than one EQS would be preferred to those failing only a single EQS.
- **Bioavailability corrections were based on defaults.** This was in order that the default values used in the screening tool in the absence of site-specific data could be confirmed as precautionary.
- **Incorporating backgrounds (ABC) improves Zn EQS compliance.** This was in order that the Ambient Background Concentrations (ABCs) of Zn (where this resulted in improved EQS compliance compared to a compliance assessment not accounting for ABC) in a waterbody could be further investigated and confirmed.

Three candidate waterbodies met the majority of the criteria listed (highlighted in green in Table 3.1). They were:

1. Lower River Fowey (GB108048001420)
2. Teigl (GB110065053670)
3. Tywi - Confluence With Cothi to spring tidal limit (GB110060029290)

After consultation with local Environment Agency staff the Lower River Fowey was selected for the scenario 1 field programme.

Table 3.1 Waterbodies in scenario 1 for further investigation

WBID	Name	Catchment	RBD Name	Mining impacted	WIMS sample points	Nº of metals monitored	Nº metals failing EQS pre-screening tool	Tool input	ABC improves Zn EQS compliance	Benthic Inverts		Fish	Diatoms	Plants
										ASPT	N-TAXA			
GB111067052060	Dee - Ceiriog To Alwen	Upper Dee	Dee	PI	7	2	1	D	No	H	G	G	G	G
GB104027064120	Barben Beck/River Dibb Catchment (Trib Of Wharfe)	Wharfe and Lower Ouse	Humber	PI	1	2	2	D	No	H	H	-	G	-
GB112073071190	River Crake	Kent/Leven	North West	PI	2	2	1	D	No ABC	G	H	G	-	-
GB112073071380	River Kent	Kent/Leven	North West	PI	3	2	1	D	No ABC	G	H	H	-	-
GB112073071430	River Sprint	Kent/Leven	North West	PI	2	2	1	D	No ABC	H	H	G	-	-
GB109054044790	R Severn - Source To Conf Afon Dulas	Severn Uplands	Severn	I	1	2	2	SS	No	H	G	G	-	H
GB109054055050	Afon Iwrch - Source To Conf Afon Tanat	Severn Uplands	Severn	I	1	2	1	SS	No	G	H	H	-	-
GB109055042310	Afon Marteg - Source To Conf R Wye	Wye	Severn	PI	1	2	1	D	No	G	H	G	-	
GB108048001420	Lower River Fowey	North Cornwall, Seaton, Looe and Fowey	South West	I	3	8	2	D	Yes	H	H	-	G	H
GB108048007640	St. Neot River	North Cornwall, Seaton, Looe and Fowey	South West	I	3	2	1	D	No	H	H	H	-	-
GB108050008100	East Okement River	North Devon	South West	PI	1	2	2	D	No	H	H	G	-	-
GB108050019970	Mole	North Devon	South West	I	2	2	1	D	No	H	H	G	-	-
GB108047004040	Lower River Plym	Tamar	South West	I	1	8	1	SS	No	H	H	G	-	G
GB108048002110	Marazion River	West Cornwall and the Fal	South West	I	3	2	1	D	No	H	G	H	-	-
GB108048002300	Bokiddickstream	West Cornwall and the Fal	South West	PI	2	1	1	D	No	-	-	-	-	-
GB110060029290	Tywi - Confluence With Cothi to spring tidal limit	Loughor to Taf	Western Wales	I	1	8	1	SS	No	H	H	-	G	H
GB110060029590	Tywi - Bishop's Pond To Conf With Gwili	Loughor to Taf	Western Wales	I	2	8	1	SS	No	H	H	-	-	-

WBID	Name	Catchment	RBD Name	Mining impacted	WIMS sample points	Nº of metals monitored	Nº metals failing EQS pre-screening tool	Tool input	ABC improves Zn EQS compliance	Benthic Inverts		Fish	Diatoms	Plants
										ASPT	N-TAXA			
	And TL													
GB110064048290	Dulas South - Lower	North West Wales	Western Wales	PI	1	2	2	D	Yes	H	H	-	-	-
GB110065053670	Teigl	North West Wales	Western Wales	I	2	5	2	SS	Yes	H	H	H	-	-
GB110065053690	Cwmystradllyn	North West Wales	Western Wales	I	1	2	1	SS	No	G	H	G	-	-
GB110065053890	Croesor	North West Wales	Western Wales	PI	1	2	2	D	No	G	G	H	-	-
GB110065053970	Llyfni	North West Wales	Western Wales	I	4	2	2	D	No	G	H	H	-	-
GB110065054010	Nant Peris	North West Wales	Western Wales	I	2	2	2	D	No	H	H	G	-	-

ASPT: Average Score Per Taxa
N-TAXA: Number of Taxa
PI: Waterbody identified as “probably impacted” by abandoned non-coal mining in the NoCAM project
I: Waterbody impacted as “impacted” by abandoned non-coal mining in the NoCAM project
D: Default (waterbody or hydrometric area) values for DOC and Ca used for screening tool input.
SS: Site-specific data for DOC, Ca and pH used for screening tool input.
H: High status, G: Good status
Candidate waterbodies are highlighted in green.

3.1.2 Objectives and scope of Scenario 3 field programme

Waterbodies in Scenario 3 (Table 3.2) had good ecological status but were failing to meet good chemical status as a result of EQS failure for one or more metals (either Cd, Pb, Ni, Cu, Fe or Zn[10] – dependent on the availability of monitoring data in individual waterbodies). Application of the bioavailability screening tools did not result in the waterbody achieving good chemical status (that is, one or more metal EQS continued to fail, either because no bioavailability correction was available (for example, Cd, Pb, Fe) or the bioavailability correction for Cu, Zn or Ni was not sufficient to prevent the EQS being exceeded). Also included in this scenario are waterbodies that passed existing EQS for Zn, Cu or Ni, and which had good ecology, but which subsequently failed a bioavailability-based EQS derived by the Screening Tools.

The objectives of the field programme in relation to Scenario 3 were:

1. Where ecological quality element datasets were not complete, undertake additional ecological monitoring to ensure that where good ecological quality is currently stated for a waterbody this is based on monitoring data rather than an assumption of good ecological status in the absence of monitoring data;
2. Assuming that point 1 could be satisfactorily demonstrated, explore various options available to achieve metal EQS compliance (or develop "alternative objectives") in a waterbody with the aim of developing "best-practice" guidance for the Environment Agency. This will include:
    - Application of the full Biotic Ligand Model bioavailability correction for Cu, Zn and Ni. This will require the collection of additional site-specific physicochemical input data (for example, DOC, major ion and major anion concentrations), where these data are not already available.
    - Development of "site-specific quality targets" for Cu, Ni and Zn based on the ecology present at each site, or the ecology predicted to be present at each site.
3. Where EQS compliance could not be demonstrated using the techniques outlined above and the ecology could robustly be demonstrated to be at good status the arguments and supporting evidence required to justify a case for non-remediation (for example, metal acclimation) were to be explored;
4. Additional metals monitoring was to be undertaken to more completely understand the metals compliance situation in a particular waterbody (the majority of waterbodies measure only Cu and Zn);
5. Collection of data from all current WIMS sample points within a waterbody (and possibly from elsewhere within a waterbody/catchment where ambient background concentrations are to be determined, as WFD compliance is assessed on a waterbody basis), and
6. Estimate waterbody-specific Ambient Background Concentrations (ABCs) for zinc.

It was envisaged that one or two waterbodies from this scenario would be included in the final field programme. Criteria for selection from the waterbodies in Scenario 3 were proposed as follows:

[10] EQS for Hg and As were not exceeded in any of the waterbodies investigated in the screening programme.

- **The waterbody should have been identified as "impacted", rather than "probably impacted" in the NoCAM project.** This was to ensure that an abandoned non-coal mine pressure has been identified within a waterbody (and details of its location were available).
- **Comprehensive ecological classification data should be available.** This provided reasonable confidence that a waterbody was at good ecological status before additional work was undertaken.
- **Multiple metals data used for classification.** The metal aspect of chemical classification for many waterbodies was based on compliance with EQS for Zn and Cu only. It is preferable that any waterbody used in the field programme has more comprehensive metals monitoring data available (including Ni, Cd, and Fe).
- **Multiple metals "significantly" failing EQS after application of the bioavailability screening tool.** Waterbodies significantly failing more than one EQS were preferred to those failing only a single EQS.
- **Bioavailability corrections were based on defaults.** Default values were derived to be conservative (under-protective). Site specific data will usually offer a greater degree of bioavailability correction.
- **Existing Environment Agency investigation planned.** Potential to utilise ongoing or planned chemical and ecological monitoring undertaken by the Environment Agency.

None of the waterbodies met all of the criteria listed above, although three waterbodies met the majority of them (Table 3.2). These were, in order of preference:

1. River Cober US Lowertown Bridge (GB108048001171)
2. Bow Street Brook - Headwaters to conf with Clarach (GB110063041630)
3. Conwy - Tidal limit to Merddwr (GB110066060030)

After consultation with local Environment Agency staff the River Cober and Bow Street Brook waterbodies were prioritised for the scenario 3 field programme. Whilst both these waterbodies are classified as scenario 3 they differ in respect to their "priority for intervention". This is determined by the probability of success that a bioavailability correction would achieve EQS compliance in a waterbody and was determined by applying the 95 percentile UK DOC value in the screening tool and observing EQS compliance. "Priority" waterbodies[11] do not meet a bioavailability based EQS even under theoretical conditions of minimum bioavailability. The Bow Street Brook was identified as a "priority" waterbody, but the Cober was not.

[11] This terminology has been adopted by wca environment rather than the Environment Agency

Table 3.2 Waterbodies in Scenario 3 for further investigation.

WBID	Name	Catchment	RBD Name	Mining Impact?	Nº sample points	EA Invest?	Metals monit	Metal fail pre-tool	Metal fail post-tool	"Signif" fails post-tool	ABC Improves Zn EQS comp	Tool Input	"Priority" WB	"Opt" WB	ASPT	N-TAXA	Fish	Diatom	Plant
GB111067057060	Y Garth	Tidal Dee	Dee	I	1	-	Cu, Zn	Zn	Cu, Zn	Cu, Zn	No	D	TRUE	No	H	G	-	-	-
GB111067051700	Black Brook	Upper Dee	Dee	I	1	-	Cu, Zn	-	Cu, Zn	Cu	No	D	FALSE	No	H	H	-	-	-
GB104027068293	River Nidd from Howstean Beck to Birstwith	Swale, Ure, Nidd & Upper Ouse	Humber	I	1	-	Cu, Zn	Cu, Zn	Zn	Zn	No	D	TRUE	No	H	H	G	-	-
GB112075070440	Newlands Beck	Derwent (NW)	North West	I	3	-	Cu, Zn	Cu, Zn	Zn	Zn	No ABC	D	TRUE	No	G	G	G	-	-
GB112075073561	River Derwent Us Bassenthwaite Lake	Derwent (NW)	North West	I	4	-	Cd, Cu, Fe, Zn	Cu, Zn	Zn	Zn	No ABC	D	TRUE	No	H	H	G	-	-
GB112075073570	Broughton Beck	Derwent (NW)	North West	I	6	-	Cu, Zn	-	Cu	-	No ABC	D	FALSE	Yes	G	H	H	-	-
GB112073071210	Yewdale/Church Beck	Kent/Leven	North West	I	3	-	Cu, Zn	Cu, Zn	Cu, Zn	Cu, Zn	No ABC	D	FALSE	No	H	H	G	-	-
GB112074069830	Haverigg Pool	South West Lakes	North West	I	4	-	Cu, Zn	-	Cu, Zn	Cu, Zn	No ABC	D	TRUE	No	G	H	-	-	-
GB103025072470	Harwood Beck from Langdon Beck to River Tees	Tees	Northumbria	PI	1	-	Cu, Zn	Cu, Zn	Zn	Zn	No	D	FALSE	No	-	-	-	-	-
GB103023074710	Allen from source to West Allen	Tyne	Northumbria	I	1	-	Cu, Zn	Zn	Zn	Zn	No	D	TRUE	No	H	H	G	H	H
GB103023074740	Horsleyhope Burn Catchment (Trib of Derwent)	Tyne	Northumbria	PI	4	-	Cu, Fe, Zn	Zn	Zn	Zn	No	D	TRUE	No	H	H	G	-	-
GB103023074770	Derwent from Nookton Burn to Burnhope Burn	Tyne	Northumbria	I	3	-	Cu, Zn	Zn	Zn	Zn	No	D	TRUE	No	H	H	H	H	-
GB103023075410	Black Burn from Aglionby BeckSouth Tyne	Tyne	Northumbria	PI	1	-	Cu, Zn	-	Zn	Zn	No	D	TRUE	No	H	H	H	H	H
GB103023075530	South Tyne from Black Burn to Allen	Tyne	Northumbria	I	4	-	Cu, Fe, Zn	-	Zn	-	No	D	TRUE	No	H	H	H	-	-
GB103023075801	Tyne from Watersmeet to tidal limit	Tyne	Northumbria	I	5	-	As, Cu, Cd, Fe, Pb, Hg, Ni, Zn	-	Zn	Zn	No	D	TRUE	No	H	H	-	-	-
GB103024077440	Wear from Ireshope to Middlehope Burn	Wear	Northumbria	I	1	-	Cu, Fe, Zn	Zn	Zn	Zn	No	D	TRUE	No	H	G	G	-	-
GB103024077460	Wear from Swinhope to Browney	Wear	Northumbria	I	10	-	Cu, Fe, Pb, Zn	-	Zn	Zn	No	D	TRUE	No	H	H	G	G	-

WBID	Name	Catchment	RBD Name	Mining Impact?	Nº sample points	EA Invest?	Metals monit	Metal fail pre-tool	Metal fail post-tool	"Signif" fails post-tool	ABC Improves Zn EQS comp	Tool Input	"Priority" WB	"Opt" WB	ASPT	N-TAXA	Fish	Diatom	Plant
GB103024077500	Kilhope Burn from source to Burnhope Burn	Wear	Northumbria	I	1	-	Cu, Zn	Zn	Zn	Zn	No	D	TRUE	No	G	H	G	-	-
GB103024077510	Stanhope Burn from source to wear	Wear	Northumbria	PI	1	-	Cu, Zn	-	Zn	Zn	No	D	TRUE	No	H	H	H	-	-
GB109053021990	Whatley Bk - Source to conf Mells R	Bristol Avon & North Somerset Streams	Severn	I	3	-	Cu, Zn	-	Zn	Zn	No	D	FALSE	No	H	H	-	-	-
GB109054044720	Afon Cerist - Source to conf Afon Trannon	Severn Uplands	Severn	I	1	-	Cu, Zn	Cu, Zn	Zn	Zn	No	D	TRUE	No	H	H	-	-	-
GB109054044760	Afon Clywedog - Clywedog Dam To R Severn	Severn Uplands	Severn	I	1	-	Cu, Zn	Cu, Zn	Zn	Zn	No	SS	FALSE	Yes	G	H	G	-	-
GB109054044840	Afon Cerist - Conf Afon Trannon To Conf R Severn	Severn Uplands	Severn	I	1	-	Cu, Zn	Cu, Zn	Zn	Zn	No	D	TRUE	No	H	H	-	-	-
GB109054049960	Afon Tanat - Conf Hirnant to conf Afon Rhaeadr	Severn Uplands	Severn	I	1	-	Cu, Zn	Cu, Zn	Zn	Zn	No	D	FALSE	No	-	-	G	-	-
GB108044009660	Tadnoll Brook (including Empool Bottom)	Dorset	South West	PI	5	-	Cu, Zn	-	Cu	-	No	D	FALSE	No	H	H	G	-	-
GB108044010060	South Winterbourne	Dorset	South West	PI	1	-	Cu, Zn	-	Cu	-	No	D	FALSE	Yes	H	H	-	-	-
GB108045008820	Yarty	East Devon	South West	PI	1	-	Cu, Zn	-	Cu	-	No ABC	D	FALSE	Yes	G	H	G	-	-
GB108049000040	St. Lawrence Stream	North Cornwall, Seaton, Looe and Fowey	South West	I	2	-	Cu, Zn	-	Cu, Zn	Cu, Zn	No	D	FALSE	No	G	H	G	-	-
GB108049000050	Lower River Ruthern	North Cornwall, Seaton, Looe and Fowey	South West	PI	1	-	Cu, Zn	-	Zn	Zn	No	D	FALSE	No	H	H	G	-	-
GB108049000210	Benny Stream	North Cornwall, Seaton, Looe and Fowey	South West	I	3	-	Cu, Zn	Zn	Zn	Zn	No	D	TRUE	No	G	G	-	-	-
GB108049007050	River Allen	North Cornwall, Seaton, Looe and Fowey	South West	I	2	-	Cu, Zn	-	Zn	Zn	No	D	FALSE	No	H	H	G	-	-
GB108050014130	Mole	North Devon	South West	I	2	-	Cu, Zn	Cu, Zn	Zn	-	No	D	FALSE	No	H	H	-	-	-
GB108047007880	Burn (Tavy)	Tamar	South West	PI	1	-	Cu, Zn	Cu, Zn	Zn	Zn	No	D	FALSE	No	H	G	G	-	-
GB108048001171	River Cober US Lowrtown Bridge	West Cornwall and the Fal	South West	I	3	-	Cu, Zn	Cu, Zn	Cu, Zn	Cu, Zn	No	D	FALSE	No	G	H	G	G	-
GB108048001250	Calenick Stream	West Cornwall and the Fal	South West	I	1	-	Cu, Zn	Cu, Zn	Cu, Zn	Cu, Zn	No	D	TRUE	No	H	H	-	-	-
GB108048002280	St. Austell River	West Cornwall	South West	I	4	-	Cu, Zn	-	Zn	Zn	No	D	FALSE	No	G	G	G	-	G

WBID	Name	Catchment	RBD Name	Mining Impact?	N° sample points	EA Invest?	Metals monit	Metal fail pre-tool	Metal fail post-tool	"Signif" fails post-tool	ABC Improves Zn EQS comp	Tool Input	"Priority" WB	"Opt" WB	ASPT	N-TAXA	Fish	Diatom	Plant
		and the Fal																	
GB108049000350	Tregeseal Stream	West Cornwall and the Fal	South West	I	2	-	Cu, Zn	Cu, Zn	Zn	Zn	No	D	FALSE	No	G	G	-	-	-
GB108049000560	Roseworthy Stream	West Cornwall and the Fal	South West	I	6	-	Cu, Zn	Cu, Zn	Cu, Zn	Cu, Zn	No	D	TRUE	No	G	H	H	G	-
GB110066060030	Conwy - Tidal limit to Merddwr	Conwy and Clwyd	Western Wales	I	3	Yes	As, Cu, Cd, Fe, Pb, Hg, Ni, Zn	Cu, Zn	Zn	Zn	No	D	TRUE	No	H	H	H	G	H
GB110060036250	Tywi (Llandovery Bran To Cothi Confl)	Loughor to Taf	Western Wales	PI	1	-	Cu, Zn	Cu, Zn	Zn	Zn	No	SS	FALSE	Yes	H	H	-	-	-
GB110064048390	Dyfi - Tidal limit to Afon Twymyn	North West Wales	Western Wales	I	4	-	As, Cu, Cd, Fe, Pb, Hg, Ni, Zn	Cu, Zn	Zn	Zn	No	D	FALSE	No	H	H	-	H	H
GB110064048710	Mawddach - Lower	North West Wales	Western Wales	I	2	-	As, Cu, Cd, Fe, Pb, Hg, Ni, Zn	Cu, Zn	Zn	Zn	No	SS	FALSE	Yes	H	G	-	-	-
GB110065053720	Goedol	North West Wales	Western Wales	I	2	-	Cu, Fe, Pb, Ni, Zn	Cu, Zn	Cu, Zn, Ni	Cu, Zn, Ni	No	SS	FALSE	Yes	H	H	-	-	-
GB110102059230	Goch Amlwch	North West Wales	Western Wales	I	1	Yes	Cd, Cu. Fe, Ni, Pb, Zn	Cd, Cu. Fe, Ni, Pb, Zn	Cd, Cu. Fe, Ni, Pb, Zn	Cd, Cu. Fe, Ni, Pb, Zn	No ABC	SS	TRUE	Yes	-	-	-	-	-
GB110058026220	Alun - Headwaters to confluence with Ewenny	Ogmore to Tawe	Western Wales	I	6	-	Cu, Zn	-	Cu, Zn	-	No	D	FALSE	No	H	H	-	-	-
GB110063041630	Bow Street Brook - Headwaters to conf with Clarach	South West Wales	Western Wales	I	2	-	Cu, Zn	Cu, Zn	Zn	Zn	No ABC	D	TRUE	No	G	H	G	-	-

ASPT: Average Score Per Taxa
N-TAXA: Number of Taxa
PI: Waterbody identified as “probably impacted” by abandoned non-coal mining in the NoCAM project
I: Waterbody impacted as “impacted” by abandoned non-coal mining in the NoCAM project
D: Default (waterbody or hydrometric area) values for DOC and Ca used for screening tool input.
SS: Site-specific data for DOC, Ca and pH used for screening tool input.
H: High status, G: Good status
Candidate waterbodies are highlighted in green.

3.1.3 Objectives and scope of Scenario 4 field programme

A single waterbody was proposed for the scenario 4 field programme. A field programme at a scenario 4 waterbody was specifically requested by the Environment Agency Steering Group. Despite the limited potential for bioavailability-based tools to improve the overall WFD classification in these waterbodies (because of the ecological failures) the appropriate management of these waterbodies by the Environment Agency under the WFD remains a significant challenge. The field programme was conducted to ensure that the bioavailability-based tools were not under-protective at sites that are clearly impacted and investigate the potential to develop “alternative objectives” for waterbodies that do not achieve EQS.

The waterbody identified for this work was the Clarach - headwaters to conf with Bow Street Brook (GB110063041610) in Western Wales. This waterbody is identified as having moderate macroinvertebrate and fisheries quality whilst failing EQS for Cu and Zn, despite a screening-level bioavailability correction. The Clarach is also subject to an ongoing EA Wales investigation (Paul Edwards, Environment Agency, Pers comm) and is also adjacent to the Bow Street Brook waterbody (GB110063041630), which was prioritised for the scenario 3 field programme. This allowed the relatively modest field programme budget to be used as efficiently as possible.

3.2 Field programme results

The field programmes for all the selected waterbodies took place concurrently between October 2010 and January 2011. Full details of the individual field programmes (for example, sample point locations, chemical determinands required, ecological survey requirements) are provided in Appendix C. Summaries of the results of the field programmes and their interpretation in terms of compliance with the WFD are provided in the following sections.

Field sampling for chemistry and ecology was undertaken by Cascade Consulting after liaison with local Environment Agency staff to gain appropriate access and permissions. Sampling was undertaken according to current Environment Agency sampling guidelines. Chemical analysis was undertaken by the Environment Agency National Laboratory Service and full details of the results are provided in Appendix D. These chemical data have also been incorporated into the Environment Agency Water Information Management System (WIMS) database. Macroinvertebrate identification was undertaken by Dr Bill Bellamy (Bill Bellamy Associates, Winterley, Cheshire). RIVPACS III+ predictions of expected macroinvertebrate community at sample sites (presence/absence and abundance) and ASPT[12] and N-Taxa[13] EQI[14] calculations were undertaken by wca environment. Diatom identification and DARES assessment was undertaken by Dr Martyn Kelly (Bowburn Consultancy, Bowburn, Durham). Full details of macroinvertebrate and diatom surveys are provided in Appendix E. A single fisheries survey on the Clarach was required, and this was undertaken by OHES (OHES, Wokingham, Berkshire - survey report provided in Appendix F).

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[12] ASPT: Average Score Per Taxa

[13] N-Taxa: Number of Taxa

[14] EQI: Environmental Quality Indices

3.2.1 Estimating waterbody-specific Ambient Background Concentrations (ABC) for zinc

Ambient background concentrations for zinc (and other metals) have been estimated in individual waterbodies by direct sampling in the headwaters of the waterbodies. This approach requires that ABC sites in headwaters are not affected by any anthropogenic source of metals to the environment (for example, any abandoned mining feature such as an adit or spoil heap). Candidate sites for ABC sampling were identified in each waterbody using a GIS in combination with information on known mining-related features in waterbodies. After discarding data from any site that showed evidence of elevated metals concentrations ABC were calculated from the remaining sites by three candidate methods:

1. Lowest value reported across all of the ABC sites;
2. Median value from the ABC site with the lowest overall measurements, and
3. Median value from the all the ABC sites in the waterbody

Method 1 was expected to estimate the most conservative ABC, whilst method 3 was expected to derive the least conservative estimate (which should still be robust if all sites are not affected by any metal inputs). For the purposes of the field programme ABC were applied in Zn EQS compliance in a stepwise fashion. Where the ABC estimated from method 1 was successful in improving Zn EQS compliance there was no requirement to progress to the less conservative estimates of ABC.

3.2.2 Derivation of site-specific quality targets for zinc based on macroinvertebrate community structure

The general principle for deriving an aquatic Environmental Quality Standard (EQS) for a substance is to define a concentration which will not result in adverse (long-term) effects on the most sensitive species in the community. Under the WFD, EQS are usually based on a threshold for "no effects" obtained from laboratory ecotoxicity tests which is then subject to an additional assessment/safety factor (the size of which is dependent on the quality and quantity of the ecotoxicity data available). This No Effects Threshold can either be based on test data from a particularly sensitive species (the lowest result in the dataset) or from a low percentile (usually five percent of species affected) from a species sensitivity distribution (SSD). It is assumed that protecting the most sensitive species will protect biological community structure, which will in turn ensure protection of biological community function. The WFD technical guidance (EC 2010) for deriving EQS also allows standards to be derived from mesocosm studies, but very few of these standards have been adopted and higher tier data are more generally used in a weight-of-evidence process in assigning the assessment factor. Under the WFD "good or better" status can only be achieved in a waterbody if all relevant EQS are met, including after an assessment of bioavailability. This paradigm assumes that sensitive species will always be present in an ecological community. Whilst this is a conservative, precautionary, position it could potentially result in a situation where an EQS is more stringent than necessary to protect the naturally occurring biological community, as the community does not contain any particularly sensitive species. Under the WFD this could result in a situation where ecological quality is determined to be at good or high status, whilst simultaneously chemical EQS are exceeded, even after accounting for bioavailability.

This project has developed a methodology for deriving site-specific quality targets for zinc, based on the macroinvertebrate community observed, or predicted to occur at a site using RIVPACS. The quality targets also take account of zinc bioavailability. The rationale for the development of such targets is that they are more closely related to the

WFD ecological protection goals than toxicologically based EQS (either conventional or bioavailability-adjusted) and could reduce the frequency of chemical and biological mis-matches during classification. Whilst not of equivalent standing to either conventional or bioavailability-based EQS, site-specific quality targets based on ecology could potentially be adopted as “alternative” objectives or targets for waterbodies. For example, where ecological quality is determined as good or better but conventional or bioavailability-based chemical EQS are exceeded, site-specific quality targets based on observed or predicted macroinvertebrate taxa offer the potential to derive a less stringent standard that is still protective of the ecology at a site; rationalising the chemical and biological elements of WFD classification. Similarly, where the ecological status of a waterbody does not achieve good status a site-specific quality target based on the predicted ecology at a site could offer a more readily achievable quality target for improving status than the conventional or bioavailability-based EQS, and therefore could be considered as a clean-up target when designing remedial intervention measures. Equally, a site-specific quality target based on the ecology observed at a site failing to achieve good ecological status would allow the derivation of a standard to protect against “no further deterioration”. Site-specific quality targets have been derived for sites in the Cober, Bow Street Brook and Clarach waterbodies. Further details of the methodology developed for deriving site-specific quality targets based on ecology is given in Appendix G. It should be emphasised that the methodology for deriving site-specific quality targets requires additional development and validation before such alternative targets can be robustly applied during surface water classification by the Environment Agency.

3.2.3 Lower River Fowey

The Lower River Fowey waterbody is shown in Figure 3.1. Compliance with chemical EQS is determined at two operational monitoring points within the Lower River Fowey waterbody: Restormel (WIMS 81520166) and Respryn (81520205). Ecological quality (macroinvertebrates, diatoms and macrophytes) is determined at a single sample point (BIOSYS 10714), which is sited adjacent to the WIMS 81520166 sampling point. The waterbody currently has no WFD fisheries classification as the main stem of the river is too wide to undertake a netted fisheries survey, which is required to apply the FCS2 fisheries classification tool used for WFD classification. However, fisheries surveys undertaken in 2008 at Restormel and 2005 at Respryn Bridge suggest that the fishery in the Lower River Fowey is in Good condition (Rob Hilman, Environment Agency, Pers com).

Summaries of existing metal and ecological monitoring data for the Lower River Fowey are given in Tables 3.3 and 3.4. The Lower River Fowey is currently classified as failing EQS for Cu and Zn but passing ecological quality elements and other metal EQS (arsenic, cadmium, iron, lead, mercury and nickel).

Table 3.3 Summary of Environment Agency ecological monitoring data in the Lower River Fowey used for classification

Site	BQE[a]	Survey	EQR[b]	WB EQR	Status
BIOSYS 10714	ASPT	2006	1.08	1.06	High
		2008	1.04		
	NTAXA	2006	0.98	0.96	High
		2008	0.94		
	Diatoms	2008	0.92	0.92	Good
	Macrophytes	2007	0.95	0.96	High
		2008	0.96		

a: BQE: biological quality element

b: EQR: environmental quality ratio

Table 3.4 Summary of Environment Agency chemical monitoring data in Lower River Fowey used for WFD classification

Determinand	Mean µg l^{-1} (std dev), N° samples[a]		Waterbody median confidence of failure
	81520166 (Restormel)	81520205 (Respryn)	
Arsenic (dissolved as As)	-	2.91 (0.77), 30	0
Benzo(a)pyrene	-	<MRL, 30	0
Benzofluoranthene	-	<MRL, 30	0
Benzoindeno	-	<MRL, 30	0
Cadmium (dissolved as Cd)	-	0.018 (0.024), 30	0
Copper (dissolved as Cu)	2.76 (1.38), 34	2.56 (1.43), 36	0.99
Diuron	<MRL, 17	<MRL, 19	0
Drins	-	<MRL, 30	0
Fluoranthene	-	<MRL, 30	0
Iron (dissolved as Zn)	-	75.93 (33.3), 30	0
Lead (dissolved as Pb)	-	<MRL, 36	0
Mecoprop	<MRL, 18	<MRL, 20	0
Mercury (dissolved as Hg)	-	0.0049 (0.011), 30	0
Nickel (dissolved as Ni)	-	<MRL, 36	0
DDT	-	<MRL, 27	0
Zinc (total as Zn)	11.38 (4.37), 34	12.01 (7.22), 36	0.99
Zinc (dissolved as Zn)	-	8.98 (2.34), 36	-
bioavailability screening tool input parameters			
Site-specific median DOC	-	2.27	-
Default median DOC (waterbody)	2.07	2.07	-
Site-specific mean pH	7.30	7.27	-
Site-specific mean Ca	6.22	6.11	-
Default mean Ca (waterbody)	6.5	6.5	-
Zn background (hydrometric area)	1.25	1.25	-

MRL: Minimum reporting limit.
a: Highlighted cells are “significant” (p less than 0.05) compliance failures before bioavailability correction (greater than 95 per cent confidence of failure).

The results of the chemical monitoring undertaken in the Lower River Fowey as part of this project are summarised in Table 3.5 as either means with standard deviation (metals), or medians (physicochemical parameters). The results of the monitoring at the operational monitoring sites (Restormel and Respryn) support the existing Environment Agency data on concentrations of dissolved metals in the waterbody. None of the other metals (Cd, Pb or Ni) are approaching concentrations that would cause EQS failure.

The concentrations of one or more of the monitored metals (Cd, Cu, Pb, Ni and Zn) are elevated at four of the five low order ABC sites, which suggests that there may be previously unidentified sources of these metals in the headwaters of this waterbody, which may be worthy of further investigation (particularly ABC site 2). Data from ABC sites 1, 2, 4 and 5 are unlikely to reflect ambient background concentrations of dissolved metals and should not be used to estimate a waterbody-specific ambient background concentration for zinc. However, dissolved metal concentrations at ABC site 3 are consistently lower, or of the same order, as those observed in the main stem of the Fowey and are likely to be the most suitable for derivation of a site-specific background concentration for Zn.

Table 3.5 Summary of analytical chemistry results at Lower River Fowey operational and ABC monitoring points from field programme

Site Name WIMS ID	Restormel 81520166	Respryn 81520205	ABC 1 81520595	ABC 2 81520596	ABC 3 81520597	ABC 4 81520598	ABC 5 81520599
DOC[a] mg l^{-1} C	2.17	2.33	-	-	-	-	-
pH[a]	7.47	7.5	7.65	7.27	7.82	7.24	7.25
Calcium[a] mg l^{-1}	6.45	6.25	-	-	-	-	-
Diss. Cd[b] µg l^{-1}	<MRV	<MRV	<MRV	0.41 (0.05)	0.06 (0.03)	0.12 (0.10)	0.16 (0.02)
Diss. Cu[b] µg l^{-1}	2.38 (0.76)	2.13 (0.67)	<MRV	2.72 (1.50)	1.12 (0.82)	4.68 (1.85)	1.01(0.79)
Diss. Pb[b] µg l^{-1}	<MRV	<MRV	<MRV	<MRV	<MRV	3.15 (2.05)	<MRV
Diss. Ni[b] µg l^{-1}	0.86 (0.41)	0.60 (0.50)	0.72 (0.31)	3.02 (0.27)	0.83 (0.53)	3.0 (0.95)	2.37 (0.21)
Diss. Zn[b] µg l^{-1}	10.16 (1.43)	9.60 (0.94)	9.18 (0.90)	48.77 (5.88)	6.51 (4.82)	19.87 (7.76)	20.03 (1.29)
Site-specific Zn background calculation							
Median complete dataset (ABC sites 1 – 5)			**-**				
Median lowest site (ABC site 3)			**5.02**				
Lowest value in dataset			**2.5**				

<MRV: less than the analytical minimum reporting value
a: median value of six samples. Results less than MRV were treated at half the MRV for calculation of medians.
b: mean and (standard deviation) of six samples. Results less than MRV were treated at half the MRV for calculation of mean.

The effect of accounting for copper bioavailability during classification is summarised in Table 3.6. The site-specific PNECs for copper derived from the simple bioavailability screening tool based on waterbody default values of DOC and Ca (6.53 and 6.56 µg l^{-1} dissolved copper for Restormel and Respryn, respectively) are very similar to the site-specific PNECs derived from DOC and Ca monitoring data (6.59 and 6.84 µg l^{-1} dissolved copper for Restormel and Respryn, respectively). This supports the use precautionary defaults during initial tiers of assessment where site-specific data is absent. The precautionary nature of the copper bioavailability screening tool is noticeable when the site-specific PNEC derived from the screening tool and the Full BLM are compared, with the site-specific PNEC from the full BLM being approximately double that derived from the screening tool. Using either the screening tool or the full BLM results in the Fowey waterbody complying with the copper EQS.

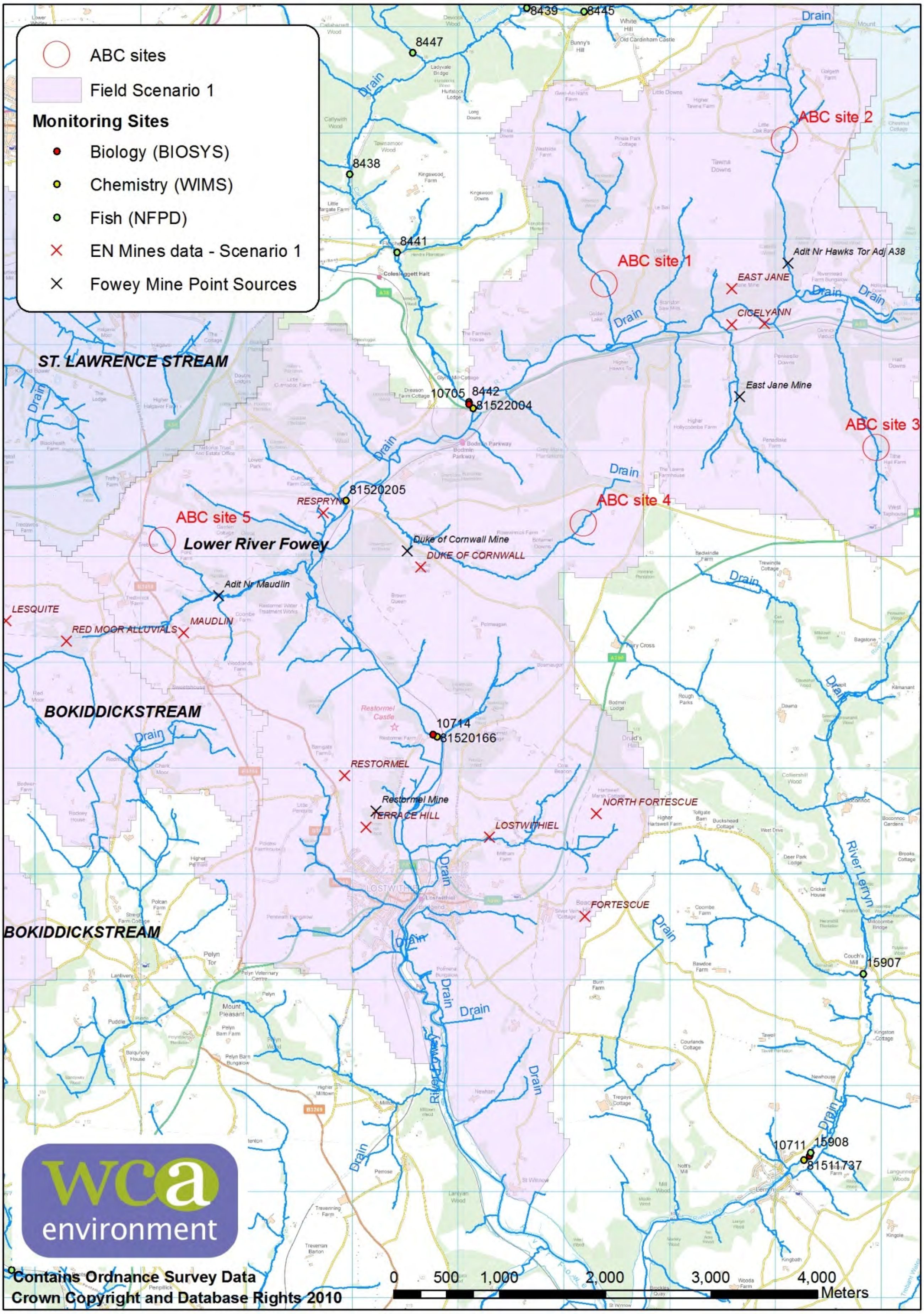

Figure 3.1 Map of Lower River Fowey water body

Table 3.6 Summary of copper site-specific PNEC values at Lower River Fowey operational monitoring points and waterbody median confidence of failure

Basis of site-specific PNEC	Site-specific PNEC ug l^{-1} dissolved Cu		
	Restormel 81520166	Respryn 81520205	Median confidence of failure[a]
WFD EQS	1.0	1.0	0.99
Bioavailability screening tool – Default DOC and Ca [waterbody]	6.53	6.56	0
Bioavailability screening tool – Site-specific DOC and Ca	6.59	6.84	0
Full BLM	13.66	14.36	0

a: red = "significant" EQS fail, orange = "reasonable" EQS, yellow = "marginal" EQS", green = EQS compliance

The effect of accounting for zinc bioavailability and ambient background concentrations is summarised in Table 3.7. Applying the screening tool using either site-specific or default physicochemical data returns the "sensitive conditions" generic site-specific PNEC of 10.9 µg l^{-1}, as the waterbody has a Ca concentration below the lower boundary of the screening tool. After incorporating the hydrometric area default ABC of 1.25 µg l^{-1} dissolved zinc this results in a site-specific PNEC of 12.2 µg l^{-1} dissolved zinc, which results in Zn EQS compliance in the waterbody. However, application of the full BLM for zinc returns a lower site-specific PNEC than the generic site-specific PNEC from the screening tool. This situation can arise as the generic EQS was developed to protect 95 per cent of water conditions, in the most sensitive region of Great Britain (NW region) and exceptions to these conditions are expected to occur. Incorporating the hydrometric area ABC to these lower site-specific PNECs does not result in EQS compliance. Although, incorporating the waterbody-specific ABC derived from the monitoring data from ABC site 3 does affect EQS compliance. When the lowest observed value from ABC site 3 is used as the waterbody-specific ABC (2.5 µg l^{-1} zinc) the significance of the EQS exceedance is reduced to a marginal fail. However, when the median observed value from ABC site 3 is used as the waterbody-specific ABC (5.02 µg l^{-1} zinc) this results in EQS compliance. Use of a site-specific quality target as an alternative objective or compliance threshold based on the predicted macroinvertebrate ecology at the Restormel site also resulted in compliance for zinc.

Table 3.7 Summary of zinc site-specific PNEC values at Lower River Fowey operational monitoring points and waterbody median confidence of failure

Basis of site-specific PNEC	Site-specific PNEC ug l^{-1} dissolved Zn		
	Restormel 81520166	Respryn 81520205	Median confidence of failure[b]
WFD EQS[a]	8.0	8.0	0.99
Bioavailability screening tool – Default DOC and Ca [waterbody-based] + hydrometric area background (1.25 ug l^{-1})	10.9 + 1.25 = 12.2	10.9 + 1.25 = 12.2	0.005
Bioavailability screening tool – Site-specific DOC and Ca + hydrometric area background (1.25 ug l^{-1})	10.9 + 1.25 = 12.2	10.9 + 1.25 = 12.2	0.005
Full BLM + hydrometric area ABC (1.25 ug l^{-1})	7.47 + 1.25 = 8.72	7.07 + 1.25 = 8.32	0.98
Full BLM + waterbody-specific ABC [lowest] (2.5 ug l^{-1})	7.47 + 2.5 = 9.97	7.07 + 2.5 = 9.57	0.54

Full BLM + waterbody-specific ABC [median ABC 3] (5.02 ug l^{-1})	7.47 + 5.02 = 12.49	7.07 + 5.02 = 12.09	0.003
Site specific (community-based) quality target + hydrometric area ABC (1.25 ug l^{-1})	9.85 + 1.25 = 11.1	No ecology data	0.07

a: WFD EQS compliance under the first WFD classification based on total zinc concentrations
b: red = "significant" EQS fail, orange = "reasonable" EQS, yellow = "marginal" EQS", green = EQS compliance

3.2.4 River Cober upstream of Lowertown Bridge

The River Cober upstream of Lowertown Bridge waterbody is shown in Figure 3.2. Compliance with chemical EQS under the WFD classification was determined at a single operational monitoring point within the River Cober [upstream of Lowertown Bridge] waterbody: Lowertown Bridge (WIMS 82010156). However, two additional operational monitoring points are located within the waterbody and were included in the field programme to ensure that the waterbody was adequately characterised: Trenear Bridge (WIMS 82010187) and Medlyn at Chy Bridge (WIMS 81520205). Confidence of failure statistics reported for this waterbody, for the purposes of this project, are based on all three of these monitoring points as these more appropriately characterise the waterbody than a single monitoring point. Ecological quality is currently determined at two sample points: BIOSYS 10894 (which is sited adjacent to the Lowertown Bridge chemical sampling point) and BIOSYS 10897 (which is situated approximately 250 metres upstream of the Trenear Bridge chemical sampling point). Fisheries surveys have been conducted at two sites around the Trenear Bridge area of the waterbody. Environment Agency ecological monitoring considers that the waterbody is achieving good ecological status (Table 3.8).

Additional ecological surveys were carried out as part of the field programme at Trenear Bridge (diatoms), and Medlyn at Chy Bridge (macroinvertebrates and diatoms), to ensure that chemical and ecological quality element sampling points were aligned and as comprehensive as possible. The results of these additional surveys have been included in Table 3.8 and confirm that overall the waterbody is achieving good status, despite potentially poor ecological quality (as determined by the ASPT metric, which responds to toxic substances such as metals) at the Medlyn at Chy Bridge sample point.

Table 3.8 Ecological monitoring data in the River Cober

Site	BQE	Survey	EQR	WB EQR	WB Status
10894 (Lowertown Bridge)	ASPT	2008	0.98 (H)	0.93	Good
	N-TAXA	2008	1.01 (H)	0.82	Good
	TDI	2008	0.89 (G)	0.79	Good
10897 (Trenear Bridge)	ASPT	2006	0.93 (G)	0.93	Good
		2008	0.95 (G)	0.93	Good
	N-TAXA	2006	0.97 (H)	0.82	Good
		2008	0.75 (G)	0.82	Good
	TDI	2010	0.62 (M)	0.79	Good
82011025 (Medlyn)	ASPT[c]	2010	0.87 (G)	0.93	Good
	N-TAXA[c]	2010	0.55 (P)	0.82	Good
	TDI	2010	0.85 (G)	0.79	Good
13318	FCS2	2006	0.73 (G)	0.54 (G)	Good
13317		2006	0.35 (M)	0.54 (G)	Good

TDI: Trophic Diatom Index
Highlighted survey data were generated as a component of this project's field programme
a: BQE: biological quality element
b: EQR: environmental quality ratio

c: macroinvertebrate assessments were based on a single season only (autumn) and should not be considered to be definitive classifications

Table 3.9 Summary of Environment Agency chemical monitoring data in River Cober used for WFD classification

Determinand	Mean µg l^{-1} (std dev), N° samples[a]			Waterbody median confidence of failure
	82010156 (Lowertown)	82010187 (Trenear)	8201125 (Medlyn)	
Copper (dissolved as Cu)	10.61 (2.25), 35	-	-	0.99
Zinc (total as Zn)	25.39 (5.22), 35	-	-	0.99
Bioavailability screening tool input parameters				
Site-specific median DOC	-	-	-	-
Default median DOC (hydrometric area)	1.87	1.87	1.87	-
Site-specific mean pH	7.08	-	-	-
Site-specific mean Ca	9.39	-	-	-
Default mean Ca (hydrometric area)	14	14	14	-
Zn background (hydrometric area)	1.25	1.25	1.25	-

MRL: Minimum reporting limit.
a: Highlighted cells are “significant” compliance failures before bioavailability correction (greater than 95 per cent confidence of failure).

The results of the chemical monitoring undertaken in the River Cober are summarised in Table 3.9 as either means with standard deviation (metals), or medians (physicochemical parameters). The results of the monitoring at Lowertown Bridge are consistent with the existing Environment Agency data on concentrations of dissolved Cu and total Zn. None of the other metals (Cd, Pb or Ni) are approaching concentrations that would cause EQS failure.

Background concentrations for metals at three of the four background monitoring sites are generally comparable and are lower than those observed in the main stem of the waterbody. All of the other metals monitored at these sites are reported at less than the MRV. Data from these ABC sites would appear, from the information available for this project, to be suitable for estimating a waterbody-specific ABC for zinc. Data from background monitoring site 3 has elevated concentrations of copper and zinc compared to the other background monitoring sites which is comparable to the zinc concentrations observed in the main stem of the waterbody and should not be used to estimate waterbody-specific ambient background concentrations for Zn.

The effect of accounting for copper bioavailability during classification is summarised in Table 3.11. The site-specific PNEC derived from the simple bioavailability screening tool using hydrometric area default values for DOC and Ca would appear to have been marginally over stringent as site-specific data for DOC and Ca results in the waterbody achieving the copper EQS. The precautionary nature of the copper screening tool is again apparent when the site-specific PNEC derived from the screening tool and the Full BLM are compared, with the site-specific PNEC from the full BLM being approximately double that derived from the screening tool.

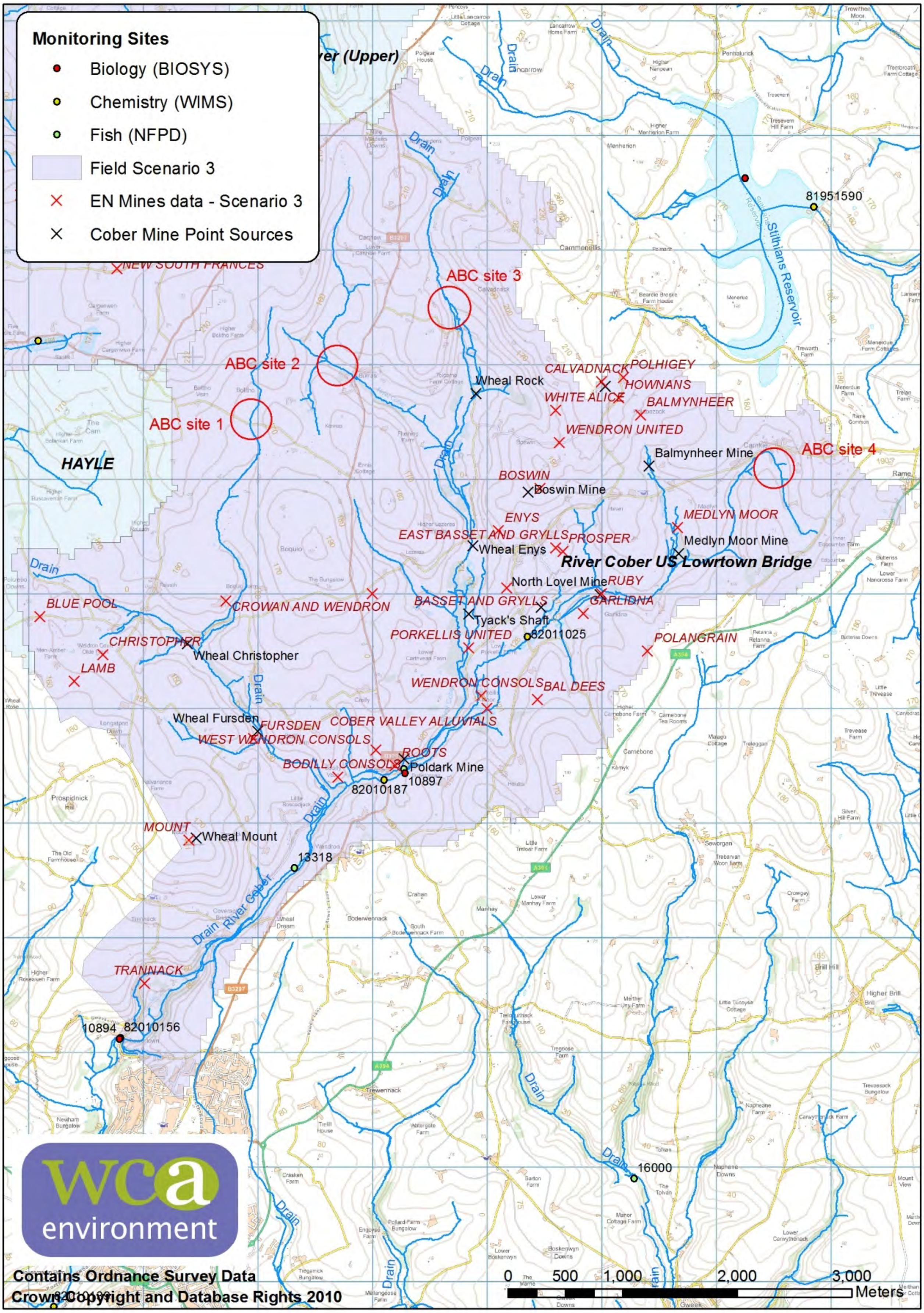

Figure 3.2 Map of River Cober upstream of Lowertown Bridge Waterbody

Table 3.10 Summary of analytical chemistry results at River Cober operational and ABC monitoring points from field programme

Site Name WIMS ID	Lowertown 82010156	Trenear 82010187	Medlyn 82011025	ABC 1 82010193	ABC 2 82010194	ABC 3 82010195	ABC 4 82010196
DOC[a] mg l^{-1} C	3.56	3.64	2.54	-	-	-	-
pH[a]	7.40	6.84	6.67	6.74	6.81	6.96	6.55
Calcium[a] mg l^{-1}	9.15	7.90	5.95	-	-	-	-
Diss. Cd[b] µg l^{-1}	<MRV	<MRV	0.07 (0.03)	<MRV	<MRV	<MRV	<MRV
Diss. Cu[b] µg l^{-1}	10.11 (2.11)	9.97 (3.61)	11.60 (1.78)	2.07 (1.23)	2.49 (0.61)	4.02 (1.44)	2.58 (0.35)
Diss. Pb[b] µg l^{-1}	<MRV	<MRV	<MRV	<MRV	<MRV	<MRV	<MRV
Diss. Ni[b] µg l^{-1}	<MRV	<MRV	<MRV	<MRV	<MRV	<MRV	0.63 (0.31)
Diss. Zn[b] µg l^{-1}	21.03 (2.11)	21.30 (4.79)	37.83 (3.0)	12.58 (1.55)	11.01 (1.12)	23.30 (1.62)	13.58 (1.31)
Site-specific Zn background calculation							
Median complete (ABC sites 1, 2 & 4)			**12.5**				
Median lowest site (ABC site 2)			**11.1**				
Lowest value in dataset			**9.27**				

<MRV: less than the analytical minimum reporting value
a: median value of six samples. Results less than MRV were treated at half the MRV for calculation of medians.
b: mean and standard deviation of six samples. Results less than MRV were treated at half the MRV for calculation of mean.

Table 3.11 Summary of copper site-specific PNEC values at River Cober operational monitoring points and waterbody median confidence of failure

Basis of site-specific PNEC	Site-specific PNEC ug l^{-1} dissolved Cu			
	Lowertown (82010156)	Trenear (82010187)	Medlyn (8201125)	Median conf of failure[a]
WFD EQS	1.0	1.0	1.0	0.99
Bioavailability screening tool – Default DOC and Ca [hydrometric area]	5.95	5.95	5.95	0.99
Bioavailability screening tool – Site-specific DOC and Ca	14.26	10.14	4.51	0.46
Full BLM	22.1	14.1	7.8	0.019

a: red = "significant" EQS fail, orange = "reasonable" EQS, yellow = "marginal" EQS", green = EQS compliance

The effect of accounting for zinc bioavailability and ambient background concentrations is summarised in Table 3.12 Applying the screening tool using either site-specific or default physicochemical data results in the "sensitive conditions" generic site-specific PNEC of 10.9 µg l^{-1} being derived, as the waterbody has concentration of Ca below the lower boundary of the screening tool. After incorporating the hydrometric area default ABC of 1.25 µg l^{-1} dissolved zinc this results in a site-specific PNEC of 12.2 µg l^{-1} dissolved zinc, which continues to result in the waterbody failing to meet the EQS. As observed in the Fowey waterbody, the application of the full BLM for zinc returns lower site-specific PNECs than the screening tool. Incorporating the hydrometric area ABC, or the waterbody-specific ABCs derived from the background monitoring data also results in EQS non-compliance, although the statistical confidence of EQS failure can be reduced from significant to reasonable or marginal through the use of ABC derived from the median of the site with the lowest Zn and the median of the complete dataset, respectively. Use of a site-specific quality target based on the predicted macroinvertebrate community in combination with the most conservative waterbody specific ABC results in waterbody compliance. Use of site-specific (community-based) quality targets would appear to be the single effective option to rationalise chemical and biological measures of status in this waterbody.

Table 3.12 Summary of zinc site-specific PNEC values at River Cober operational monitoring points and waterbody median confidence of failure

Basis of site-specific PNEC	Site-specific PNEC µg l^{-1} dissolved Zn			
	Lowertown (82010156)	Trenear (82010187)	Medlyn (8201125)	Median conf of failure[b]
WFD EQS[a]	8.0	8.0	8.0	0.99
Bioavailability screening tool – Default DOC and Ca [waterbody] + hydrometric area background (1.25 ug l^{-1})	10.9+1.25= 12.2	10.9+1.25= 12.2	10.9+1.25= 12.2	0.99
Bioavailability screening tool – Site-specific DOC and Ca + hydrometric area background (1.25 ug l^{-1})	10.9+1.25= 12.2	10.9+1.25= 12.2	10.9+1.25= 12.2	0.99
Full BLM + hydrometric area ABC (1.25 ug l^{-1})	9.32+1.25= 10.57	8.17+1.25= 9.42	6.69+1.25= 7.92	0.99
Full BLM + waterbody-specific ABC [lowest ABC 2] (9.27 ug l^{-1})	9.32+9.27= 18.59	8.17+9.27= 17.44	6.69+9.27= 15.96	0.98
Full BLM + waterbody-specific ABC [median ABC 2] (11.1 ug l^{-1})	9.32+11.1= 20.41	8.17+11.1= 19.27	6.69+11.1= 17.79	0.82
Full BLM + waterbody-specific ABC [median ABC 1,2 & 4] (12.5 ug l^{-1})	9.32+12.5= 21.82	8.17+12.5= 20.67	6.69+12.5= 19.19	0.62
Site specific (community-based) quality target + hydrometric area ABC (1.25 ug l^{-1})	16.88+1.25 =18.13	13.79+1.25 =15.04	10.74+1.25 =11.99	0.99
Site specific (community-based) quality target + waterbody-specific ABC [lowest ABC 2] (9.27 ug l^{-1})	16.88+9.27 =26.15	13.79+9.27 =23.06	10.74+9.27 =20.01	0.20
Site specific (community-based) quality target + waterbody-specific ABC [median ABC 2] (11.1 ug l^{-1})	16.88+11.1 =27.98	13.79+11.1 =24.89	10.74+11.1 =21.84	0.063

a: WFD EQS compliance under the first WFD classification based on total zinc concentrations
b: red = “significant” EQS fail, orange = “reasonable” EQS, yellow = “marginal” EQS”, green = EQS compliance

3.2.5 Bow Street Brook – Headwaters to confluence with Clarach

The Bow Street Brook – Headwaters to confluence with Clarach is shown in Figure 3.3. Compliance with chemical EQS is determined at two operational monitoring points within the Bow Street Brook waterbody for WFD classification: Upstream of Bow Street Brook STW (WIMS 80009) and Downstream of Bow Street Brook STW (WIMS 80010). Benthic macroinvertebrate data are available at a single sample point (BIOSYS 10714), which is sited adjacent to the WIMS 80010 sampling point. The fisheries sampling location (16516) is adjacent to WIMS 80009 upstream of the STW. Summaries of existing metal and ecological monitoring data for the Bow Street Brook are given in Tables 3.13 and 3.14. The Bow Street Brook is currently classified as failing EQS for Cu and Zn (no other metals were included in the WFD classification) but achieving good ecological quality. An additional diatom survey was carried out as part of the field programme at BIOSYS site 44440 (downstream Bow Street Brook STW) to provide a full suite of biological quality element data and ensure that chemical and ecological quality element sampling points were aligned as far as reasonably possible. The results of the additional diatom survey at BIOSYS site 44440 have been included in Table 3.13 and reports that this quality element is currently achieving moderate status. The response of the TDI[15] to toxic stressors such as metals is not fully characterised, and should be interpreted with caution (Martyn Kelly, Bowburn Consultancy, pers com). The Bow Street Brook is currently classified as meeting standards for phosphorus, although the nitrate status of the waterbody is not a component of the WFD classification. Nitrate

[15] TDI: Trophic Diatom Index

leaching from sheep-grazed pasture in the Bow Street Brook waterbody may be contributing to the response of the diatom tool in this waterbody. Further investigation would be necessary to confirm this, although the absence of nitrate standards for rivers for WFD surface water classification makes additional interpretation of chemical monitoring data difficult. Recent work by the Environment Agency to derive threshold concentrations of chemicals (including nitrate) consistent with the class boundaries for ecological tools used for WFD classification may be useful in this instance (Environment Agency, in press).

Table 3.13 Ecological monitoring data in the Bow Street Brook

Site	BQE	Survey	EQR	WB EQR	Status
44440	ASPT	2007	0.86 (G)	0.86 (G)	Good
	NTAXA	2007	1.04 (H)	1.04 (H)	High
	TDI	2010	0.56 (M)	0.56 (M)	Moderate
16516	FCS2	2005	0.63 (G)	0.63 (G)	Good

Highlighted survey data were generated as a component of this project's field programme
a: BQE: biological quality element
b: EQR: environmental quality ratio

Table 3.14 Summary of Environment Agency chemical monitoring data in the Bow Street Brook used for WFD classification

Determinand	Mean µg l^{-1} (std dev), N° samples[a]		Waterbody median confidence of failure
	80009 (US STW)	80010 (DS STW)	
Copper (dissolved as Cu)	1.41 (0.73), 36	1.66 (0.75), 36	0.99
Zinc (total as Zn)	32.76 (11.45), 36	30.57 (12.47), 36	0.99
bioavailability screening tool input parameters			
Site-specific median DOC	-	-	-
Default median DOC (hydrometric area)	1.74	1.74	-
Site-specific mean pH	7.04	7.13	-
Site-specific mean Ca	11.58	11.35	-
Default mean Ca (hydrometric area)	5.71	5.71	-
Zn background (hydrometric area)	No hydrometric area default	No hydrometric area default	-

MRL: Minimum reporting limit.
a: Highlighted cells are "significant" (p less than 0.05) compliance failures before bioavailability correction (greater than 95 per cent confidence of failure).

The results of the chemical monitoring undertaken in the Bow Street Brook are summarised in Table 3.15 as either means with standard deviation (metals), or medians (physicochemical parameters). The results of the monitoring at the operational monitoring sites (Upstream Bow Street Brook STW and Downstream Bow Street Brook STW) support the existing Environment Agency data on concentrations of dissolved metals in the waterbody. None of the other metals (Ag, Cd, Pb or Ni) are approaching concentrations that would cause EQS failure. Background concentrations at all of the background monitoring sites are below levels observed in the main stem of the waterbody, and do suggest any anthropogenic inputs. However, the median measurement for dissolved Zn within the dataset is calculated to be 2.5 µg l^{-1}, which is the value substituted when results are reported as "<MRV" (MRV for dissolved zinc is 5.0 ug l^{-1}). Whilst this value can reasonably be used as a waterbody-specific ABC it should be applied with caution.

Table 3.15 Summary of analytical chemistry results at Bow Street Brook operational and ABC monitoring points from field programme

Site Name WIMS ID	US-STW 80009	DS-STW 80010	ABC 1 35774	ABC 2 35775	ABC 3 35776	ABC 4 35777	ABC 5 35778
DOC[a] mg l^{-1} C	2.22	2.17	3.39	2.04	1.96	3.78	3.40
pH[a]	7.68	7.36	7.12	6.89	7.47	7.20	7.34
Calcium[a] mg l^{-1}	9.80	9.80	10.70	11.10	4.30	9.95	9.80
Diss. Ag[b] ng l^{-1}	3.45 (2.30)	3.13 (2.01)	4.67 (3.58)	2.47 (1.63)	<MRV	2.85 (1.49)	4.58 (3.56)
Diss. Cd[b] µg l^{-1}	<MRV	<MRV	<MRV	<MRV	<MRV	<MRV	<MRV
Diss. Cu[b] µg l^{-1}	1.32 (0.99)	1.30 (0.97)	2.14 (0.84)	1.26 (0.88)	<MRV	1.75 (0.79)	1.45 (0.85)
Diss. Pb[b] µg l^{-1}	<MRV	<MRV	<MRV	<MRV	<MRV	<MRV	1.27 (0.65)
Diss. Ni[b] µg l^{-1}	0.80 (0.34)	<MRV	<MRV	0.64 (0.34)	<MRV	0.82 (0.36)	0.66 (0.39)
Diss. Zn[b] µg l^{-1}	25.0 (3.94)	23.80 (3.27)	3.78 (1.99)	4.33 (4.49)	4.14 (1.85)	4.77 (3.58)	7.57 (3.79)
Site-specific Zn background calculation							
Median complete dataset (ABC sites 1 – 5)			**2.5**				
Median lowest site (ABC site 1)			**2.5**				
Lowest value in dataset			**2.5**				

<MRV: less than the analytical minimum reporting value
a: median value of six samples. Results less than MRV were treated at half the MRV for calculation of medians.
b: mean and standard deviation of six samples. Results less than MRV were treated at half the MRV for calculation of mean.

The effect of accounting for copper bioavailability during classification is summarised in Table 3.16. The site-specific PNECs derived from the simple bioavailability screening tool using hydrometric area default values of DOC and Ca are marginally more precautionary that the site-specific PNECs derived from the bioavailability screening tool using site-specific measurements of DOC and Ca. This supports the use of defaults in the absence of site-specific data. The precaution of the copper screening tool is apparent when the site-specific PNECs derived from the screening tool and the Full BLM are compared, with the site-specific PNEC from the full BLM being approximately double that derived from the screening tool. Using either the screening tool or the full BLM results in the Bow Street Brook waterbody complying with the copper EQS.

Table 3.16 Summary of copper site-specific PNEC values at Bow Street Brook operational monitoring points and waterbody median confidence of failure

Basis of site-specific PNEC	Site-specific PNEC ug l^{-1} dissolved Cu		
	US-STW 80009	DS-STW 80010	Median confidence of failure[a]
WFD EQS	1.0	1.0	0.99
Bioavailability screening tool – Default DOC and Ca [hydrometric area based defaults]	5.50	5.46	0
Bioavailability screening tool – Site-specific DOC and Ca	6.34	6.21	0
Full BLM	12.7	11.1	0

a: red = “significant” EQS fail, orange = “reasonable” EQS, yellow = “marginal” EQS”, green = EQS compliance

The effect of accounting for zinc bioavailability and ambient background concentrations is summarised in Table 3.17. As the background concentration of zinc is low (~ 5.0 ug l^{-1}) none of the data treatments, including the derivation of a site-specific quality target based on either the ecology predicted or observed to be present at BIOSYS site 44440 are able to improve the Zn EQS compliance failure.

Table 3.17 Summary of zinc site-specific PNEC values at Bow Street Brook operational monitoring points and waterbody median confidence of failure

Basis of EQS	Site-specific EQS µg l^{-1} dissolved Zn		
	US-STW 80009	DS-STW 80010	Median confidence of failure[b]
WFD EQS[a]	8.0	8.0	0.99
Bioavailability screening tool – Default DOC and Ca [waterbody] + generic national ABC (1.1 ug l^{-1})	10.9 + 1.1 = 12.0	10.9 + 1.1 = 12.0	0.99
Bioavailability screening tool – Site-specific DOC and Ca + generic national ABC (1.1 ug l^{-1})	10.9 + 1.1 = 12.0	10.9 + 1.1 = 12.0	0.99
Full BLM + generic national ABC (1.1 ug l^{-1})	7.52 + 1.1 = 8.62	7.42 + 1.1 = 8.52	0.99
Full BLM + waterbody-specific ABC (2.5 ug l^{-1})	7.52 + 2.5 = 10.02	7.42 + 2.5 = 9.92	0.99
Site specific (community-based) quality target (predicted fauna) + generic national ABC (1.1 ug l^{-1})	No ecology data	12.92 + 1.1 = 14.02	0.99
Site specific (community-based) quality target (predicted fauna) + waterbody-specific ABC (2.5 ug l^{-1})	No ecology data	12.92 + 2.5 = 15.42	0.99
Site specific (community-based) quality target (observed fauna) + generic national ABC (1.1 ug l^{-1})	No ecology data	13.5 + 1.1 = 14.6	0.99
Site specific (community-based) quality target (observed fauna) + waterbody-specific ABC (2.5 ug l^{-1})	No ecology data	13.5 + 2.5 = 16.0	0.99

a: WFD EQS compliance under the first WFD classification based on total zinc concentrations
b: red = “significant” EQS fail, orange = “reasonable” EQS, yellow = “marginal” EQS”, green = EQS compliance

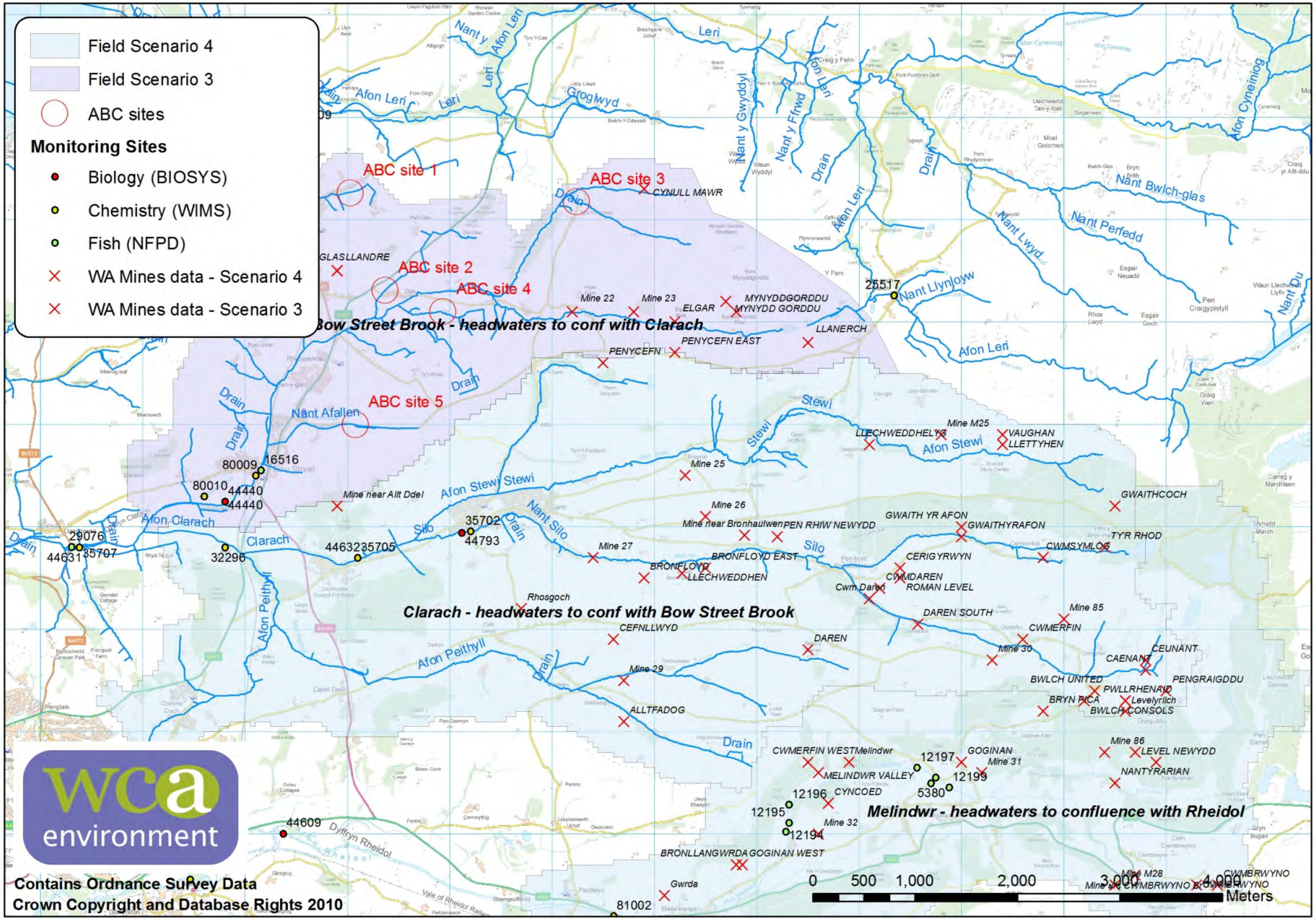

Figure 3.3 Map of Clarach and Bow Street Brook Waterbodies

3.2.6 Clarach - headwaters to confluence with Bow Street Brook

Compliance with chemical EQS for WFD classification is determined at three operational monitoring points within the Clarach [headwaters to confluence with Bow Street Brook] waterbody:

- Clarach at Rhydhir Uchaf (WIMS 32296)
- Clarach at Plas Gogerddan (WIMS 35705)
- Nant Silo at Penrhyncoch (WIMS 35702).

However, several additional operational monitoring points are located within the waterbody and were also included in the field programme to ensure that the waterbody was adequately characterised:

- Nant Silo at Penbont Rhyd Y Be (WIMS 35701)
- Nant Stewi at Penrhyncoch (WIMS 35703)
- Nant Peithyll near Capel Dewi (WIMS 35704)
- Nant Penycefn (WIMS 81223).

Ecological quality is currently determined at two sample points: BIOSYS 44632 (which is sited adjacent to the Clarach at Plas Gogerddan WIMS sample point) and BIOSYS 44793 (which is adjacent to the Nant Silo at Penrhyncoch WIMS sample point). Additional ecological surveys were carried out as part of the field programme at:

- Clarach at Plas Gogerddan (fisheries and diatoms)
- Nant Silo at Penrhyncoch (diatoms)
- Nant Stewi at Penrhyncoch (macroinvertebrates and diatoms)
- Nant Silo at Penbont Rhyd Y Be (macroinvertebrates and diatoms)
- Nant Peithyll near Capel Dewi (macroinvertebrates and diatoms)

This was to ensure that chemical and ecological quality elements sampling points were aligned and as comprehensive as possible. The results of these additional surveys have been included in Table 3.18 along with existing Environment Agency survey data and confirm that the waterbody is not achieving good ecological status, primarily as determined by the macroinvertebrate ASPT metric, which responds to toxic substances such as metals, and the diatom TDI which may or may not be responding to metal exposure. In addition, a fisheries survey was undertaken at Plas Gogerddan, which reported an absence of minor species such as bullheads which is consistent with a classification of moderate status (full details of the fisheries survey are provided in Appendix F).

Table 3.18 Ecological monitoring data in the River Clarach

Site	BQE	Survey	EQR	WB EQR	Status
44632 (Plas Gogerddan)	ASPT	2008	0.98 (H)	0.99	High
	NTAXA	2008	0.61 (M)	0.68	Moderate
	TDI	2010	0.46 (P)	0.49	Poor
44793 (Nant Silo at Penrhyncoch)	ASPT	2008	0.99 (H)	0.99	High
	NTAXA	2008	0.62 (M)	0.68	Moderate
	TDI	2010	0.47 (P)	0.49	Poor
35704 (Nant Peithyll near Capel Dewi)	ASPT[c]	2010	0.95 (G)	0.99	High
	NTAXA[c]	2010	0.95 (H)	0.68	Moderate
	TDI	2010	N/D	0.49	Poor
35703 (Nant Stewi at Penrhyncoch)	ASPT[c]	2010	N/D	0.99	High
	NTAXA[c]	2010	N/D	0.68	Moderate
	TDI	2010	0.49 (P)	0.49	Poor
35701 (Nant Silo at Penbont Rhyd Y Be)	ASPT[c]	2010	1.05 (H)	0.99	High
	NTAXA[c]	2010	0.54 (P)	0.68	Moderate
	TDI	2010	0.55 (M)	0.49	Poor

Highlighted survey data were generated as a component of this project's field programme
a: BQE: biological quality element
b: EQR: environmental quality ratio
c: macroinvertebrate assessments were based on a single season only (autumn) and should not be considered to be definitive classifications
N/D: No data. Site not suitable for RIVPACS predictions or substrate not suitable for diatom collection

Table 3.19 Summary of Environment Agency chemical monitoring data in River Clarach used for WFD classification

Determinand	Mean µg l^{-1} (std dev), N° samples[a]			Waterbody median confidence of failure
	32296 (Rhydhir Uchaf)	35705 (Plas Gogerddan)	35702 (Silo at Penrhyncoch)	
Copper (dissolved as Cu)	4.60 (1.16), 34	5.97 (1.52), 36	8.78 (2.27), 36	0.99
Zinc (total as Zn)	108.9 (31.64), 34	148.5 (35.72), 36	148.5 (32.64), 36	0.99
bioavailability screening tool input parameters				
Site-specific median DOC	-	-	1.94	-
Default median DOC (hydrometric area)	1.74	1.74	1.74	-
Site-specific mean pH	7.19	7.20	7.22	-
Site-specific mean Ca	11.42	9.07	8.62	-
Default mean Ca (hydrometric area)	5.71	5.71	5.71	-
Zn background (hydrometric area)	No HA default	No HA default	No HA default	-

MRL: Minimum reporting limit.
a: Highlighted cells are "significant" (p less than 0.05) compliance failures before bioavailability correction (greater than 95 per cent confidence of failure).

The results of the chemical monitoring undertaken in the Clarach are summarised in Table 3.20 as either means with standard deviation (metals), or medians (physicochemical parameters). The results of the monitoring are consistent with the existing Environment Agency data on concentrations of dissolved Cu and total Zn. Several of the other metals monitored (Cd and Pb) also exceed concentrations that would result in an EQS failure. In the absence of suitable ABC monitoring points in the waterbody (inspection of Environment Agency Wales GIS layers identified multiple mining related features in all of the headwaters of the Clarach waterbody) ABCs from the adjacent Bow Street Brook waterbody were used for waterbody-specific ABCs.

Table 3.20 Summary of analytical chemistry results at Clarach operational monitoring points from field programme

Site Name (WIMS ID)	Rhydhir Uchaf (32296)	Peithyll near Dewi (35704)	Plas Gogerddan (35705)	Silo at Penrhyncoch (35702)	Stewi at Penrhyncoch (35703)	Penycefn (81223)	Silo at Penbont (35701)
DOC[a] mg l^{-1} C	1.35	1.84	1.19	0.99	1.59	3.54	0.91
pH[a]	7.57	7.24	7.39	-	-	7.27	-
Calcium[a] mg l^{-1}	8.95	11.85	7.65	7.34	7.40	11.45	6.78
Diss. Ag[b] ng l^{-1}	14.48 (3.89)	2.40 (1.48)	19.33 (3.74)	-	-	37.93 (6.68)	-
Diss. Cd[b] µg l^{-1}	0.22 (0.02)	<MRV	0.31 (0.01)	0.26 (0.03)	0.42 (0.05)	0.56 (0.06)	0.32 (0.04)
Diss. Cu[b] µg l^{-1}	3.12 (0.64)	0.81 (0.49)	4.12 (0.77)	9.81 (4.19)	1.56 (0.29)	1.97 (0.19)	6.40 (1.91)
Diss. Pb[b] µg l^{-1}	18.93 (5.64)	3.25 (1.90)	29.05 (7.57)	67.75 (14.14)	4.91 (0.79)	18.42 (5.20)	81.68 (22.49)
Diss. Ni[b] µg l^{-1}	0.66 (0.40)	0.69 (0.47)	0.60 (0.23)	1.30 (0.20)	0.45 (0.19)	1.20 (0.13)	1.39 (0.15)
Diss. Zn[b] µg l^{-1}	92.0 (6.02)	<MRV	132.83 (5.12)	124.18 (22.43)	153.0 (15.02)	288.33 (38.88)	155.67 (22.96)
Site-specific Zn background calculation (from Bow Street Brook – Headwaters to confluence with Clarach waterbody)							
Median complete dataset (ABC sites 1 – 5)			**2.5**				
Median lowest site (ABC site 1)			**2.5**				
Lowest value in dataset			**2.5**				

<MRV: less than the analytical minimum reporting value
a: median value of six samples. Results less than MRV were treated at half the MRV for calculation of medians.
b: mean and standard deviation of seven samples. Results less than MRV were treated at half the MRV for calculation of mean.

The effect of accounting for copper bioavailability during classification is summarised in Table 3.21. The site-specific PNEC derived from the simple bioavailability screening tool using hydrometric area default values for DOC and Ca would appear to have been marginally over stringent as site-specific data for DOC and Ca results in the waterbody achieving the EQS. The precaution of the copper screening tool is apparent when the site-specific PNECs derived from the screening tool and the Full BLM are compared, with the site-specific PNEC from the full BLM being approximately double that derived from the screening tool.

Table 3.21 Summary of copper site-specific PNEC values at Clarach operational monitoring points and waterbody median confidence of failure

Basis of site-specific PNEC	Site-specific PNEC ug l^{-1} dissolved Cu							
	32296	35704	35705	35702	35703	81223	35701	Median conf of failure[a]
WFD EQS	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.99
Bioavailability screening tool – Default DOC and Ca [hydrometric area]	5.42	-	5.66	5.69	-	-	-	0.89
Bioavailability screening tool – Site-specific DOC and Ca	4.55	4.42	2.10	5.53	5.56	13.57	2.08	0.001
Full BLM	7.39	6.54	5.53	8.19	7.87	16.73	4.85	0.000

a: red = "significant" EQS fail, orange = "reasonable" EQS, yellow = "marginal" EQS", green = EQS compliance

The effect of accounting for zinc bioavailability and ambient background concentrations is summarised in Table 3.22. Given the very high concentrations of zinc observed in the waterbody, accounting for the bioavailability of zinc in the Clarach waterbody has no effect on EQS compliance. The waterbody continues to “significantly fail” the Zn EQS under all bioavailability, ABC and site-specific (community based scenarios (observed or predicted ecology))quality targets. The site-specific quality target based on the observed macroinvertebrate community found at each of the monitoring sites in the waterbody can be used to derive a target consistent with “no further deterioration”. These no further deterioration standards range from 12.2 to 14.9 µg l^{-1} across the monitoring sites in the waterbody and would continue to offer a significant challenge to the Environment Agency in terms of compliance.

Table 3.22 Summary of zinc site-specific PNEC values at Clarach operational monitoring points and waterbody median confidence of failure

Basis of site-specific PNEC	Site-specific PNEC ug l^{-1} dissolved Zn							
	32296	35704	35705	35702	35703	81223	35701	Median conf of failure[b]
WFD EQS	8.0	8.0	8.0	8.0	8.0	8.0	8.0	0.99
Bioavailability screening tool – Default DOC and Ca [waterbody] + generic national ABC (1.1 ug l^{-1})	12.0	-	12.0	12.0	-	-	-	0.99
Bioavailability screening tool – Site-specific DOC and Ca + generic national ABC (1.1 ug l^{-1})	12.0	12.0	12.0	12.0	12.0	13.2	12.0	0.99
Full BLM + generic national ABC (1.1 ug l^{-1})	7.46	8.29	7.13	6.81	-	10.24	6.54	0.99
Full BLM + waterbody-specific ABC (2.5 ug l^{-1})	8.86	9.69	8.53	8.21	-	11.64	7.94	0.99
Site specific (community-based) quality target (predicted fauna) + generic national ABC (1.1 ug l^{-1})	No Ecology data	13.22	11.25	7.87	No Ecology data	No Ecology data	8.99	0.99
Site specific (community-based) quality targetcommunity standard (predicted fauna) + waterbody-specific ABC (2.5 ug l^{-1})	No Ecology data	14.62	12.65	9.27	No Ecology data	No Ecology data	10.39	0.99
Site specific (community-based) quality target (observed fauna) + generic national ABC (1.1 ug l^{-1})	No Ecology data	12.4	12.1	13.5	No Ecology data	No Ecology data	10.8	0.99
Site specific (community-based) quality target (observed fauna)+ waterbody-specific ABC (2.5 ug l^{-1})	No Ecology data	13.8	13.5	14.9	No Ecology data	No Ecology data	12.2	0.99

a: WFD EQS compliance under the first WFD classification based on total zinc concentrations.
b: red = “significant” EQS fail, orange = “reasonable” EQS, yellow = “marginal” EQS”, green = EQS compliance

4 Discussion

Rationalising chemical and ecological measures of environmental quality is not a pre-requisite of the scheme used for WFD surface water classification in Great Britain. The adoption of the “one out, all out” principle is a pragmatic, precautionary, approach to situations where either EQS or ecological measures of environmental quality are not considered to have achieved good status.

Failure of one or more biological quality elements (BQE) to achieve good status in the absence of a corresponding chemical EQS failure, particularly the benthic macroinvertebrate BQE which is considered to be sensitive to toxic pressure, can readily be interpreted as the consequence of an incomplete understanding of the chemical pressures acting in a waterbody (many hundreds of chemicals present, many without EQS), or possibly the consequence of the cumulative pressure of different chemicals, each at a concentrations below their respective threshold for adverse toxicological effects when considered in isolation (mixture, or cocktail effects) affecting ecological community structure. However, failure of chemical EQS, which automatically results in a failure to achieve good surface water status, in a waterbody where all BQEs are considered to be at good or high status is more problematic to resolve conceptually. A possible explanation that is widely cited is that the BQEs developed for WFD classification are not sufficiently sensitive to detect all the perturbations on ecological community structure and function. This may be true, but if a perturbation is such that it cannot be detected by the reference-based BQEs used for WFD surface water classification, is it sufficiently significant that it justifies a regulatory intervention? In the case of metals, and especially in the instance of abandoned non-coal mines where exposures have been elevated for potentially hundreds of years, is there an environmental impact as a consequence of metal exposure? Adaptation, acclimation (Environment Agency 2009e, Crane and Maltby 1991, Bossuyt and Jannsen 2005) and bioavailability mechanisms (Pagenkpof 1983, Environment Agency 2009a-d,f) operating within a waterbody may be ameliorating the impact of elevated metals exposure that are occurring in excess of an EQS. Critically, where programmes of measures are required, potentially at great cost, will achieving the failed EQS result in an environmental improvement, if an environmental impact cannot be detected in the first instance?

Demonstrating the adaptation or acclimation of the native fauna within a waterbody to metal concentrations above an EQS, relative to the organisms used to derive the EQS in the laboratory, even within waterbodies suspected or known to be impacted by abandoned non-coal mines is likely to be impractical, if not impossible, on an operational basis within the Environment Agency (or any European Regulator). Accounting for metal bioavailability, which may not be the only mechanism protecting a fauna from adverse effects in a waterbody, is likely to offer the most pragmatic means to rationalise chemical and biological measures of harm within a waterbody.

Accounting for the bioavailability of dissolved copper using either the simplified bioavailability screening tool or the full Biotic Ligand Model was particularly effective at achieving the EQS within mining affected waterbodies that were meeting Good status in terms of biology, but exceeding the current hardness banded EQS. As the full chronic copper BLM is available as a stand alone software package (similar to an excel spreadsheet) and is less precautionary than the copper screening tool where sufficient information on the required physicochemical input parameters are available it could be readily used at higher tiers of risk assessment, where residual risks are not negated by use of the simple copper bioavailability screening tool.

Accounting for the bioavailability of zinc was less successful in rationalising the biological response within waterbodies. In both the Cober and Bow Street Brook waterbodies accounting for the bioavailability of zinc, despite the use of Ambient Background Concentrations, did not result in EQS compliance, despite the ecology being at Good Status. It is possible that adaptation and acclimation mechanisms (which are not accounted for in EQS development) are more prevalent for zinc than copper, despite both these metals being essential elements and it may be possible to investigate this further.

A methodology to derive site-specific quality targets for zinc based on either the predicted or observed macroinvertebrate ecology was attempted as part of this project, and should be considered to have been at least partially successful (as compliance in the Cober waterbody was improved on the basis of these standards). The methodology is based on the understanding that, unlike EQS, "sensitive-species" will not be present at every site, so any standard applied need not be as stringent to adequately protect the native ecology. Additional development and validation of the proposed methodology is necessary before these targets can be applied operationally (greater detail and discussion is provided in Appendix G). In addition to methodology development further consideration as to what these "alternative" targets constitute, in terms of their relationship with EQS, is required. For example, is compliance with a site-specific quality target based on local ecology equivalent to an EQS (allowing a waterbody to achieve Good status), or would these targets form part of a package of "alternative objectives" for a waterbody, where it is considered not to have achieved Good status. Also of note, and of specific relevance to the Bow Street Brook and Clarach waterbodies, is the utility of the methodology for identifying waterbodies as "priority for intervention" in terms of their low potential to achieve any bioavailability based EQS as a consequence of the failure of EQS despite the use of a high DOC concentration in bioavailability screening tools (95^{th} percentile of DOC observed in Great Britain). Both the Bow Street Brook and Clarach were identified as "priority for intervention" waterbodies. The observation that EQS compliance in these waterbodies was not improved after considering bioavailability supports the use of the "priority for intervention" criteria to identify waterbodies where accounting for bioavailability will have limited success. Equally, waterbodies in Scenario 3 were identified as "optimistic" as a marginal increase in the available DOC would result in EQS compliance. It was not possible to investigate any of these waterbodies further, although it may be useful for the Environment Agency to prioritise the collection of site-specific physicochemical data (particularly DOC) from these waterbodies.

Another important observation involved the behaviour of the simplified zinc screening tool compared to the full zinc BLM developed for this project. The full BLM consistently derived site-specific PNECs below the generic zinc PNEC of 10.9 µg l^{-1} dissolved zinc reported by the zinc screening tool. The generic PNEC is intended to be protective of "sensitive" (that is, high zinc bioavailability) water physicochemistry and was derived as the 5^{th} percentile of site-specific PNECs derived in the most Zn sensitive region of England and Wales (Environment Agency North West region). As such, not all sites will be protected by this generic PNEC. It is possible that, by co-incidence, the waterbodies selected for the field programme of this project were all within the 5 per cent of sites that would not be protected by the generic PNEC. It is also possible, and more likely, that the changes to the ecotoxicity dataset incorporated in the full Zn BLM used in this project (which are consistent with the ecotoxicity dataset used for Zn EQS derivation) resulted in the full BLM returning lower site-specific PNECs than the Zn screening tool, which was developed using a slightly different underpinning ecotoxicity dataset. The Environment Agency is undertaking ongoing research to finalise and embed the bioavailability screening tools into routine analytical operations. The findings of this project have already been used to refine future versions of the Environment Agency zinc bioavailability screening tool.

The effect of accounting for nickel bioavailability in the classification of waterbodies affected by abandoned non-coal mines was difficult to resolve with any confidence.

Only a limited proportion of waterbodies (16 per cent) included in the screening assessment reported data for dissolved nickel. The revision of the Annex X EQS at the European level also confounded the interpretation of the effect of accounting for bioavailability as the generic PNEC used in the bioavailability screening tool is intended to be in line with the proposed revised EU EQS (which will be between 2 and 4 µg l^{-1}) rather than the existing EQS (20 ug l^{-1}). Accounting for nickel bioavailability in this project resulted in a similar number of EQS exceedance across the screening assessment database to applying the existing Annex X EQS. As the revised EQS for nickel is likely to be an order of magnitude lower than the existing Annex X EQS accounting for bioavailability is likely to be a useful tool for preventing additional Ni EQS failures in subsequent rounds of WFD classification. None of the waterbodies included in the field programme reported data for nickel. The additional monitoring undertaken for the field programmes did not identify nickel EQS failures where none was apparent from the WFD classification data.

Risks from aluminium in waterbodies affected by abandoned non-coal mines were not specifically investigated as part of this project despite being identified as potentially important in previous research linking metals exposures to ecological effects (Environment Agency 2008). Aluminium s currently not considered a specific pollutant in Great Britain and, as such is not a component of WFD classification. Scenario 2 waterbodies, where the effects of aluminium would be most important, were considered to be outside the project’s scope.

5 Conclusions

1. Accounting for the bioavailability of copper in waterbodies affected by abandoned non-coal mines using simple screening tools reduces the face-value EQS failure rate by about 66 per cent, and the "significant" EQS failure rate by greater than 70 per cent.
2. Accounting for the bioavailability of Zn and Ni as well as Cu using simple screening tools does not affect the overall burden of EQS failure across waterbodies impacted by abandoned non-coal mines, but reduces the proportion of mining impacted waterbodies affected by one or more "significant" EQS failures from 54 to 36 per cent.
3. An assessment of the risk posed by mixtures of metals can be readily conducted on compliance data expressed as "confidence of failure". However, the lack of metals data in the majority of waterbodies included in the WFD surface water classification limited the useful application of this approach.
4. Collection of site-specific physicochemical data can be used to refine the predictions of bioavailability screening tools made using conservative defaults, and are likely to result in improved compliance (particularly for the copper EQS).
5. The full BLM for copper provides less precautionary estimates of site-specific PNECs than the simple Cu bioavailability screening tool and could be readily applied by the Environment Agency to refine EQS compliance where risks remain after application of the bioavailability screening tool.
6. Waterbody-specific ambient background concentrations (ABC) for zinc can be estimated by sampling in the headwaters of waterbodies, but care must be taken to ensure that these estimates are reliable since records of abandoned mine locations are incomplete.
7. Site-specific quality targets for zinc, based on the macroinvertebrate ecology predicted or observed at a site, can be derived and can result in improved compliance compared to the use of both conventional and bioavailability-based EQS. In addition to zinc, the approach is likely to be applicable to other metals and possibly other types of chemical stressors (for example, pesticides). However, the methodology for deriving site-specific quality targets requires additional development and validation before they can be robustly applied during surface water classification.
8. Guidance for Environment Agency staff on the appropriate application of bioavailability-based tools in waterbodies affected by abandoned non-coal mines has been produced (Appendix H).

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Appendix A – Pre-selection of NoCAM water bodies

Table A.1 Pre-selection of 470 NoCAM water bodies for screening assessment

WBID	Name	Region	Area	Catchment	RBD name	NoCAM impact status	Criteria for inclusion in initial screen (applied from left to right)				WB included in initial screening assessment
							WFD classification data?	Non-metal pressures?	Number of metal determinands with data	Bioavailability screening tool input parameters?	
GB110066060040		0	0	Conwy and Clwyd		PI	TRUE	FALSE	0	N/A	FALSE
GB212074070210		0	0	South West Lakes		I	FALSE	N/A	N/A	N/A	FALSE
GB105032045140	Ise	1	3	Nene	Anglian	PI	TRUE	FALSE	1	FALSE	FALSE
GB111067056870	Dolfechlas Brook	8	24	Middle Dee	Dee	PI	TRUE	TRUE	N/A	N/A	FALSE
GB111067052173	Alyn - Hope to confluence with Dee	8	24	Middle Dee	Dee	I	TRUE	TRUE	N/A	N/A	FALSE
GB111067052172	Alyn - Leadmill to Hope, US STW	8	24	Middle Dee	Dee	I	TRUE	TRUE	N/A	N/A	FALSE
GB111067052171	Alyn - Rhydymwyn to Leadmill	8	24	Middle Dee	Dee	I	TRUE	FALSE	5	TRUE	TRUE
GB111067051810	Alyn - Upper River above Rhydymwyn	8	24	Middle Dee	Dee	I	TRUE	FALSE	5	TRUE	TRUE
GB111067051800	Terrig	8	24	Middle Dee	Dee	PI	TRUE	FALSE	2	TRUE	TRUE
GB111067051770	Cegidog	8	24	Middle Dee	Dee	PI	TRUE	FALSE	3	TRUE	TRUE
GB111067056900	Lead Brook	8	24	Tidal Dee	Dee	PI	TRUE	FALSE	0	N/A	FALSE
GB111067057060	Y Garth	8	24	Tidal Dee	Dee	I	TRUE	FALSE	2	TRUE	TRUE
GB111067052060	Dee - Ceiriog to Alwen	8	24	Upper Dee	Dee	PI	TRUE	FALSE	2	TRUE	TRUE
GB111067051970	Dee - Outlet Bala Lake to Inlet Bala Lake	8	24	Upper Dee	Dee	PI	TRUE	FALSE	2	TRUE	TRUE
GB111067051940	Trystion	8	24	Upper Dee	Dee	PI	TRUE	FALSE	2	TRUE	TRUE
GB111067051920	Tryweryn - Mynach to Hesgin	8	24	Upper Dee	Dee	PI	TRUE	FALSE	0	N/A	FALSE
GB111067051910	Ceiriog - Confluence Dee to Teirw	8	24	Upper Dee	Dee	PI	TRUE	FALSE	2	TRUE	TRUE
GB111067051860	Hirnant	8	24	Upper Dee	Dee	PI	TRUE	FALSE	2	TRUE	TRUE
GB111067051750	Alwen - Ceirw To Brenig	8	24	Upper Dee	Dee	I	TRUE	FALSE	2	TRUE	TRUE
GB111067051720	Clywedog - Above Black Brook	8	24	Upper Dee	Dee	I	TRUE	FALSE	3	TRUE	TRUE
GB111067051700	Black Brook	8	24	Upper Dee	Dee	I	TRUE	FALSE	2	TRUE	TRUE
GB111067046420	Twrch	8	24	Upper Dee	Dee	I	TRUE	FALSE	2	TRUE	TRUE
GB104027063031	Aire from Eshton Beck to Gill Beck (Baildon)	3	34	Aire and Calder	Humber	I	TRUE	TRUE	N/A	N/A	FALSE
GB104027063032	Aire from Esholt STW to River Calder	3	34	Aire and Calder	Humber	I	TRUE	TRUE	N/A	N/A	FALSE
GB104028053460	River Lathkill from R Bradford to R Wye	2	30	Derbyshire Derwent	Humber	PI	TRUE	FALSE	2	FALSE	FALSE
GB104028057820	River Wye from Monk's Dale to R Derwent	2	30	Derbyshire Derwent	Humber	I	TRUE	FALSE	2	FALSE	FALSE
GB104028057850	River Noe from Peakshole Water to R Derwent	2	30	Derbyshire Derwent	Humber	PI	TRUE	FALSE	2	FALSE	FALSE
GB104028057880	River Derwent from R Ashop to R Wye	2	30	Derbyshire Derwent	Humber	I	TRUE	FALSE	4	TRUE	TRUE
GB104028057890	River Noe from source to Peakshole Water	2	30	Derbyshire Derwent	Humber	I	TRUE	FALSE	2	FALSE	FALSE
GB104028	River Ecclesborne	2	30	Derbyshire	Humber	I	TRUE	TRUE	N/A	N/A	FALSE

WBID	Name	Region	Area	Catchment	RBD name	NoCAM impact status	Criteria for inclusion in initial screen (applied from left to right)				WB included in initial screening assessment
							WFD classification data?	Non-metal pressures?	Number of metal determinands with data	Bioavailability screening tool input parameters?	
052720	Catchment (Trib of R Derwent)			Derwent							
GB104028 058450	River Lathkill from source to R Bradford	2	30	Derbyshire Derwent	Humber	I	TRUE	TRUE	N/A	N/A	FALSE
GB104028 052330	River Amber from Alfreton Brook to R Derwent	2	30	Derbyshire Derwent	Humber	I	TRUE	TRUE	N/A	N/A	FALSE
GB104028 052380	River Amber from source to Press Brook	2	30	Derbyshire Derwent	Humber	I	TRUE	FALSE	5	TRUE	TRUE
GB104027 057370	River Loxley from Strines Dyke to Rivelin	3	34	Don and Rother	Humber	I	TRUE	FALSE	3	TRUE	TRUE
GB104028 052890	River Manifold from Warslow Brook to River Hamps	2	29	Dove	Humber	PI	TRUE	FALSE	3	FALSE	FALSE
GB104028 052920	River Manifold from Blake Brook to Warslow Brook	2	29	Dove	Humber	PI	TRUE	FALSE	2	FALSE	FALSE
GB104028 053340	Lyme Brook Catchment (Trib of Trent)	2	29	Staffordshire Trent Valley	Humber	I	TRUE	FALSE	3	FALSE	FALSE
GB104027 069590	River Swale/Ouse from Wiske to Naburn	3	34	Swale, Ure, Nidd & Upper Ouse	Humber	PI	TRUE	TRUE	N/A	N/A	FALSE
GB104027 068293	River Nidd from Howstean Beck to Birstwith	3	34	Swale, Ure, Nidd & Upper Ouse	Humber	I	TRUE	FALSE	2	TRUE	TRUE
GB104027 068300	Howstean Beck from source to River Nidd	3	34	Swale, Ure, Nidd & Upper Ouse	Humber	PI	FALSE	N/A	N/A	N/A	FALSE
GB104027 068380	River Nidd from source to Howstean Beck	3	34	Swale, Ure, Nidd & Upper Ouse	Humber	PI	FALSE	N/A	N/A	N/A	FALSE
GB104027 063890	River Nidd from source to Howstean Beck	3	34	Swale, Ure, Nidd & Upper Ouse	Humber	PI	TRUE	FALSE	0	N/A	FALSE
GB104027 068790	Birdforth/Green's Bks Catch (Trib of Swale)	3	34	Swale, Ure, Nidd & Upper Ouse	Humber	PI	TRUE	FALSE	0	N/A	FALSE
GB104027 068820	Cod Beck from Spital Beck to River Swale	3	34	Swale, Ure, Nidd & Upper Ouse	Humber	PI	TRUE	FALSE	2	TRUE	TRUE
GB104027 069080	Barney Bk/Hard Level Gill from source to R Swale	3	34	Swale, Ure, Nidd & Upper Ouse	Humber	I	TRUE	FALSE	0	N/A	FALSE
GB104027 064080	Fir Beck/Blands Beck Catchment (Trib of Wharfe)	3	34	Wharfe and Lower Ouse	Humber	PI	FALSE	N/A	N/A	N/A	FALSE
GB104027 064090	Linton Beck Catchment (Trib of Wharfe)	3	34	Wharfe and Lower Ouse	Humber	PI	TRUE	FALSE	2	TRUE	TRUE
GB104027 064120	Barben Beck/River Dibb Catchment (Trib of Wharfe)	3	34	Wharfe and Lower Ouse	Humber	PI	TRUE	FALSE	2	TRUE	TRUE
GB104027 064180	River Skirfare from Cowside Beck to River Wharfe	3	34	Wharfe and Lower Ouse	Humber	PI	TRUE	FALSE	2	TRUE	TRUE
GB104027 064190	Hebden Beck Catchment (Trib of Wharfe)	3	34	Wharfe and Lower Ouse	Humber	PI	TRUE	FALSE	2	TRUE	TRUE
GB104027 064252	Wharfe Barben Beck/River Dibb to River Washburn	3	34	Wharfe and Lower Ouse	Humber	PI	TRUE	FALSE	3	TRUE	TRUE
GB104027 064253	Wharfe Ffom Park Gill Bk to Barben Beck/River Dibb	3	34	Wharfe and Lower Ouse	Humber	I	TRUE	FALSE	2	TRUE	TRUE
GB104027 069220	Park Gill Beck from source to River Wharfe	3	34	Wharfe and Lower Ouse	Humber	PI	TRUE	TRUE	N/A	N/A	FALSE
GB104027 069290	Wharfe from Oughtershaw Beck to Park Gill Beck	3	34	Wharfe and Lower Ouse	Humber	PI	FALSE	N/A	N/A	N/A	FALSE
GB112075 070350	River Cocker	4	11	Derwent (NW)	North West	I	TRUE	FALSE	2	TRUE	TRUE
GB112075 070410	River Derwent	4	11	Derwent (NW)	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB112075 070420	Naddle Beck	4	11	Derwent (NW)	North West	PI	FALSE	N/A	N/A	N/A	FALSE
GB112075 070430	St John's Beck	4	11	Derwent (NW)	North West	PI	TRUE	FALSE	0	N/A	FALSE
GB112075 070440	Newlands Beck	4	11	Derwent (NW)	North West	I	TRUE	FALSE	2	TRUE	TRUE

WBID	Name	Region	Area	Catchment	RBD name	NoC AM impact status	Criteria for inclusion in initial screen (applied from left to right)				WB included in initial screening assessment
							WFD classification data?	Non-metal pressures?	Number of metal determinands with data	Bioavailability screening tool input parameters?	
GB112075070460	Glenderamackin (Greta)	4	11	Derwent (NW)	North West	I	TRUE	FALSE	2	TRUE	TRUE
GB112075070490	Glenderamackin U/S Troutbeck	4	11	Derwent (NW)	North West	PI	TRUE	FALSE	0	N/A	FALSE
GB112075070500	Wythop Beck	4	11	Derwent (NW)	North West	PI	TRUE	FALSE	0	N/A	FALSE
GB112075070470	Glenderamackin D/S Trout Beck	4	11	Derwent (NW)	North West	PI	TRUE	FALSE	0	N/A	FALSE
GB112075070520	River Derwent	4	11	Derwent (NW)	North West	I	TRUE	TRUE	N/A	N/A	FALSE
GB112075070530	Dash Beck	4	11	Derwent (NW)	North West	PI	TRUE	FALSE	0	N/A	FALSE
GB112075073561	River Derwent Us Bassenthwaite Lake	4	11	Derwent (NW)	North West	I	TRUE	FALSE	4	TRUE	TRUE
GB112075073562	River Derwent Ds Bassenthwaite Lake	4	11	Derwent (NW)	North West	I	TRUE	FALSE	2	TRUE	TRUE
GB112075073570	Broughton Beck	4	11	Derwent (NW)	North West	I	TRUE	FALSE	2	TRUE	TRUE
GB112070064952	River Yarrow Ds Big Lodge Water	4	11	Douglas	North West	PI	TRUE	FALSE	6	TRUE	TRUE
GB112070064951	River Yarrow Us Big Lodge Water	4	11	Douglas	North West	PI	TRUE	FALSE	5	TRUE	TRUE
GB112073071390	River Kent	4	11	Kent/Leven	North West	PI	TRUE	FALSE	0	N/A	FALSE
GB112073071130	Trout Beck	4	11	Kent/Leven	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB112073071140	River Rothay	4	11	Kent/Leven	North West	PI	TRUE	FALSE	6	TRUE	TRUE
GB112073071120	Great Langdale Beck	4	11	Kent/Leven	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB112073071190	River Crake	4	11	Kent/Leven	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB112073071210	Yewdale/Church Beck	4	11	Kent/Leven	North West	I	TRUE	FALSE	2	TRUE	TRUE
GB112073071380	River Kent	4	11	Kent/Leven	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB112073071410	River Gowan	4	11	Kent/Leven	North West	PI	TRUE	FALSE	0	N/A	FALSE
GB112073071420	River Leven	4	11	Kent/Leven	North West	PI	TRUE	FALSE	7	TRUE	TRUE
GB112073071430	River Sprint	4	11	Kent/Leven	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB112073071450	River Brathay	4	11	Kent/Leven	North West	PI	FALSE	N/A	N/A	N/A	FALSE
GB112071065420	Whitendale River	4	11	Ribble	North West	PI	TRUE	FALSE	0	N/A	FALSE
GB112071065400	River Brennand	4	11	Ribble	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB112071065140	Sabden Brook	4	11	Ribble	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB112071065600	Long Preston Beck	4	11	Ribble	North West	PI	FALSE	N/A	N/A	N/A	FALSE
GB112071065550	Holden Beck	4	11	Ribble	North West	PI	TRUE	FALSE	0	N/A	FALSE
GB112071065530	Swanside Beck	4	11	Ribble	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB112071065510	Mearley Brook	4	11	Ribble	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB112074069720	River Annas	4	11	South West Lakes	North West	I	TRUE	FALSE	2	TRUE	TRUE
GB112074069830	Haverigg Pool	4	11	South West Lakes	North West	I	TRUE	FALSE	2	TRUE	TRUE
GB112074070030	River Keekle (Upper)	4	11	South West Lakes	North West	I	TRUE	FALSE	6	TRUE	TRUE
GB112074070040	Lowca Beck	4	11	South West Lakes	North West	I	TRUE	FALSE	0	N/A	FALSE
GB112069061330	Mobberley Brook	4	12	Upper Mersey	North West	I	TRUE	TRUE	N/A	N/A	FALSE
GB112069061320	River Bollin (source to Dean)	4	12	Upper Mersey	North West	I	TRUE	FALSE	2	TRUE	TRUE
GB112072066240	Tarnbrook Wyre	4	11	Wyre	North West	PI	TRUE	FALSE	2	TRUE	TRUE
GB103022076980	Wansbeck from Hart Burn to Font	3	35	Northumberland Rivers	Northumbria	PI	FALSE	N/A	N/A	N/A	FALSE
GB103022076770	Alwin Catchment (Trib of Coquet)	3	35	Northumberland Rivers	Northumbria	PI	TRUE	FALSE	2	TRUE	TRUE
GB103022076540	Forest Burn Catchment (Trib of	3	35	Northumberland Rivers	Northumbria	PI	FALSE	N/A	N/A	N/A	FALSE

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	Coquet)										
GB103022076510	Font from source to Wansbeck	3	35	Northumberland Rivers	Northumbria	PI	TRUE	TRUE	N/A	N/A	FALSE
GB103025076080	Tees from Trout Beck to Maize Beck	3	35	Tees	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103025071960	Saltburn Gill Catch Trib of North Sea	3	35	Tees	Northumbria	I	TRUE	TRUE	N/A	N/A	FALSE
GB103025071950	Kilton Beck from Middle Gill Beck to North Sea	3	35	Tees	Northumbria	I	TRUE	FALSE	3	TRUE	TRUE
GB103025071940	Middle Gill Beck From Source To Kilton Beck	3	35	Tees	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103025071930	Kilton Beck from Mill Beck to Middle Gill Beck	3	35	Tees	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103025071880	Leven from Tame to River Tees	3	35	Tees	Northumbria	PI	TRUE	TRUE	N/A	N/A	FALSE
GB103025072440	Maize Beck from source to River Tees	3	35	Tees	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103025072510	River Tees from Maize Beck to River Greta	3	35	Tees	Northumbria	I	TRUE	FALSE	3	TRUE	TRUE
GB103025072500	Bowlees Beck Catchment (Trib of Tees)	3	35	Tees	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103025072490	Eggleston Burn Catchment (Trib of Tees)	3	35	Tees	Northumbria	I	TRUE	FALSE	3	TRUE	TRUE
GB103025072480	Hudeshope Beck Catchment (Trib of Tees)	3	35	Tees	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103025072470	Harwood Beck from Langdon Beck to River Tees	3	35	Tees	Northumbria	PI	TRUE	FALSE	2	TRUE	TRUE
GB103025071970	Skelton Beck Catch (Saltburn) Trib of North Sea	3	35	Tees	Northumbria	I	TRUE	TRUE	N/A	N/A	FALSE
GB103023075020	Hareshaw Burn Catch (Trib of N Tyne)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023074890	Barrasford Burn Catchment (Trib of N Tyne)	3	35	Tyne	Northumbria	I	TRUE	FALSE	0	N/A	FALSE
GB103023074870	Erring Burn Catchment (Trib of Tyne)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023074810	Simon Burn from Crook Burn to N Tyne	3	35	Tyne	Northumbria	PI	TRUE	FALSE	2	TRUE	TRUE
GB103023074790	Derwent from Burnhope Burn to River Tyne	3	35	Tyne	Northumbria	I	TRUE	TRUE	N/A	N/A	FALSE
GB103023074770	Derwent from Nookton Burn to Burnhope Burn	3	35	Tyne	Northumbria	I	TRUE	FALSE	2	TRUE	TRUE
GB103023074760	Burnhope Burn from source to River Derwent	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023074750	Derwent from source to Nookton Burn	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023074740	Horsleyhope Burn Catchment (Trib of Derwent)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	3	TRUE	TRUE
GB103023074710	Allen from source to West Allen	3	35	Tyne	Northumbria	I	TRUE	FALSE	2	TRUE	TRUE
GB103023074730	Nookton Burn from source to River Derwent	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023074720	Allen from West Allen to South Tyne	3	35	Tyne	Northumbria	I	TRUE	FALSE	2	TRUE	TRUE
GB103023074700	West Allen from Wellhope Burn to Allen	3	35	Tyne	Northumbria	I	TRUE	FALSE	2	TRUE	TRUE
GB103023074680	West Allen from source to Wellhope Burn	3	35	Tyne	Northumbria	I	TRUE	FALSE	2	TRUE	TRUE
GB103023074670	Wellhope Burn Catchment (Trib of West Allen)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE

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GB103023075710	South Tyne from Allen to North Tyne	3	35	Tyne	Northumbria	I	TRUE	TRUE	N/A	N/A	FALSE
GB103023075700	Stanley Burn Catchment (Trib of Tyne)	3	35	Tyne	Northumbria	I	FALSE	N/A	N/A	N/A	FALSE
GB103023075650	March Burn Catchment (Trib of Tyne)	3	35	Tyne	Northumbria	PI	TRUE	TRUE	N/A	N/A	FALSE
GB103023075640	Stocksfield Burn Catchment (Trib of Tyne)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	2	TRUE	TRUE
GB103023075801	Tyne from Watersmeet to tidal limit	3	35	Tyne	Northumbria	I	TRUE	FALSE	7	TRUE	TRUE
GB103023075600	Devils Water from source to Tyne	3	35	Tyne	Northumbria	I	FALSE	N/A	N/A	N/A	FALSE
GB103023075802	N Tyne from Barrasford to S Tyne Confluence	3	35	Tyne	Northumbria	I	TRUE	TRUE	N/A	N/A	FALSE
GB103023075790	Horsley to Heddon on the wall area (Tyne N Bank)	3	35	Tyne	Northumbria	PI	FALSE	N/A	N/A	N/A	FALSE
GB103023075730	Red Burn (Trib of Tyne)	3	35	Tyne	Northumbria	I	TRUE	FALSE	1	TRUE	TRUE
GB103023075560	Newbrough Burn Catchment (Trib of South Tyne)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023075550	Honeycrook Burn Catchment (Trib of S Tyne)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023075530	South Tyne from Black Burn to Allen	3	35	Tyne	Northumbria	I	TRUE	FALSE	3	TRUE	TRUE
GB103023075440	Knar Burn Catchment (Trib of South Tyne)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023075430	Gilderdale Burn Catchment (Trib of South Tyne)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023075420	Nent from source to South Tyne	3	35	Tyne	Northumbria	I	TRUE	FALSE	2	TRUE	TRUE
GB103023075410	Black Burn from Aglionby Becksouth Tyne	3	35	Tyne	Northumbria	PI	TRUE	FALSE	2	TRUE	TRUE
GB103023075400	South Tyne from Cross Gill to Black Burn (Aleson)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023075380	South Tyne from source to Cross Gill	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023075360	Cross Gill Catchment (Trib of South Tyne)	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103023075150	Tarret Burn	3	35	Tyne	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103024077460	Wear from Swinhope to Browney	3	35	Wear	Northumbria	I	TRUE	FALSE	4	TRUE	TRUE
GB103024077590	Twizell Burn from source to Cong Burn	3	35	Wear	Northumbria	I	TRUE	TRUE	N/A	N/A	FALSE
GB103024077530	Rookhope Burn from source to Wear	3	35	Wear	Northumbria	I	TRUE	FALSE	2	TRUE	TRUE
GB103024077520	Waskerley Beck from source to Wear	3	35	Wear	Northumbria	I	TRUE	FALSE	3	TRUE	TRUE
GB103024077510	Stanhope Burn from source to Wear	3	35	Wear	Northumbria	PI	TRUE	FALSE	2	TRUE	TRUE
GB103024077500	Kilhope Burn from source to Burnhope Burn	3	35	Wear	Northumbria	I	TRUE	FALSE	2	TRUE	TRUE
GB103024077480	Middlehope Burn from source to Wear	3	35	Wear	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103024077430	Burnhope Burn from source to Kilhope Burn	3	35	Wear	Northumbria	I	TRUE	FALSE	2	TRUE	TRUE
GB103024077440	Wear from Ireshope to Middlehope Burn	3	35	Wear	Northumbria	I	TRUE	FALSE	3	TRUE	TRUE
GB103024077400	Wear from Middlehope to Swinhope Burn	3	35	Wear	Northumbria	PI	TRUE	FALSE	2	TRUE	TRUE
GB103024077380	Westernhope Burn from source to Wear	3	35	Wear	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103024077370	Swinhope Burn from source to Wear	3	35	Wear	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE

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GB103024077360	Bollihope Burn from source to Wear	3	35	Wear	Northumbria	I	TRUE	FALSE	2	TRUE	TRUE
GB103024077340	Harthorpe Beck (Trib of Bedburn Beck)	3	35	Wear	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB103024077310	Browney from source to Pan Burn	3	35	Wear	Northumbria	PI	TRUE	FALSE	0	N/A	FALSE
GB109053027370	R Avon (Brist) - Conf Semington Bk to Netham Dam	6	28	Bristol Avon & North Somerset Streams	Severn	I	TRUE	TRUE	N/A	N/A	FALSE
GB109053027440	R Avon (Brist) Conf R Marden to Conf Semington Bk	6	28	Bristol Avon & North Somerset Streams	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109053021850	R Chew - Source to Conf Winford Bk	6	28	Bristol Avon & North Somerset Streams	Severn	I	TRUE	TRUE	N/A	N/A	FALSE
GB109053021860	Midford Bk - Conf Cam Bk to Conf R Avon (Brist)	6	28	Bristol Avon & North Somerset Streams	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109053021920	Clackers Bk - Source to Conf R Avon (Brist)	6	28	Bristol Avon & North Somerset Streams	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109053021940	Unnamed Trib - Source to Conf R Avon (Brist)	6	28	Bristol Avon & North Somerset Streams	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109053021990	Whatley Bk - Source to Conf Mells R	6	28	Bristol Avon & North Somerset Streams	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109053022000	Nunney Bk - Source to Conf Mells R	6	28	Bristol Avon & North Somerset Streams	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109053022050	R Marden - Source to Conf Abberd Bk	6	28	Bristol Avon & North Somerset Streams	Severn	PI	TRUE	FALSE	4	TRUE	TRUE
GB109053022190	Poulshot Str - Source to Conf Summerham Bk	6	28	Bristol Avon & North Somerset Streams	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109053022200	Semington Bk-Milebourne Str to Conf R Avon (Brist)	6	28	Bristol Avon & North Somerset Streams	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109054049570	Rea Bk - Conf Minsterley Bk to Conf Pontesford Bk	2	31	Severn Uplands	Severn	I	TRUE	TRUE	N/A	N/A	FALSE
GB109054049500	Pontesford Bk - Source to Conf Rea Bk	2	31	Severn Uplands	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109054049480	Minsterley Bk - Source to Conf Rea Bk	2	31	Severn Uplands	Severn	I	TRUE	FALSE	4	TRUE	TRUE
GB109054049460	Unnamed Trib - Source to Conf Cound Bk	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054049440	Aylesford Bk - Source to Conf R Camlad	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054049410	Afon Rhiw (Conf N and S Arm) to Conf R Severn	2	31	Severn Uplands	Severn	I	TRUE	FALSE	5	TRUE	TRUE
GB109054049350	Afon Rhiw (S Arm) - Ty-Newydd to Dwyrhiew	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054049330	Bechan Bk - Source to Conf Highgate Bk	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054049300	Afon Carno - Source to Conf Afon Cwm-Llwyd	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054049310	R Severn - Conf Afon Dulas to Conf R Camlad	2	31	Severn Uplands	Severn	I	TRUE	FALSE	6	TRUE	TRUE
GB109054049230	Afon Trannon - Source to Nr Argoed	2	31	Severn Uplands	Severn	I	TRUE	TRUE	N/A	N/A	FALSE
GB109054049220	Nant Rhyd-Ros Lan - Source to Conf R Severn	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054055050	Afon Iwrch - Source to Conf Afon Tanat	2	31	Severn Uplands	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109054055040	Afon Rhaeadr - Source to Conf Afon Tanat	2	31	Severn Uplands	Severn	I	TRUE	TRUE	N/A	N/A	FALSE
GB109054050050	Afon Tanat - Conf Afon Rhaeadr to Conf	2	31	Severn Uplands	Severn	I	TRUE	TRUE	N/A	N/A	FALSE

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	Afon Vyrnwy										
GB109054050040	Afon Eirth - Source to Conf Afon Tanat	2	31	Severn Uplands	Severn	I	TRUE	FALSE	0	N/A	FALSE
GB109054049960	Afon Tanat - Conf Hirnant to Conf Afon Rhaeadr	2	31	Severn Uplands	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109054050000	Afon Tanat - Conf Afon Eirth to Conf Hirnant	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054049930	R Morda - Conf Unnamed Trib to Conf Afon Vyrnwy	2	31	Severn Uplands	Severn	PI	FALSE	N/A	N/A	N/A	FALSE
GB109054049920	Hirnant - Source to Conf Afon Tanat	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054049720	Afon Vyrnwy - Conf Afon Cownwy to Conf Afon Banwy	2	31	Severn Uplands	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109054044870	Afon Clwedog - Source to Conf Afon Lwyd	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054044580	Afon Dulas - Source to Conf R Severn	2	31	Severn Uplands	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109054044650	Nant Feinion - Source to Conf R Severn	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054044720	Afon Cerist - Source to Conf Afon Trannon	2	31	Severn Uplands	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109054044760	Afon Clywedog - Clywedog Dam to R Severn	2	31	Severn Uplands	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109054044790	R Severn - Source to Conf Afon Dulas	2	31	Severn Uplands	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109054044840	Afon Cerist - Conf Afon Trannon to Conf R Severn	2	31	Severn Uplands	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109054049860	Nant Fyllon - Source to Conf Afon Cain	2	31	Severn Uplands	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109054049850	Afon Banwy - Conf Afon Gam to Afon Vyrnwy	2	31	Severn Uplands	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109054049810	Afon Hirddu - Source to Lake Vyrnwy	2	31	Severn Uplands	Severn	I	TRUE	FALSE	0	N/A	FALSE
GB109054049800	Afon Vyrnwy - Conf Afon Tanat to Conf R Severn	2	31	Severn Uplands	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109054032640	Cannop Bk - Source to R Severn Estuary	2	31	Severn Vale	Severn	I	TRUE	FALSE	6	TRUE	TRUE
GB109054049910	Sundorne Bk - Source to Conf R Severn	2	31	Shropshire Middle Severn	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109057027280	Rhymney R - Conf Nant Cylla to Chapel Wood	8	25	South East Valleys	Severn	I	TRUE	TRUE	N/A	N/A	FALSE
GB109057027160	Nant Glandulas - Source to Conf Rhymney R	8	25	South East Valleys	Severn	PI	TRUE	FALSE	0	N/A	FALSE
GB109057027120	Ely R - Source to Conf Nant Mychydd	8	25	South East Valleys	Severn	I	TRUE	FALSE	5	TRUE	TRUE
GB109057027100	Nant Clun - Source to Conf Ely R	8	25	South East Valleys	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109057027080	Nant Dowlais - Source to Conf Ely R	8	25	South East Valleys	Severn	PI	TRUE	TRUE	N/A	N/A	FALSE
GB109055029670	Valley Bk - Source to Conf R Wye	8	25	Wye	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109055042360	R Wye - Source to Conf Afon Tarenig	8	25	Wye	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109055042350	Afon Tarenig - Source to Conf R Wye	8	25	Wye	Severn	PI	TRUE	FALSE	2	TRUE	TRUE
GB109055042340	Afon Bidno - Source to Conf R Wye	8	25	Wye	Severn	PI	TRUE	FALSE	2	TRUE	TRUE
GB109055042330	R Wye - Conf Afon Tarenig to Conf Afon Bidno	8	25	Wye	Severn	I	TRUE	TRUE	N/A	N/A	FALSE
GB109055042320	R Wye - Conf Afon Bidno to Conf Afon Marteg	8	25	Wye	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109055042310	Afon Marteg - Source to Conf R Wye	8	25	Wye	Severn	PI	TRUE	FALSE	2	TRUE	TRUE
GB109055042300	Afon Elan - Source to Pont Ar Elan	8	25	Wye	Severn	PI	TRUE	FALSE	2	TRUE	TRUE

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GB109055042280	R Wye - Conf Afon Marteg to Conf Afon Elan	8	25	Wye	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109055029730	Rudhall Bk - Source to Conf R Wye	8	25	Wye	Severn	PI	TRUE	FALSE	2	TRUE	TRUE
GB109055029700	Walford Bk - Source to Conf R Wye	8	25	Wye	Severn	PI	FALSE	N/A	N/A	N/A	FALSE
GB109055041910	R Irfon - Source to Conf Afon Gwesyn	8	25	Wye	Severn	I	TRUE	FALSE	2	TRUE	TRUE
GB109055037111	R Wye - Conf Walford Bk to Bigsweir Br	8	25	Wye	Severn	I	TRUE	FALSE	7	TRUE	TRUE
GB102076073992	River Petteril U/S M6	4	11	Eden and Esk	Solway Tweed	PI	TRUE	FALSE	2	TRUE	TRUE
GB102076073991	River Petteril D/S M6	4	11	Eden and Esk	Solway Tweed	PI	TRUE	TRUE	N/A	N/A	FALSE
GB102076073840	Raven Beck	4	11	Eden and Esk	Solway Tweed	PI	TRUE	FALSE	2	TRUE	TRUE
GB102076073810	Robberby Water	4	11	Eden and Esk	Solway Tweed	PI	TRUE	FALSE	0	N/A	FALSE
GB102076073790	Crowdundle Beck	4	11	Eden and Esk	Solway Tweed	PI	TRUE	FALSE	0	N/A	FALSE
GB102076073740	Whelpo (Cald) Beck	4	11	Eden and Esk	Solway Tweed	I	TRUE	FALSE	2	TRUE	TRUE
GB102076071000	Milburn Beck	4	11	Eden and Esk	Solway Tweed	PI	TRUE	FALSE	1	FALSE	FALSE
GB102076070770	Hilton Beck	4	11	Eden and Esk	Solway Tweed	I	TRUE	FALSE	0	N/A	FALSE
GB102076070740	Glenridding Beck	4	11	Eden and Esk	Solway Tweed	I	TRUE	TRUE	N/A	N/A	FALSE
GB108044009800	Hooke	6	28	Dorset	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108044009780	Frome Dorset (Upper)	6	28	Dorset	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108044009690	Frome Dorset (Lower) & Furzebrook Stream	6	28	Dorset	South West	PI	TRUE	FALSE	7	TRUE	TRUE
GB108044009680	Frome Dorset Trib (Compton Valence Stream)	6	28	Dorset	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108044009660	Tadnoll Brook (including Empool Bottom)	6	28	Dorset	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108044009650	Frome Dorset Trib (River Win)	6	28	Dorset	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108044009710	Cerne	6	28	Dorset	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108044009700	Sydling Water	6	28	Dorset	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108043016050	Stour (Middle)	6	28	Dorset	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108044010060	South Winterbourne	6	28	Dorset	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108045015100	Barle	6	27	East Devon	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108045015080	Brockey River	6	27	East Devon	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108045015060	Exe	6	27	East Devon	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108045015040	Iron Mill Stream	6	27	East Devon	South West	PI	FALSE	N/A	N/A	N/A	FALSE
GB108045014920	Madford River	6	27	East Devon	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108045014840	Axe	6	27	East Devon	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108045014830	Kit Brook	6	27	East Devon	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108045014820	Forton Brook	6	27	East Devon	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108045009200	Tale	6	27	East Devon	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108045009190	Wolf (Otter)	6	27	East Devon	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108045009180	Otter	6	27	East Devon	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108045009170	River Otter	6	27	East Devon	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108045009080	Jackmoor Brook	6	27	East Devon	South West	PI	TRUE	FALSE	0	N/A	FALSE

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GB108045009070	Creedy	6	27	East Devon	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108045008870	Axe	6	27	East Devon	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108045008850	Blackwater River	6	27	East Devon	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108045008820	Yarty	6	27	East Devon	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108043022390	Bourne	6	28	Hampshire Avon	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108048002320	River Seaton	6	27	North Cornwall, Seaton, Looe and Fowey	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048007630	Warleggan River	6	27	North Cornwall, Seaton, Looe and Fowey	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048007640	St. Neot River	6	27	North Cornwall, Seaton, Looe and Fowey	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108049000030	Lanivet Stream	6	27	North Cornwall, Seaton, Looe and Fowey	South West	I	TRUE	FALSE	0	N/A	FALSE
GB108049000040	St. Lawrence Stream	6	27	North Cornwall, Seaton, Looe and Fowey	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108049000050	Lower River Ruthern	6	27	North Cornwall, Seaton, Looe and Fowey	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108049000190	Lower River Camel	6	27	North Cornwall, Seaton, Looe and Fowey	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108049000210	Benny Stream	6	27	North Cornwall, Seaton, Looe and Fowey	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048001410	River Fowey (Warleggan to St Neot)	6	27	North Cornwall, Seaton, Looe and Fowey	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108048001420	Lower River Fowey	6	27	North Cornwall, Seaton, Looe and Fowey	South West	I	TRUE	FALSE	7	TRUE	TRUE
GB108048001450	Cardinham Water	6	27	North Cornwall, Seaton, Looe and Fowey	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108049006980	River Camel (De Lank to Stannon)	6	27	North Cornwall, Seaton, Looe and Fowey	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108049007030	De Lank River	6	27	North Cornwall, Seaton, Looe and Fowey	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108049007050	River Allen	6	27	North Cornwall, Seaton, Looe and Fowey	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108050008250	Taw	6	27	North Devon	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108050013950	Nadrid Water	6	27	North Devon	South West	I	TRUE	FALSE	0	N/A	FALSE
GB108050014130	Mole	6	27	North Devon	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108050014150	Burcombe Stream	6	27	North Devon	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108050014520	Hawkridge Brook	6	27	North Devon	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108050014530	Taw	6	27	North Devon	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108050019970	Mole	6	27	North Devon	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108050020020	Knowl Water	6	27	North Devon	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108050008100	East Okement River	6	27	North Devon	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108050008080	West Okement	6	27	North Devon	South West	I	TRUE	FALSE	4	TRUE	TRUE
GB108052015510	Hillfarrance Bk	6	28	South & West Somerset	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108052021370	Tone, Upper	6	28	South & West Somerset	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108052015330	Lopen Bk	6	28	South & West Somerset	South West	PI	FALSE	N/A	N/A	N/A	FALSE

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GB108052015380	Westford Str	6	28	South & West Somerset	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108052015390	Haywards Wtr	6	28	South & West Somerset	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108052015400	Hele Bk	6	28	South & West Somerset	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108052015410	Sherford Str	6	28	South & West Somerset	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108052015420	Broughton Brook	6	28	South & West Somerset	South West	PI	FALSE	N/A	N/A	N/A	FALSE
GB108046005270	Ashburn	6	27	South Devon	South West	PI	TRUE	FALSE	2	FALSE	FALSE
GB108046005250	Webburn	6	27	South Devon	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108046008490	Bramble Brook	6	27	South Devon	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108046008300	Bovey	6	27	South Devon	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108046008570	Fingle Brook	6	27	South Devon	South West	PI	FALSE	N/A	N/A	N/A	FALSE
GB108046008550	Teign	6	27	South Devon	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108046008540	Teign	6	27	South Devon	South West	I	TRUE	FALSE	4	FALSE	FALSE
GB108046008350	Dart	6	27	South Devon	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108046008340	Dart	6	27	South Devon	South West	PI	TRUE	FALSE	2	FALSE	FALSE
GB108046008330	Wray Brook	6	27	South Devon	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108046008500	Beadon Brook	6	27	South Devon	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108046008320	Bovey	6	27	South Devon	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108046008480	Kate Brook	6	27	South Devon	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108046008470	Bovey	6	27	South Devon	South West	PI	TRUE	FALSE	4	FALSE	FALSE
GB108046008460	Ugbrooke Stream	6	27	South Devon	South West	PI	TRUE	FALSE	2	FALSE	FALSE
GB108046008450	River Lemon	6	27	South Devon	South West	I	TRUE	FALSE	2	FALSE	FALSE
GB108046008430	River Teign	6	27	South Devon	South West	PI	TRUE	FALSE	7	TRUE	TRUE
GB108046008420	East Dart River	6	27	South Devon	South West	PI	TRUE	FALSE	2	FALSE	FALSE
GB108046008400	West Dart River	6	27	South Devon	South West	PI	TRUE	FALSE	2	FALSE	FALSE
GB108047007770	Lew (Tamar)	6	27	Tamar	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108047007690	Upper River Lynher	6	27	Tamar	South West	I	TRUE	FALSE	0	N/A	FALSE
GB108047007680	Withey Brook	6	27	Tamar	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108047007670	River Lynher	6	27	Tamar	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108047004050	Upper River Yealm	6	27	Tamar	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108047004040	Lower River Plym	6	27	Tamar	South West	I	TRUE	FALSE	7	TRUE	TRUE
GB108047004020	Piall	6	27	Tamar	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108047004010	Lower River Yealm	6	27	Tamar	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108047003660	Meavy	6	27	Tamar	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108047003650	Upper River Plym	6	27	Tamar	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108047003640	Tory Brook	6	27	Tamar	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108047008060	Claw	6	27	Tamar	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108047008040	Carey	6	27	Tamar	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108047007950	Upper River Tavy	6	27	Tamar	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108047007940	River Tamar (Launceston)	6	27	Tamar	South West	PI	TRUE	TRUE	N/A	N/A	FALSE

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GB108047007930	Quither Stream	6	27	Tamar	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108047007920	Lowley Brook	6	27	Tamar	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108047007910	River Tamar Below River Lyd	6	27	Tamar	South West	I	TRUE	FALSE	0	N/A	FALSE
GB108047007900	Tamar (Kelly Brook)	6	27	Tamar	South West	PI	TRUE	FALSE	0	N/A	FALSE
GB108047007890	Lower River Inny	6	27	Tamar	South West	PI	TRUE	TRUE	N/A	N/A	FALSE
GB108047007880	Burn (Tavy)	6	27	Tamar	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108047007870	Walkham	6	27	Tamar	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108047007860	Lower River Tamar	6	27	Tamar	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108047007850	Lumburn	6	27	Tamar	South West	PI	TRUE	FALSE	2	TRUE	TRUE
GB108047007840	Lower River Tavy	6	27	Tamar	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108048001140	River Kennal	6	27	West Cornwall and the Fal	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108048002110	Marazion River	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048002290	Par River (Lower)	6	27	West Cornwall and the Fal	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108048002300	Bokiddickstream	6	27	West Cornwall and the Fal	South West	PI	TRUE	FALSE	1	TRUE	TRUE
GB108048002280	St. Austell River	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048002310	Par River (Upper)	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	4	TRUE	TRUE
GB108048001150	Hicks Mill Stream	6	27	West Cornwall and the Fal	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108048001160	Upper Carnon River	6	27	West Cornwall and the Fal	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108048001171	River Cober Us Lowrtown Bridge	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048001172	River Cober Ds Lowrtown Bridge	6	27	West Cornwall and the Fal	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108049000350	Tregeseal Stream	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108049000380	Hayle	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048001230	Lower River Carnon And Perranwell Stream	6	27	West Cornwall and the Fal	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108048001250	Calenick Stream	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048001270	Lower River Fal	6	27	West Cornwall and the Fal	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB108048001330	Crinnis River	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048001350	Gwindra Stream	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108049000530	Hayletidal, Lands End, St.Ives	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108049000560	Roseworthy Stream	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108049000570	Red River (Lower)	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	7	TRUE	TRUE
GB108049000600	Red River (Upper)	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	6	TRUE	TRUE
GB108049000620	Portreath Stream	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048001390	Upper River Fal	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108049000630	Porthtowan Stream	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	5	TRUE	TRUE
GB108049000670	Trevellas Stream	6	27	West Cornwall and the Fal	South West	I	TRUE	FALSE	2	TRUE	TRUE
GB108048001870	Lestraines River	6	27	West Cornwall and the Fal	South West	I	TRUE	TRUE	N/A	N/A	FALSE
GB110066059770	Aled - Elwy to Deunant	8	24	Conwy and Clwyd	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110066059710	Nant Melai	8	24	Conwy and Clwyd	Western Wales	PI	TRUE	FALSE	0	N/A	FALSE

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GB110066054950	Ystrad	8	24	Conwy and Clwyd	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110066054940	Lledr	8	24	Conwy and Clwyd	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110066054880	Crafnant	8	24	Conwy and Clwyd	Western Wales	I	FALSE	N/A	N/A	N/A	FALSE
GB110066060030	Conwy - Tidal limit to Merddwr	8	24	Conwy and Clwyd	Western Wales	I	TRUE	FALSE	7	TRUE	TRUE
GB110066060020	Elwy - Clwyd to Afon Melai	8	24	Conwy and Clwyd	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110066059960	Clwyd - Tidal limit to Hesbin	8	24	Conwy and Clwyd	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110066059950	Bach	8	24	Conwy and Clwyd	Western Wales	PI	TRUE	TRUE	N/A	N/A	FALSE
GB110066059930	Wheeler - Lower	8	24	Conwy and Clwyd	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110066054670	Clwyd - Upstream Hesbin	8	24	Conwy and Clwyd	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110059032080	Dulais - Headwaters to confluence with Loughor	8	26	Loughor to Taf	Western Wales	PI	TRUE	FALSE	0	N/A	FALSE
GB110059032140	Aman - Conf with Garnant to conf with Loughor	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110060036300	Cothi - Headwaters to confluence with Tywi	8	26	Loughor to Taf	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110060029062	Gwendraeth Fawr - Afan Goch to tidal limit	8	26	Loughor to Taf	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110060029061	Gwendraeth Fawr - Headwaters Afan Goch	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110060041360	Tywi - Headwaters to Llyn Brianne Reservoir	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	3	TRUE	TRUE
GB110060041350	Camddwr - Headwaters to Llyn Brianne Reservoir	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	3	TRUE	TRUE
GB110060036400	Doethie - Headwaters to conf with Pysgotwr Fawr	8	26	Loughor to Taf	Western Wales	PI	FALSE	N/A	N/A	N/A	FALSE
GB110060036370	Gwenffrwd - Headwaters to confluence with Tywi	8	26	Loughor to Taf	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110060036360	Doethie - Pysgotwr Fawr conf to conf with Tywi	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	3	TRUE	TRUE
GB110060036390	Pysgotwr Fawr - Headwaters to conf with Doethie	8	26	Loughor to Taf	Western Wales	PI	FALSE	N/A	N/A	N/A	FALSE
GB110060036380	Tywi - Llyn Brianne to confluence with Doethie	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	3	TRUE	TRUE
GB110060036350	Tywi - Conf With Doethie to conf with Gwydderig	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	3	TRUE	TRUE
GB110060036340	Gwenlais - Headwaters to confluence with Tywi	8	26	Loughor to Taf	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110060036320	Dunant - Headwaters to confluence with Tywi	8	26	Loughor to Taf	Western Wales	PI	TRUE	FALSE	0	N/A	FALSE
GB110060036280	Taf - Headwaters to confluence with Cynin	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	7	TRUE	TRUE
GB110060036250	Tywi (Llandovery Bran to Cothi Confl)	8	26	Loughor to Taf	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110060036210	Dulais - Conf With Ddu to confluence with Tywi	8	26	Loughor to Taf	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110060036220	Bran - Headwaters to confluence with Ydw	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	0	N/A	FALSE
GB110060036200	Sannan - Headwaters to confluence with Dulas	8	26	Loughor to Taf	Western Wales	PI	FALSE	N/A	N/A	N/A	FALSE
GB110060036050	Cothi - Headwaters to confluence with Twrch	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	0	N/A	FALSE
GB110060035940	Gwydderig - Headwaters to confluence with Bran	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE

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GB110060029590	Tywi - Bishop's Pond to conf with Gwili And TL	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	7	TRUE	TRUE
GB110060029350	Annell - Headwaters to confluence with Tywi	8	26	Loughor to Taf	Western Wales	PI	TRUE	FALSE	0	N/A	FALSE
GB110060029290	Tywi - Confluence with Cothi to spring tidal limit	8	26	Loughor to Taf	Western Wales	I	TRUE	FALSE	7	TRUE	TRUE
GB110065053670	Teigl	8	24	North West Wales	Western Wales	I	TRUE	FALSE	5	TRUE	TRUE
GB110102059230	Goch Amlwch	8	24	North West Wales	Western Wales	I	TRUE	FALSE	6	TRUE	TRUE
GB110102059000	Goch Dulas	8	24	North West Wales	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110102058940	Ceint	8	24	North West Wales	Western Wales	PI	TRUE	TRUE	N/A	N/A	FALSE
GB110102058790	Cefni - Cefni Reservoir West	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	0	N/A	FALSE
GB110102058780	Cefni - Cefni Reservoir East	8	24	North West Wales	Western Wales	PI	FALSE	N/A	N/A	N/A	FALSE
GB110102058670	Cefni - Tidal limit to Ceint	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110065053720	Goedol	8	24	North West Wales	Western Wales	I	TRUE	FALSE	5	TRUE	TRUE
GB110065053760	Soch	8	24	North West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110065053740	Dwyfawr - Upper	8	24	North West Wales	Western Wales	I	TRUE	FALSE	0	N/A	FALSE
GB110065053700	Erch - Upper	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	0	N/A	FALSE
GB110065053690	Cwmystradllyn	8	24	North West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110065053630	Cynfal	8	24	North West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110065053610	Dwyryd - Upper	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	0	N/A	FALSE
GB110065053600	Dwyryd - Lower	8	24	North West Wales	Western Wales	I	TRUE	FALSE	7	TRUE	TRUE
GB110064054640	Gain	8	24	North West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110064054620	Mawddach - Upper	8	24	North West Wales	Western Wales	I	TRUE	FALSE	3	TRUE	TRUE
GB110064048820	Cwm-Mynach	8	24	North West Wales	Western Wales	I	FALSE	N/A	N/A	N/A	FALSE
GB110064048840	Wnion - Upper	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	0	N/A	FALSE
GB110064048800	Wnion - Lower	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	7	TRUE	TRUE
GB110064048790	Clywedog (Wnion)	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	0	N/A	FALSE
GB110064048750	Eden - Lower	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110064048740	Wen (Mawddach)	8	24	North West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110064048730	Mawddach - Middle	8	24	North West Wales	Western Wales	I	FALSE	N/A	N/A	N/A	FALSE
GB110064048710	Mawddach - Lower	8	24	North West Wales	Western Wales	I	TRUE	FALSE	7	TRUE	TRUE
GB110064048570	Dulas North	8	24	North West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110064048530	Dysynni - Upper	8	24	North West Wales	Western Wales	I	TRUE	FALSE	0	N/A	FALSE
GB110064048520	Cadair	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110064048440	Dysynni - Lower	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	7	TRUE	TRUE
GB110064048390	Dyfi - Tidal limit to Afon Twymyn	8	24	North West Wales	Western Wales	I	TRUE	FALSE	7	TRUE	TRUE
GB110064048340	Nant Gwydol	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110064048320	Twymyn - Upper	8	24	North West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110064048290	Dulas South - Lower	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110065054190	Gwyrfai	8	24	North West Wales	Western Wales	I	TRUE	FALSE	7	TRUE	TRUE

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							WFD classification data?	Non-metal pressures?	Number of metal determinands with data	Bioavailability screening tool input parameters?	
GB110065054130	Geirch	8	24	North West Wales	Western Wales	PI	FALSE	N/A	N/A	N/A	FALSE
GB110065054120	Penrhos	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110065054010	Nant Peris	8	24	North West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110065053890	Croesor	8	24	North West Wales	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110065053970	Llyfni	8	24	North West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110065053950	Colwyn	8	24	North West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110065053930	Nanmor	8	24	North West Wales	Western Wales	I	TRUE	FALSE	0	N/A	FALSE
GB110065053840	Gaseg - Upper	8	24	North West Wales	Western Wales	I	TRUE	FALSE	0	N/A	FALSE
GB110065053750	Prysor	8	24	North West Wales	Western Wales	I	TRUE	FALSE	7	TRUE	TRUE
GB110058026280	Ogmore - Confluence with Llynfi to tidal limit	8	26	Ogmore to Tawe	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110058026220	Alun - Headwaters to confluence with Ewenny	8	26	Ogmore to Tawe	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110058026160	Kenfig - Nant Cwm Philip Conf to Margam Moors Conf	8	26	Ogmore to Tawe	Western Wales	I	TRUE	FALSE	0	N/A	FALSE
GB110062043562	Teifi - Camddwr Conf to Nant Wern-Macwydd Conf	8	26	South West Wales	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110061030660	Narbeth Brook - Headwaters to conf with E. Cleddau	8	26	South West Wales	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE
GB110062043550	Meurig - Headwaters to confluence with Teifi	8	26	South West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110062043540	Teifi - Headwaters to confluence with Meurig	8	26	South West Wales	Western Wales	I	TRUE	FALSE	3	TRUE	TRUE
GB110062043480	Brennig - Headwaters to confluence with Teifi	8	26	South West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110062043470	Berwyn - Headwaters to confluence with Groes	8	26	South West Wales	Western Wales	I	TRUE	FALSE	0	N/A	FALSE
GB110062039250	Brefi - Headwaters to confluence with Teifi	8	26	South West Wales	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110062039200	Clywedog - Headwaters to confluence with Teifi	8	26	South West Wales	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110062039110	Ceri - Headwaters to confluence with Teifi	8	26	South West Wales	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110063041720	Ystwyth - Headwaters to conf with Cwmnewydion	8	26	South West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110063041710	Ystwyth - Conf with Cwmnewydion to tidal limit	8	26	South West Wales	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110063041660	Hengwm - Headwaters to Nant Y Moch Reservoir	8	26	South West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110063041690	Llanfihangel - Headwaters to conf with Ystwyth	8	26	South West Wales	Western Wales	PI	TRUE	FALSE	0	N/A	FALSE
GB110063041680	Magwr - Headwaters to confluence with Ystwyth	8	26	South West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110063041670	Cwmnewydion - Headwaters to conf with Ystwyth	8	26	South West Wales	Western Wales	I	TRUE	FALSE	0	N/A	FALSE
GB110061031340	W. Cleddau - Anghof Conf to Cartlett Brook Conf	8	26	South West Wales	Western Wales	I	TRUE	TRUE	N/A	N/A	FALSE
GB110063041650	Llechwedd Mawr - HW to Nant Y Moch Reservoir	8	26	South West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110063041640	Hengwm - Conf with Llechwedd-Mawr to Rheidol Conf	8	26	South West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE

WBID	Name	Region	Area	Catchment	RBD name	NoCAM impact status	Criteria for inclusion in initial screen (applied from left to right)				WB included in initial screening assessment
							WFD classification data?	Non-metal pressures?	Number of metal determinands with data	Bioavailability screening tool input parameters?	
GB110063041630	Bow Street Brook - Headwaters to conf with Clarach	8	26	South West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110063041610	Clarach - Headwaters to conf with Bow Street Brook	8	26	South West Wales	Western Wales	I	TRUE	FALSE	3	TRUE	TRUE
GB110063041570	Rheidol - Confluence with Castell to tidal limit	8	26	South West Wales	Western Wales	I	TRUE	FALSE	7	TRUE	TRUE
GB110063041590	Melindwr - Headwaters to confluence with Rheidol	8	26	South West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110063041580	Castell - Headwaters to confluence with Rheidol	8	26	South West Wales	Western Wales	I	TRUE	FALSE	2	TRUE	TRUE
GB110063041560	Mynach - Headwaters to confluence with Rheidol	8	26	South West Wales	Western Wales	PI	TRUE	FALSE	2	TRUE	TRUE

I: Impacted
P: Probably impacted

Appendix B - Results of screening assessment

Table B.1 Scenario 1 water bodies

WBID	Name	Environment Agency Region	Environment Agency Area	Catchment	RBD name	Number of sample points	Number of metals monitored	Number of metals failing EQS	Tool input	ABC improves Zn EQS compliance	Centre for Ecology & Hydrology Site Number[1]	Environment Agency investigation[2]
GB111067 052060	Dee - Ceiriog to Alwen	8	24	Upper Dee	Dee	7	2	1	D	No	-	-
GB104027 064120	Barben Beck/River Dibb Catchment (Trib of Wharfe)	3	34	Wharfe and Lower Ouse	Humber	1	2	2	D	No	-	-
GB112073 071190	River Crake	4	11	Kent/Leven	North West	2	2	1	D	No ABC	-	-
GB112073 071380	River Kent	4	11	Kent/Leven	North West	3	2	1	D	No ABC	-	-
GB112073 071430	River Sprint	4	11	Kent/Leven	North West	2	2	1	D	No ABC	-	-
GB109054 044790	R Severn - Source to Conf Afon Dulas	2	31	Severn Uplands	Severn	1	2	2	SS	No	-	-
GB109054 055050	Afon Iwrch - Source to Conf Afon Tanat	2	31	Severn Uplands	Severn	1	2	1	SS	No	-	-
GB109055 042310	Afon Marteg - Source to Conf R Wye	8	25	Wye	Severn	1	2	1	D	No	-	-
GB108048 001420	Lower River Fowey	6	27	North Cornwall, Seaton, Looe and Fowey	South West	3	8	2	D	Yes	-	-
GB108048 007640	St. Neot River	6	27	North Cornwall, Seaton, Looe and Fowey	South West	3	2	1	D	No	-	-
GB108050 008100	East Okement River	6	27	North Devon	South West	1	2	2	D	No	-	-
GB108050 019970	Mole	6	27	North Devon	South West	2	2	1	D	No	-	-
GB108047 004040	Lower River Plym	6	27	Tamar	South West	1	8	1	SS	No	-	-
GB108048 002110	Marazion River	6	27	West Cornwall and the Fal	South West	3	2	1	SS	No	-	-
GB108048 002300	Bokiddickstream	6	27	West Cornwall and the Fal	South West	2	1	1	D	No	-	-
GB110060 029290	Tywi - Confluence eith Cothi to spring tidal limit	8	26	Loughor to Taf	Western Wales	1	8	1	SS	No	-	-
GB110060 029590	Tywi - Bishop's Pond to Conf with Gwili and TL	8	26	Loughor to Taf	Western Wales	2	8	1	SS	No	-	-
GB110064 048290	Dulas South - Lower	8	24	North West Wales	Western Wales	1	2	2	D	Yes	-	-
GB110065 053670	Teigl	8	24	North West Wales	Western Wales	2	5	2	SS	Yes	-	-
GB110065 053690	Cwmystradllyn	8	24	North West Wales	Western Wales	1	2	1	SS	No	-	-
GB110065 053890	Croesor	8	24	North West Wales	Western Wales	1	2	2	D	No	-	-
GB110065 053970	Llyfni	8	24	North West Wales	Western Wales	4	2	2	D	No	-	-
GB110065 054010	Nant Peris	8	24	North West Wales	Western Wales	2	2	2	D	No	-	-

[1]Water body contains a sample site used in Environment Agency (2008b): *Environmental quality standards for trace metals in the aquatic environment*, project by Centre for Ecology and Hydrology.
[2]Water body is subject to planned or ongoing monitoring/investigation in Environment Agency Wales (Paul Edwards, personal communication).

Table B.2 Scenario 2 water bodies

WBID	Name	Environment Agency Region	Environment Agency Area	Catchment	RBD name	Number of sample points	Number of metals monitored	Number of metals failing EQS	Tool input	ABC improves Zn EQS compliance	Centre for Ecology & Hydrology Site Number[1]	Environment Agency investigation[2]
GB111067051800	Terrig	8	24	Middle Dee	Dee	1	2	0	Defaults	No	-	-
GB111067046420	Twrch	8	24	Upper Dee	Dee	1	2	1	Site Specific	No	-	-
GB111067051750	Alwen - Ceirw to Brenig	8	24	Upper Dee	Dee	2	2	1	Defaults	No	-	-
GB111067051910	Ceiriog - Confluence Dee to Teirw	8	24	Upper Dee	Dee	2	2	0	Defaults	No	-	-
GB111067051940	Trystion	8	24	Upper Dee	Dee	1	2	1	Defaults	No	-	-
GB111067051970	Dee - Outlet Bala Lake to Inlet Bala Lake	8	24	Upper Dee	Dee	1	2	0	Site Specific	No	-	-
GB104027064180	River Skirfare from Cowside Beck to River Wharfe	3	34	Wharfe and Lower Ouse	Humber	1	2	0	Defaults	No	-	-
GB104027064253	Wharfe from Park Gill Bk to Barben Beck/River Dibb	3	34	Wharfe and Lower Ouse	Humber	2	2	0	Defaults	No	-	-
GB112075070410	River Derwent	4	11	Derwent (NW)	North West	2	2	0	Defaults	No ABC	8	-
GB112075070460	Glenderamackin (Greta)	4	11	Derwent (NW)	North West	3	2	1	Defaults	No ABC	11	-
GB112070064952	River Yarrow Ds Big Lodge Water	4	11	Douglas	North West	5	6	0	Defaults	No ABC	-	-
GB112073071420	River Leven	4	11	Kent/Leven	North West	5	8	1	Defaults	No ABC	-	-
GB112071065400	River Brennand	4	11	Ribble	North West	1	2	2	Site Specific	No	-	-
GB112069061320	River Bollin (source to Dean)	4	12	Upper Mersey	North West	7	2	0	Defaults	No	-	-
GB103025072510	River Tees from Maize Beck to River Greta	3	35	Tees	Northumbria	6	3	0	Defaults	No	-	-
GB103023074810	Simon Burn from Crook Burn to N Tyne	3	35	Tyne	Northumbria	1	2	0	Defaults	No	-	-
GB103024077430	Burnhope Burn from source to Kilhope Burn	3	35	Wear	Northumbria	2	2	2	Defaults	No	-	-
GB103024077520	Waskerley Beck from source to Wear	3	35	Wear	Northumbria	1	3	0	Defaults	No	-	-
GB109054044580	Afon Dulas - Source to Conf R Severn	2	31	Severn Uplands	Severn	2	2	2	Defaults	No	-	-
GB109054049720	Afon Vyrnwy - Conf Afon Cownwy to Conf Afon Banwy	2	31	Severn Uplands	Severn	1	2	1	Defaults	No	-	-
GB109054049850	Afon Banwy - Conf Afon Gam to Afon Vyrnwy	2	31	Severn Uplands	Severn	3	2	1	Defaults	No	-	-
GB109054032640	Cannop Bk - Source to R Severn Estuary	2	31	Severn Vale	Severn	16	7	0	Defaults	No	-	-
GB109057027120	Ely R - Source to Conf Nant Mychydd	8	25	South East Valleys	Severn	3	5	0	Defaults	No	-	-
GB109055029730	Rudhall Bk - Source to Conf R Wye	8	25	Wye	Severn	3	2	0	Defaults	No	-	-
GB109055037111	R Wye - Conf Walford Bk to Bigsweir Br	8	25	Wye	Severn	5	8	0	Defaults	No	-	-
GB109055042320	R Wye - Conf Afon Bidno to Conf Afon Marteg	8	25	Wye	Severn	2	2	2	Site Specific	No	-	-
GB109055042340	Afon Bidno - Source to Conf R Wye	8	25	Wye	Severn	1	2	0	Site Specific	No	-	-
GB102076073992	River Petteril U/S M6	4	11	Eden and Esk	Solway Tweed	3	2	0	Defaults	No ABC	-	-

WBID	Name	Environment Agency Region	Environment Agency Area	Catchment	RBD name	Number of sample points	Number of metals monitored	Number of metals failing EQS	Tool input	ABC improves Zn EQS compliance	Centre for Ecology & Hydrology Site Number[1]	Environment Agency investigation[2]
GB108044009700	Sydling Water	6	28	Dorset	South West	4	2	0	Defaults	No	-	-
GB108044009710	Cerne	6	28	Dorset	South West	3	2	0	Defaults	No	-	-
GB108044009780	Frome Dorset (Upper)	6	28	Dorset	South West	1	2	0	Defaults	No	-	-
GB108044009800	Hooke	6	28	Dorset	South West	4	2	0	Defaults	No	-	-
GB108045009070	Creedy	6	27	East Devon	South West	3	2	0	Defaults	No ABC	-	-
GB108045014920	Madford River	6	27	East Devon	South West	3	2	1	Defaults	No ABC	-	-
GB108049007030	De Lank River	6	27	North Cornwall, Seaton, Looe and Fowey	South West	2	2	0	Defaults	No	-	-
GB108050020020	Knowl Water	6	27	North Devon	South West	1	2	0	Defaults	No	-	-
GB108046008320	Bovey	6	27	South Devon	South West	1	2	1	Site Specific	No ABC	-	-
GB108046008430	River Teign	6	27	South Devon	South West	2	8	1	Site Specific	No ABC	-	-
GB108047003660	Meavy	6	27	Tamar	South West	4	2	0	Site Specific	No	-	-
GB108047004010	Lower River Yealm	6	27	Tamar	South West	6	2	0	Defaults	No	-	-
GB108047004020	Piall	6	27	Tamar	South West	1	2	1	Defaults	No	-	-
GB108047004050	Upper River Yealm	6	27	Tamar	South West	4	2	0	Defaults	No	-	-
GB108047008040	Carey	6	27	Tamar	South West	3	2	0	Defaults	No	-	-
GB108047008060	Claw	6	27	Tamar	South West	1	2	0	Defaults	No	-	-
GB110066054670	Clwyd - Upstream Hesbin	8	24	Conwy and Clwyd	Western Wales	1	2	0	Defaults	No	-	-
GB110066054940	Lledr	8	24	Conwy and Clwyd	Western Wales	1	2	0	Defaults	No	-	-
GB110066054950	Ystrad	8	24	Conwy and Clwyd	Western Wales	1	2	0	Defaults	No	-	-
GB110066059770	Aled - Elwy to Deunant	8	24	Conwy and Clwyd	Western Wales	1	2	0	Site Specific	No	-	-
GB110066059930	Wheeler - Lower	8	24	Conwy and Clwyd	Western Wales	1	2	0	Defaults	No	-	-
GB110060035940	Gwydderig - Headwaters to confluence with Bran	8	26	Loughor to Taf	Western Wales	1	2	0	Site Specific	No	-	-
GB110060036300	Cothi - Headwaters to confluence with Tywi	8	26	Loughor to Taf	Western Wales	2	2	1	Defaults	No	-	-
GB110060036340	Gwenlais - Headwaters to confluence with Tywi	8	26	Loughor to Taf	Western Wales	1	2	0	Defaults	No	-	-
GB110060036350	Tywi - Conf with Doethie to conf with Gwydderig	8	26	Loughor to Taf	Western Wales	5	3	0	Defaults	No	-	-
GB110060036370	Gwenffrwd - Headwaters to confluence with Tywi	8	26	Loughor to Taf	Western Wales	1	2	0	Defaults	No	-	-
GB110064048340	Nant Gwydol	8	24	North West Wales	Western Wales	1	2	1	Site Specific	No	-	-
GB110064048520	Cadair	8	24	North West Wales	Western Wales	1	2	1	Defaults	No	-	-
GB110064048570	Dulas North	8	24	North West Wales	Western Wales	2	2	1	Defaults	No	-	-
GB110064048750	Eden - Lower	8	24	North West Wales	Western Wales	1	2	0	Defaults	No	-	-
GB110065053750	Prysor	8	24	North West Wales	Western Wales	3	8	2	Defaults	No	-	-
GB110065054190	Gwyrfai	8	24	North West Wales	Western Wales	4	8	0	Defaults	No	-	-
GB110061030660	Narbeth Brook - Headwaters to conf with E.	8	26	South West Wales	Western Wales	1	2	0	Defaults	No	-	-

WBID	Name	Environment Agency Region	Environment Agency Area	Catchment	RBD name	Number of sample points	Number of metals monitored	Number of metals failing EQS	Tool input	ABC improves Zn EQS compliance	Centre for Ecology & Hydrology Site Number[1]	Environment Agency investigation[2]
	Cleddau											
GB110062043480	Brennig - Headwaters to confluence with Teifi	8	26	South West Wales	Western Wales	1	2	0	Defaults	No	-	-
GB110062043540	Teifi - Headwaters to confluence with Meurig	8	26	South West Wales	Western Wales	3	3	0	Defaults	No	-	Yes

[1]Water body contains a sample site used in Environment Agency (2008b): *Environmental quality standards for trace metals in the aquatic environment*, project by Centre for Ecology and Hydrology.
[2]Water body is subject to planned or ongoing monitoring/investigation in Environment Agency Wales (Paul Edwards, personal communication).

Table B.3 Scenario 3 water bodies

WBID	Name	EA Region	EA Area	Catchment	RBD name	Number of sample points	Number of metals monitored	Number of metals failing EQS pre-tool	Number of metals failing EQS post-tool	Number of metals "significantly" failing EQS post-tool	Tool input[+]	ABC available	Centre for Ecology and Hydrology Site Number[1]	Environment Agency investigation[2]	"Priority" water body[3]	"Optimistic" water body[4]
GB111067057060	Y Garth	8	24	Tidal Dee	Dee	1	2	1	2	2	D	Yes	-	-	TRUE	FALSE
GB111067051700	Black Brook	8	24	Upper Dee	Dee	1	2	0	2	1	D	Yes	-	-	FALSE	FALSE
GB104027068293	River Nidd from Howstean Beck to Birstwith	3	34	Swale, Ure, Nidd & Upper Ouse	Humber	1	2	2	1	1	D	Yes	-	-	TRUE	FALSE
GB112075073570	Broughton Beck	4	11	Derwent (NW)	North West	6	2	0	1	0	D	No ABC	-	-	FALSE	TRUE
GB112075070440	Newlands Beck	4	11	Derwent (NW)	North West	3	2	2	1	1	D	No ABC	5	-	TRUE	FALSE
GB112075073561	River Derwent Us Bassenthwaite Lake	4	11	Derwent (NW)	North West	4	4	2	1	1	D	No ABC	-	-	TRUE	FALSE
GB112073071210	Yewdale/Church Beck	4	11	Kent/Leven	North West	3	2	2	2	2	D	No ABC	1	-	FALSE	FALSE
GB112074069830	Haverigg Pool	4	11	South West Lakes	North West	4	2	0	2	2	D	No ABC	-	-	TRUE	FALSE
GB103025072470	Harwood Beck from Langdon Beck to River Tees	3	35	Tees	Northumbria	1	2	2	1	1	D	Yes	-	-	FALSE	FALSE
GB103023074710	Allen from source to West Allen	3	35	Tyne	Northumbria	1	2	1	1	1	D	Yes	-	-	TRUE	FALSE
GB103023074740	Horsleyhope Burn Catchment (Trib of Derwent)	3	35	Tyne	Northumbria	4	3	1	1	1	D	Yes	-	-	TRUE	FALSE
GB103023074770	Derwent from Nookton Burn to Burnhope Burn	3	35	Tyne	Northumbria	3	2	1	1	1	D	Yes		-	TRUE	FALSE
GB103023075410	Black Burn from Aglionby Becksouth Tyne	3	35	Tyne	Northumbria	1	2	0	1	1	D	Yes	-	-	TRUE	FALSE
GB103023075530	South Tyne from Black Burn to Allen	3	35	Tyne	Northumbria	4	3	0	1	0	D	Yes	-	-	TRUE	FALSE
GB103023075801	Tyne from Watersmeet to tidal limit	3	35	Tyne	Northumbria	5	8	0	1	1	SS	Yes	-	-	TRUE	FALSE
GB103024077440	Wear from Ireshope to	3	35	Wear	Northumbria	1	3	1	1	1	D	Yes	-	-	TRUE	FALSE

WBID	Name	EA Region	EA Area	Catchment	RBD name	Number of sample points	Number of metals monitored	Number of metals failing EQS pre-tool	Number of metals failing EQS post-tool	Number of metals “significantly” failing EQS post-tool	Tool input[+]	ABC available	Centre for Ecology and Hydrology Site Number[1]	Environment Agency investigation[2]	"Priority" water body[3]	“Optimistic” water body[4]
	Middlehope Burn															
GB103024077460	Wear from Swinhope to Browney	3	35	Wear	Northumbria	10	4	0	1	1	D	Yes	-	-	TRUE	FALSE
GB103024077500	Kilhope Burn from source to Burnhope Burn	3	35	Wear	Northumbria	1	2	1	1	1	D	Yes	20	-	TRUE	FALSE
GB103024077510	Stanhope Burn from source to Wear	3	35	Wear	Northumbria	1	2	0	1	1	SS	Yes	-	-	TRUE	FALSE
GB109053021990	Whatley Bk - Source to Conf Mells R	6	28	Bristol Avon & North Somerset Streams	Severn	3	2	0	1	1	D	Yes	-	-	FALSE	FALSE
GB109054044760	Afon Clywedog - Clywedog Dam to R Severn	2	31	Severn Uplands	Severn	1	2	2	1	1	D	Yes	-	-	FALSE	TRUE
GB109054049960	Afon Tanat - Conf Hirnant to Conf Afon Rhaeadr	2	31	Severn Uplands	Severn	1	2	2	1	1	D	Yes	-	-	FALSE	FALSE
GB109054044720	Afon Cerist - Source to Conf Afon Trannon	2	31	Severn Uplands	Severn	1	2	2	1	1	D	Yes	-	-	TRUE	FALSE
GB109054044840	Afon Cerist - Conf Afon Trannon to Conf R Severn	2	31	Severn Uplands	Severn	1	2	2	1	1	SS	Yes	-	-	TRUE	FALSE
GB108044010060	South Winterbourne	6	28	Dorset	South West	1	2	0	1	0	D	Yes	-	-	FALSE	TRUE
GB108044009660	Tadnoll Brook (including Empool Bottom)	6	28	Dorset	South West	5	2	0	1	0	D	Yes	-	-	FALSE	FALSE
GB108045008820	Yarty	6	27	East Devon	South West	1	2	0	1	0	D	No ABC	-	-	FALSE	TRUE
GB108049000040	St. Lawrence Stream	6	27	North Cornwall, Seaton, Looe and Fowey	South West	2	2	0	2	2	D	Yes	-	-	FALSE	FALSE
GB108049000050	Lower River Ruthern	6	27	North Cornwall, Seaton, Looe and Fowey	South West	1	2	0	1	1	D	Yes	-	-	FALSE	FALSE
GB108049007050	River Allen	6	27	North Cornwall, Seaton, Looe and Fowey	South West	2	2	0	1	1	D	Yes	-	-	FALSE	FALSE
GB108049000210	Benny Stream	6	27	North Cornwall, Seaton, Looe and Fowey	South West	3	2	1	1	1	SS	Yes	-	-	TRUE	FALSE
GB108050014130	Mole	6	27	North Devon	South West	2	2	2	1	0	D	Yes	-	-	FALSE	FALSE
GB108047007880	Burn (Tavy)	6	27	Tamar	South West	1	2	2	1	1	D	Yes	-	-	FALSE	FALSE
GB108048001171	River Cober Us Lowrtown Bridge	6	27	West Cornwall and the Fal	South West	3	2	2	2	2	D	Yes	-	-	FALSE	FALSE
GB108048002280	St. Austell River	6	27	West Cornwall and the Fal	South West	4	2	0	1	1	D	Yes	-	-	FALSE	FALSE
GB108049000350	Tregeseal Stream	6	27	West Cornwall and the Fal	South West	2	2	2	1	0	D	Yes	-	-	FALSE	FALSE
GB108048001250	Calenick Stream	6	27	West Cornwall and the	South West	1	2	2	2	2	D	Yes	-	-	TRUE	FALSE

WBID	Name	EA Region	EA Area	Catchment	RBD name	Number of sample points	Number of metals monitored	Number of metals failing EQS pre-tool	Number of metals failing EQS post-tool	Number of metals "significantly" failing EQS post-tool	Tool input+	ABC available	Centre for Ecology and Hydrology Site Number[1]	Environment Agency investigation[2]	"Priority" water body[3]	"Optimistic" water body[4]
				Fal												
GB108049000560	Roseworthy Stream	6	27	West Cornwall and the Fal	South West	6	2	2	2	2	SS	Yes	-	-	TRUE	FALSE
GB110066060030	Conwy - Tidal limit to Merddwr	8	24	Conwy and Clwyd	Western Wales	3	8	2	1	1	D	Yes	-	Yes	TRUE	FALSE
GB110060036250	Tywi (Llandovery Bran to Cothi Confl)	8	26	Loughor to Taf	Western Wales	1	2	2	1	1	D	Yes	-	-	FALSE	TRUE
GB110064048710	Mawddach - Lower	8	24	North West Wales	Western Wales	2	8	2	1	1	D	Yes	-	-	FALSE	TRUE
GB110065053720	Goedol	8	24	North West Wales	Western Wales	2	5	2	3	3	D	Yes	-	-	FALSE	TRUE
GB110064048390	Dyfi - Tidal limit to Afon Twymyn	8	24	North West Wales	Western Wales	4	8	2	1	1	D	Yes	-	-	FALSE	FALSE
GB110102059230	Goch Amlwch	8	24	North West Wales	Western Wales	1	6	6	6	6	D	No ABC	-	Yes	TRUE	FALSE
GB110058026220	Alun - Headwaters to confluence with Ewenny	8	26	Ogmore to Tawe	Western Wales	6	2	0	2	0	D	Yes	-	-	FALSE	FALSE
GB110063041630	Bow Street Brook - Headwaters to conf with Clarach	8	26	South West Wales	Western Wales	2	2	2	1	1	D	No ABC	-	-	TRUE	FALSE

+Tool input. D: Default dissolved organic carbon (DOC) and Ca. SS: Site specific measurements of DOC and Ca

[1]Water body contains a sample site used in Environment Agency (2008b): *Environmental quality standards for trace metals in the aquatic environment,* project by Centre for Ecology and Hydrology.

[2]Water body is subject to planned or ongoing monitoring/investigation in Environment Agency Wales (Paul Edwards, personal communication).

[3]"Priority" water bodies are those where the EQS for Zn, Cu or Ni would be expected to fail – irrespective of any reasonable bioavailability correction.

[4]"Optimistic" water bodies are those that could reasonably be expected to pass a refined bioavailability correction based on site-specific data.

Table B.4 Scenario 4 water bodies

WBID	Name	EA Region	EA Area	Catchment	RBD name	Number of sample points	Number of metals monitored	Number of metals failing EQS pre-tool	N° of metals failing EQS post-tool	Tool input	Centre for Ecology and Hydrology Site Number[1]	Environment Agency investigation[2]	"Priority" water body[3]
GB111067051810	Alyn - Upper River above Rhydymwyn	8	24	Middle Dee	Dee	2	5	0	1	Defaults	-	-	FALSE
GB111067052171	Alyn - Rhydymwyn to Leadmill	8	24	Middle Dee	Dee	2	5	0	1	Defaults	-	-	FALSE
GB111067051770	Cegidog	8	24	Middle Dee	Dee	4	3	0	1	Defaults	-	-	TRUE
GB111067051720	Clywedog - Above Black Brook	8	24	Upper Dee	Dee	2	3	1	1	Defaults	-	Yes	TRUE
GB104028052380	River Amber from source to Press Brook	2	30	Derbyshire Derwent	Humber	2	5	0	1	Defaults	-	-	FALSE
GB104027057370	River Loxley from Strines Dyke to Rivelin	3	34	Don and Rother	Humber	3	3	0	1	Defaults	-	-	TRUE
GB104027064190	Hebden Beck Catchment (Trib of Wharfe)	3	34	Wharfe and Lower Ouse	Humber	2	2	1	1	Defaults	-	-	TRUE
GB112075073562	River Derwent Ds Bassenthwaite Lake	4	11	Derwent (NW)	North West	3	2	2	1	Site Specific	-	-	FALSE
GB112071065510	Mearley Brook	4	11	Ribble	North West	1	2	0	1	Site Specific	-	-	FALSE
GB112074069720	River Annas	4	11	South West Lakes	North West	5	2	1	1	Defaults	-	-	FALSE
GB112074070030	River Keekle (Upper)	4	11	South West Lakes	North West	3	7	0	2	Defaults	-	-	FALSE
GB103025071950	Kilton Beck from Middle Gill Beck to North Sea	3	35	Tees	Northumbria	2	3	1	1	Defaults	-	-	FALSE
GB103025072490	Eggleston Burn Catchment (Trib of Tees)	3	35	Tees	Northumbria	1	3	2	2	Defaults	-	-	TRUE
GB103023074680	West Allen from source to Wellhope Burn	3	35	Tyne	Northumbria	1	2	1	1	Defaults	-	-	TRUE
GB103023074700	West Allen from Wellhope Burn to Allen	3	35	Tyne	Northumbria	2	2	1	1	Defaults	-	-	TRUE
GB103023074720	Allen from West Allen to South Tyne	3	35	Tyne	Northumbria	1	2	1	1	Defaults	-	-	TRUE
GB103023075420	Nent from source to South Tyne	3	35	Tyne	Northumbria	1	2	1	1	Defaults	21	-	TRUE

WBID	Name	EA Region	EA Area	Catchment	RBD name	Number of sample points	Number of metals monitored	Number of metals failing EQS pre-tool	N° of metals failing EQS post-tool	Tool input	Centre for Ecology and Hydrology Site Number[1]	Environment Agency investigation[2]	"Priority" water body[3]
GB103024077400	Wear from Middlehope to Swinhope Burn	3	35	Wear	Northumbria	1	2	0	1	Defaults	-	-	TRUE
GB103024077530	Rookhope Burn from source to Wear	3	35	Wear	Northumbria	1	2	1	1	Defaults	-	-	TRUE
GB109053022050	R Marden - Source to Conf Abberd Bk	6	28	Bristol Avon & North Somerset Streams	Severn	5	4	1	2	Defaults	-	-	TRUE
GB109054049310	R Severn - Conf Afon Dulas to Conf R Camlad	2	31	Severn Uplands	Severn	5	6	3	2	Defaults	-	-	FALSE
GB109054049480	Minsterley Bk - Source to Conf Rea Bk	2	31	Severn Uplands	Severn	2	4	1	1	Defaults	-	-	TRUE
GB109055042280	R Wye - Conf Afon Marteg to Conf Afon Elan	8	25	Wye	Severn	1	2	2	1	Site Specific	-	-	FALSE
GB102076073740	Whelpo (Cald) Beck	4	11	Eden and Esk	Solway Tweed	1	2	0	1	Defaults	9	-	FALSE
GB108044009690	Frome Dorset (Lower) & Furzebrook Stream	6	28	Dorset	South West	13	8	0	1	Defaults	-	-	FALSE
GB108045009180	Otter	6	27	East Devon	South West	3	2	0	1	Defaults	-	-	FALSE
GB108048007630	Warleggan River	6	27	North Cornwall, Seaton, Looe and Fowey	South West	1	2	2	1	Defaults	-	-	FALSE
GB108048002320	River Seaton	6	27	North Cornwall, Seaton, Looe and Fowey	South West	7	2	2	2	Defaults	-	-	TRUE
GB108047003640	Tory Brook	6	27	Tamar	South West	3	2	1	1	Defaults	-	-	FALSE
GB108047007850	Lumburn	6	27	Tamar	South West	2	2	0	1	Defaults	-	-	FALSE
GB108047007950	Upper River Tavy	6	27	Tamar	South West	3	2	2	1	Defaults	-	-	FALSE
GB108048001390	Upper River Fal	6	27	West Cornwall and the Fal	South West	6	2	2	1	Defaults	-	-	FALSE
GB108048002310	Par River (Upper)	6	27	West Cornwall and the Fal	South West	9	5	2	1	Defaults	-	-	FALSE
GB108048001330	Crinnis River	6	27	West Cornwall and the Fal	South West	1	2	1	2	Defaults	-	-	TRUE
GB108049000380	Hayle	6	27	West Cornwall and the Fal	South West	9	2	2	2	Defaults	-	-	TRUE
GB108049000570	Red River (Lower)	6	27	West Cornwall and	South West	2	8	3	3	Defaults	-	-	TRUE

WBID	Name	EA Region	EA Area	Catchment	RBD name	Number of sample points	Number of metals monitored	Number of metals failing EQS pre-tool	N° of metals failing EQS post-tool	Tool input	Centre for Ecology and Hydrology Site Number[1]	Environment Agency investigation[2]	"Priority" water body[3]
				the Fal									
GB108049000600	Red River (Upper)	6	27	West Cornwall and the Fal	South West	4	7	3	3	Defaults	-	-	TRUE
GB108049000620	Portreath Stream	6	27	West Cornwall and the Fal	South West	2	2	2	2	Defaults	-	-	TRUE
GB108049000630	Porthtowan Stream	6	27	West Cornwall and the Fal	South West	4	6	3	3	Defaults	-	-	TRUE
GB108049000670	Trevellas Stream	6	27	West Cornwall and the Fal	South West	1	2	2	2	Defaults	-	-	TRUE
GB110059032140	Aman - Conf with Garnant to conf with Loughor	8	26	Loughor to Taf	Western Wales	2	2	0	1	Defaults	-	-	FALSE
GB110060029061	Gwendraeth Fawr - Headwaters Afan Goch	8	26	Loughor to Taf	Western Wales	2	2	0	1	Defaults	-	-	FALSE
GB110060036280	Taf - Headwaters to confluence with Cynin	8	26	Loughor to Taf	Western Wales	7	8	0	1	Defaults	-	-	FALSE
GB110064048740	Wen (Mawddach)	8	24	North West Wales	Western Wales	1	2	1	1	Defaults	-	-	FALSE
GB110065053600	Dwyryd - Lower	8	24	North West Wales	Western Wales	1	8	2	3	Site Specific	-	-	FALSE
GB110064048320	Twymyn - Upper	8	24	North West Wales	Western Wales	1	2	2	1	Defaults	-	Yes	TRUE
GB110062043550	Meurig - Headwaters to confluence with Teifi	8	26	South West Wales	Western Wales	1	2	2	1	Defaults	-	-	TRUE
GB110063041590	Melindwr - Headwaters to confluence with Rheidol	8	26	South West Wales	Western Wales	1	2	2	1	Defaults	-	-	TRUE
GB110063041610	Clarach - Headwaters to conf with Bow Street Brook	8	26	South West Wales	Western Wales	4	3	2	2	Defaults	-	Yes	TRUE
GB110063041680	Magwr - Headwaters to confluence with Ystwyth	8	26	South West Wales	Western Wales	1	2	2	1	Defaults	-	Yes	TRUE

[1]Water body contains a sample site used in Environment Agency (2008b): *Environmental quality standards for trace metals in the aquatic environment,* project by Centre for Ecology and Hydrology.
[2]Water body is subject to planned or ongoing monitoring/investigation in Environment Agency Wales (Paul Edwards, personal communication).
[3]"Priority" water bodies are those where the EQS for Zn, Cu or Ni would be expected to fail – irrespective of any reasonable bioavailability correction.

Table B.5 Scenario 5 water bodies

WBID	Name	Environment Agency Region	Environment Agency Area	Catchment	RBD name
GB111067051860	Hirnant	8	24	Upper Dee	Dee
GB104028057880	River Derwent from R Ashop to R Wye	2	30	Derbyshire Derwent	Humber
GB104027068820	Cod Beck from Spital Beck to River Swale	3	34	Swale, Ure, Nidd & Upper Ouse	Humber
GB104027064090	Linton Beck Catchament (Trib of Wharfe)	3	34	Wharfe and Lower Ouse	Humber
GB104027064252	Wharfe Barben Beck/River Dibb to River Washburn	3	34	Wharfe and Lower Ouse	Humber
GB112070064951	River Yarrow Us Big Lodge Water	4	11	Douglas	North West
GB112073071120	Great Langdale Beck	4	11	Kent/Leven	North West
GB112073071130	Trout Beck	4	11	Kent/Leven	North West
GB112073071140	River Rothay	4	11	Kent/Leven	North West
GB112071065140	Sabden Brook	4	11	Ribble	North West
GB112071065530	Swanside Beck	4	11	Ribble	North West
GB103023075640	Stocksfield Burn Catchment (Trib of Tyne)	3	35	Tyne	Northumbria
GB103023075730	Red Burn (Trib of Tyne)	3	35	Tyne	Northumbria
GB103024077360	Bollihope Burn from source to Wear	3	35	Wear	Northumbria
GB109054049410	Afon Rhiw (Conf N and S Arm) to Conf R Severn	2	31	Severn Uplands	Severn
GB109055029670	Valley Bk - Source to Conf R Wye	8	25	Wye	Severn
GB102076073840	Raven Beck	4	11	Eden and Esk	Solway Tweed
GB108045014830	Kit Brook	6	27	East Devon	South West
GB108045015080	Brockey River	6	27	East Devon	South West
GB108045015100	Barle	6	27	East Devon	South West
GB108049006980	River Camel (De Lank to Stannon)	6	27	North Cornwall, Seaton, Looe and Fowey	South West
GB108052021370	Tone, Upper	6	28	South & West Somerset	South West
GB108047007770	Lew (Tamar)	6	27	Tamar	South West
GB108047007920	Lowley Brook	6	27	Tamar	South West
GB108047007930	Quither Stream	6	27	Tamar	South West
GB110064048440	Dysynni - Lower	8	24	North West Wales	Western Wales
GB110064048800	Wnion - Lower	8	24	North West Wales	Western Wales
GB110065053760	Soch	8	24	North West Wales	Western Wales
GB110065054120	Penrhos	8	24	North West Wales	Western Wales
GB110102058670	Cefni - Tidal limit to Ceint	8	24	North West Wales	Western Wales

Table B.6 Scenario 6 water bodies

WBID	Name	Environment Agency Region	Environment Agency Area	Catchment	RBD name	Number of metal elements failing pre-tool	Number of metal elements failing post-tool	"Priority" water body[1]
GB112075070350	River Cocker	4	11	Derwent (NW)	North West	0	0	FALSE
GB112072066240	Tarnbrook Wyre	4	11	Wyre	North West	1	0	FALSE
GB103022076770	Alwin Catchment (trib of Coquet)	3	35	Northumberland Rivers	Northumbria	0	0	FALSE
GB108049000530	Hayle Tidal, Lands End, St.Ives	6	27	West Cornwall and the Fal	South West	1	0	FALSE
GB110065053630	Cynfal	8	24	North West Wales	Western Wales	2	0	FALSE
GB110065053950	Colwyn	8	24	North West Wales	Western Wales	1	0	FALSE
GB110063041580	Castell - headwaters to confluence with Rheidol	8	26	South West Wales	Western Wales	2	1	FALSE
GB110063041650	Llechwedd Mawr - HW to Nant y Moch reservoir	8	26	South West Wales	Western Wales	2	1	FALSE
GB110063041570	Rheidol - confluence with Castell to tidal limit	8	26	South West Wales	Western Wales	3	1	TRUE

[1]"Priority" water bodies are those where the EQS for Zn, Cu or Ni would be expected to fail – irrespective of any reasonable bioavailability correction.

Table B.7 Scenario 7 water bodies

WBID	Name	Environment Agency Region	Environment Agency Area	Catchment	RBD name	Number of metals monitored	Number of metal elements failing pre-tool	Number of metal elements failing post-tool	"Priority" water body[1]
GB109055041910	R Irfon - Source to Conf Afon Gwesyn	8	25	Wye	Severn	2	1	0	FALSE
GB109055042300	Afon Elan - Source to Pont Ar Elan	8	25	Wye	Severn	2	0	0	FALSE
GB109055042350	Afon Tarenig - Source to Conf R Wye	8	25	Wye	Severn	2	2	1	FALSE
GB109055042360	R Wye - Source to Conf Afon Tarenig	8	25	Wye	Severn	2	2	1	FALSE
GB108050008080	West Okement	6	27	North Devon	South West	4	2	1	TRUE
GB108047003650	Upper River Plym	6	27	Tamar	South West	2	0	0	FALSE
GB108047007680	Withey Brook	6	27	Tamar	South West	2	0	0	FALSE
GB108047007870	Walkham	6	27	Tamar	South West	2	1	0	FALSE
GB108048001350	Gwindra Stream	6	27	West Cornwall and the Fal	South West	2	2	1	TRUE
GB110060036360	Doethie - Pysgotwr Fawr conf to conf with Tywi	8	26	Loughor to Taf	Western Wales	3	0	0	FALSE
GB110060036380	Tywi - Llyn Brianne to confluence with Doethie	8	26	Loughor to Taf	Western Wales	3	1	0	FALSE
GB110060041350	Camddwr - Headwaters to	8	26	Loughor to Taf	Western Wales	3	0	0	FALSE

WBID	Name	Environment Agency Region	Environment Agency Area	Catchment	RBD name	Number of metals monitored	Number of metal elements failing pre-tool	Number of metal elements failing post-tool	"Priority" water body[1]
	Llyn Brianne Reservoir								
GB110060041360	Tywi - Headwaters to Llyn Brianne Reservoir	8	26	Loughor to Taf	Western Wales	3	2	1	FALSE
GB110064054620	Mawddach - Upper	8	24	North West Wales	Western Wales	3	2	1	FALSE
GB110064054640	Gain	8	24	North West Wales	Western Wales	2	2	1	FALSE
GB110063041560	Mynach - Headwaters to confluence with Rheidol	8	26	South West Wales	Western Wales	2	2	0	FALSE
GB110063041640	Hengwm - Conf with Llechwedd-Mawr to Rheidol Conf	8	26	South West Wales	Western Wales	2	2	1	FALSE
GB110063041660	Hengwm - Headwaters to Nant Y Moch Reservoir	8	26	South West Wales	Western Wales	2	1	0	FALSE
GB110063041720	Ystwyth - Headwaters to conf with Cwmnewydion	8	26	South West Wales	Western Wales	2	2	0	FALSE

[1]"Priority" water bodies are those where the EQS for Zn, Cu or Ni would be expected to fail – irrespective of any reasonable bioavailability correction.

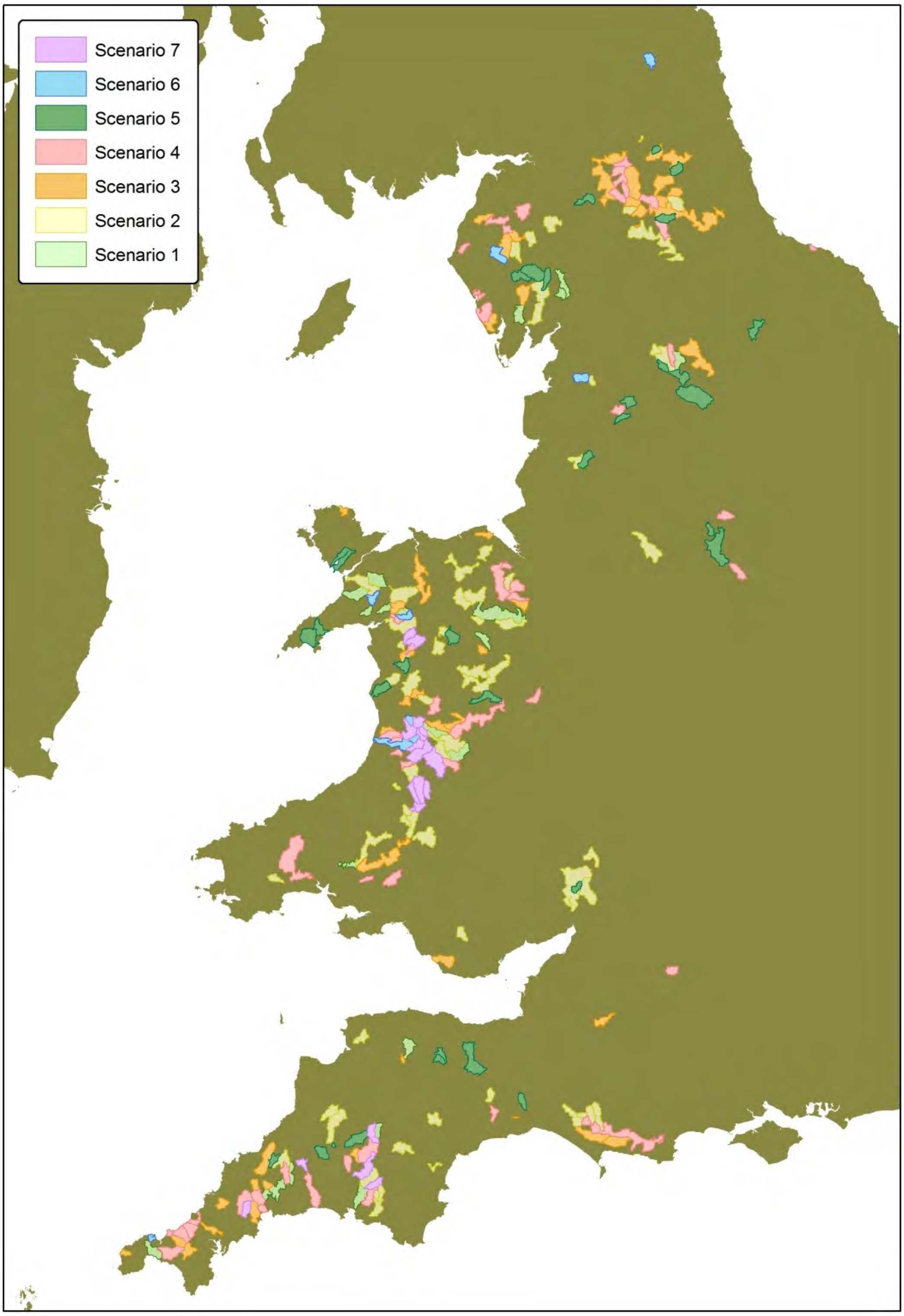

Figure B.1 Overview of water body compliance scenarios across England and Wales

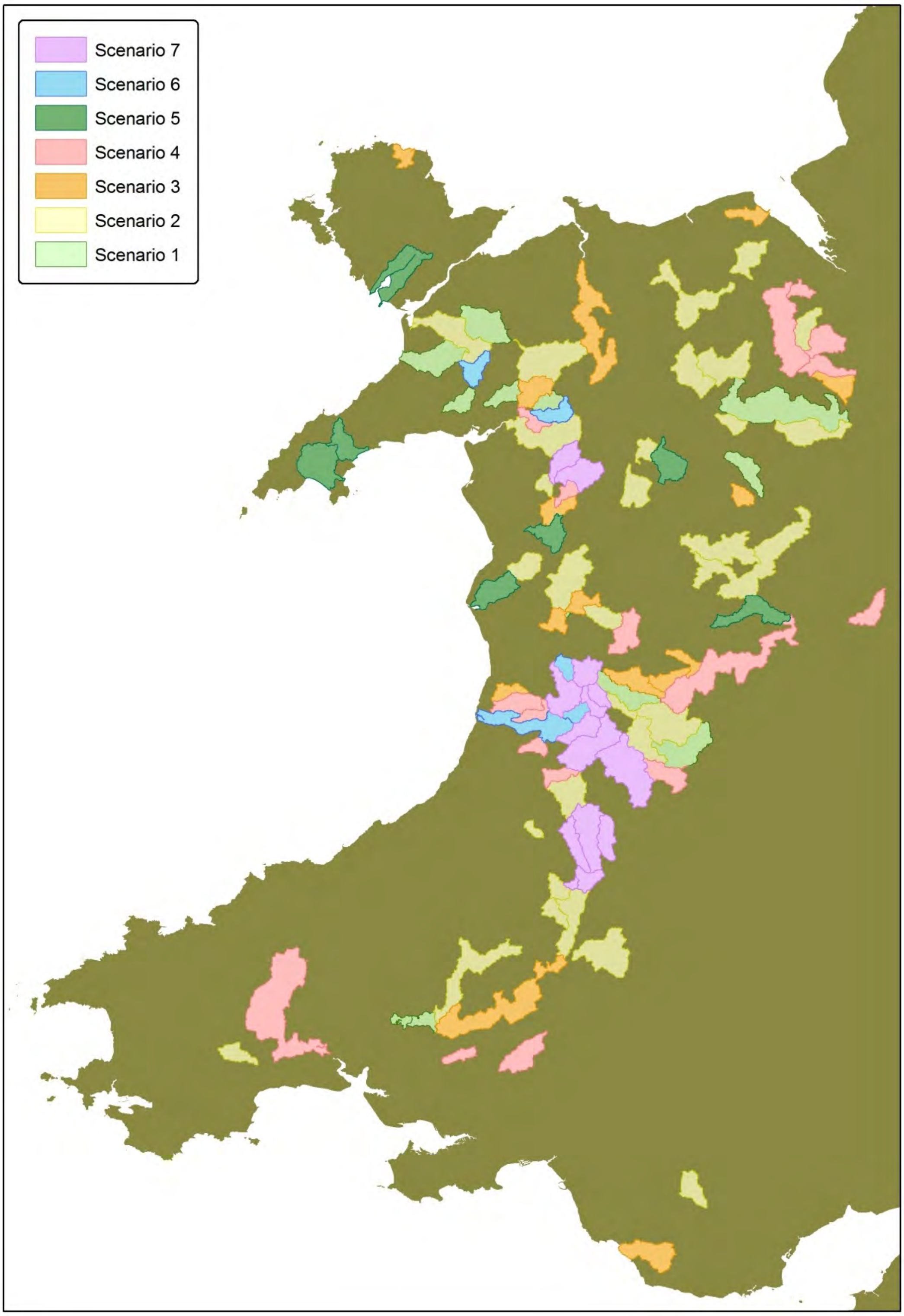

Figure B.2 Water body compliance scenarios in Wales

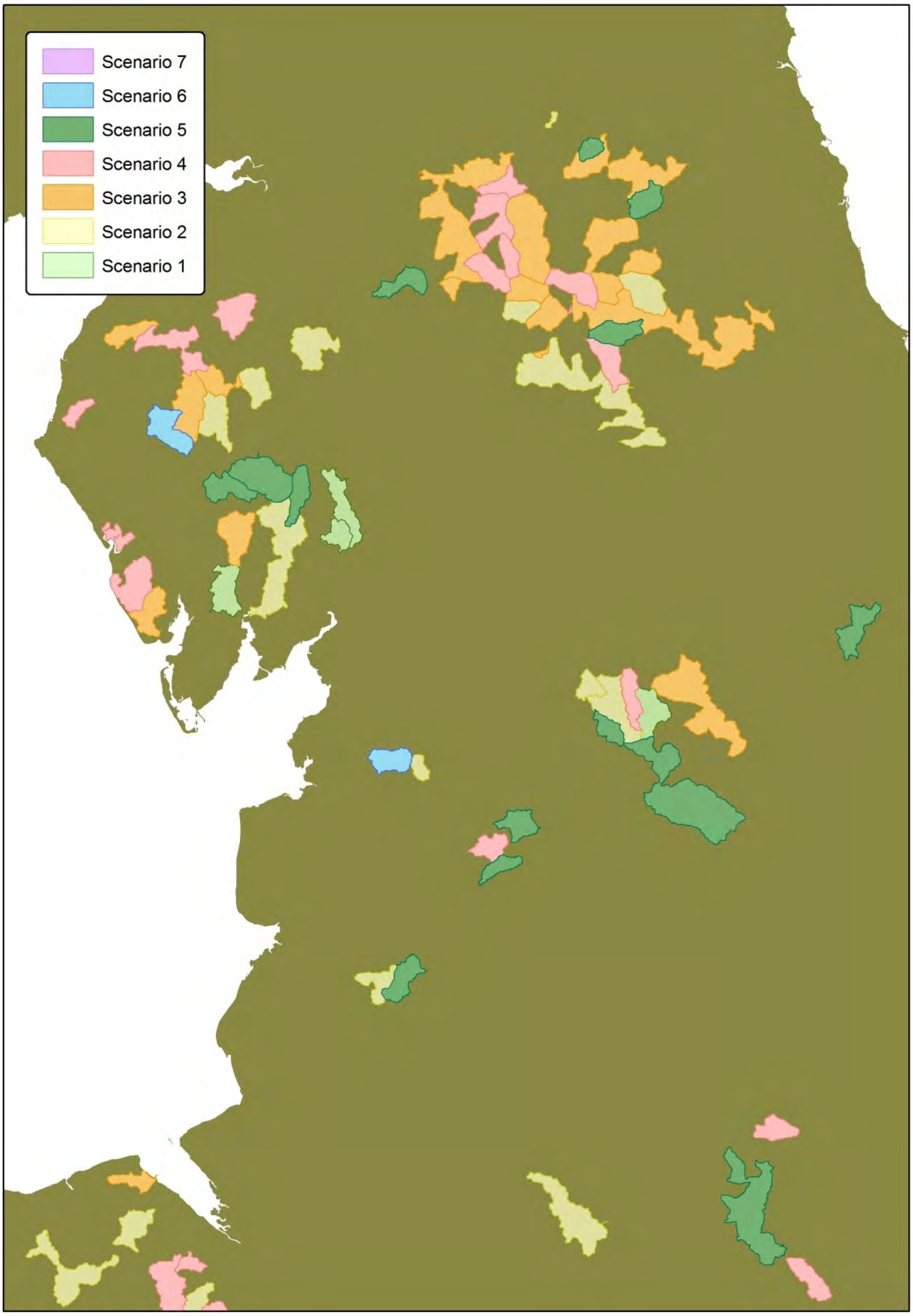

Figure B.3 **Water body compliance scenarios in Northern England**

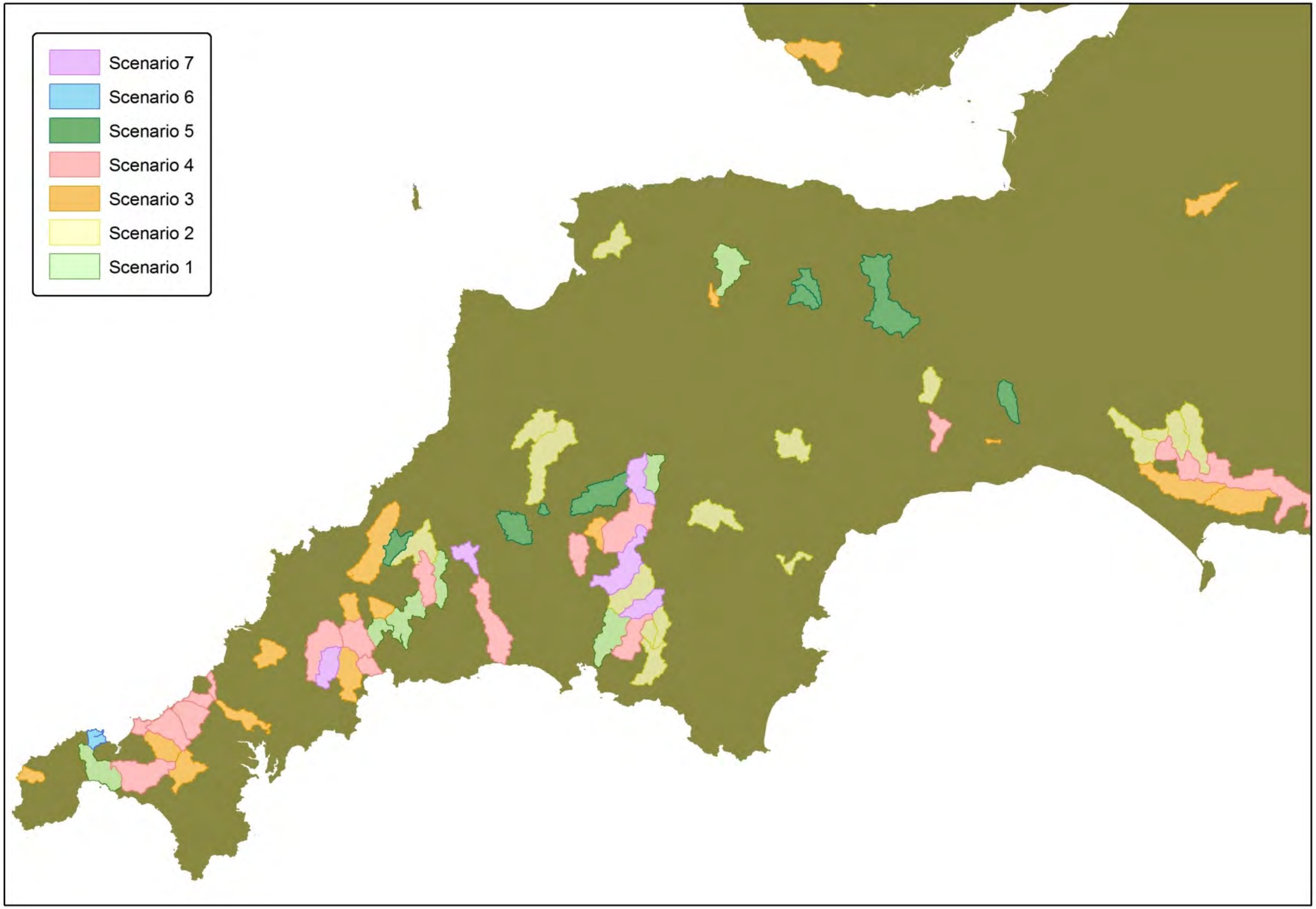

Figure B.4 Water body compliance scenarios in South West England

Appendix C – Field survey planning documentation

C.1 Lower River Fowey

C.1.1 Background

The Lower River Fowey water body (GB108048001420) was identified as 'impacted' by the NoCAM project and a Scenario 1 waterbody in the initial screening assessment of this project. It is classified as meeting good status for ecology (Table C.1) but failing to meet good status for chemistry because of environmental quality standard (EQS) failures for zinc and copper (Table C.2). Accounting for the bioavailability of zinc and copper using simple screening tools results in compliance with EQS for copper and zinc. Because site-specific data on all the physicochemical input parameters required for the bioavailability screening tools were not available, default values (derived from monitoring conducted in the wider hydrometric area) were used. The use of a hydrometric area default ambient background concentration (ABC) for zinc also contributed to the improvement in EQS compliance.

Table C.1 Summary of ecological monitoring data used for classification of GB108048001420 (BQE, biological quality element; EQR, environmental quality ratio)

Site	BQE	Survey	EQR	WB EQR	Status
10714	ASPT	2006	1.08	1.06	High
		2008	1.04		
	NTAXA	2006	0.98	0.96	High
		2008	0.94		
	Diatoms	2008	0.92	0.92	Good
	Macrophytes	2007	0.95	0.96	High
		2008	0.96		

Table C.2 Summary of chemical monitoring data used for classification of GB108048001420

Determinand	Mean µg l^{-1} (std dev), number of samples[a]	
	81520166	81520205
Arsenic (dissolved As)	-	2.91 (0.77), 30
Benzo(a)pyrene	-	<MRL, 30
Benzofluoranthene	-	<MRL, 30
Benzoindeno	-	<MRL, 30
Cadmium (dissolved Cd)	-	0.018 (0.024), 30
Copper (dissolved Cu)	2.76 (1.38), 34	2.56 (1.43), 36
Diuron	<MRL, 17	<MRL, 19
Drins	-	<MRL, 30
Fluoranthene	-	<MRL, 30

Determinand	Mean µg l^{-1} (std dev), number of samples[a]	
	81520166	81520205
Iron (dissolved Fe)	-	75.93 (33.3), 30
Lead (dissolved Pb)	-	<MRL, 36
Mecoprop	<MRL, 18	<MRL, 20
Mercury (dissolved Hg)	-	0.0049 (0.011), 30
Nickel (dissolved Ni)	-	<MRL, 36
DDT	-	<MRL, 27
Zinc (total Zn)	11.38 (4.37), 34	12.01 (7.22), 36
Zinc (dissolved Zn)	-	8.98 (2.34), 36
Bioavailability screening tool input parameters		
Median DOC	-	2.27
Default DOC (hydrometric area)	1.87	1.87
Mean pH	7.30	7.27
Mean Ca	6.22	6.11
Default Ca (hydrometric area)	14	14

MRL: minimum reporting limit.

[a]Highlighted cells are “significant” ($p<0.05$) compliance failures before bioavailability correction (>95% confidence of failure).

Table C.3 Location of known or suspected mine point sources in GB108048001420

Name	Easting	Northing
East Jane Mine	213664	64507
Restormel Mine	210223	60596
Duke of Cornwall Mine	210522	63051
Adit Nr Maudlin	208739	62628
Afit Nr Hawks Tor Adj A38	214119	65771

C.1.2 Field programme objectives

The objectives of the field programme in the Fowey are as follows:

1. Undertake a fisheries survey to ensure that the current “good ecological status” classification is based on a complete set of ecology data.
2. Obtained measured values for the default input parameters required for the bioavailability screening tool (dissolved organic carbon (DOC), pH and Ca) to ensure that default values are not under-protective.
3. Obtain measured values for the full biotic ligand model (BLM) input parameters (temperature, pH, DOC, major cations [Ca, Mg, Na and K], major anions [SO_4, Cl] and alkalinity) to ensure that the bioavailability screening tool is not under–protective.
4. Obtain measured values for dissolved zinc at all the chemical monitoring points in the water body and attempt to establish zinc ABC in the Lowey River Fowey (by sampling low order tributaries) to ensure that default ABC values are not under-protective.

C.1.3 Sampling required

1. Single fisheries survey and classification according to FCS2 at, or close to, BIOSYS sample point 10714 (Restormel).

2. Chemistry sampling at WIMS sample points 81520166 (River Fowey at Restormel) and 81520205 (River Fowey at Respryn Bridge) for dissolved metals and physicochemical input parameters for bioavailability screening tool and full biotic ligand models for copper and zinc:
    - Two sites.
    - Sampling every two weeks for three months.

3. Chemistry sampling at low strahler order sites in the water body that are not affected by mine discharge for determination of zinc ambient background concentration.
    - Three to four sites (depending on suitable sites e.g. access/permission).
    - Sampling every two weeks for three months.

Table C.4 Location of candidate background monitoring sites in GB108048001420

Candidate background site	Easting	Northing
1	212382	65575
2	214086	66934
3	214950	64032
4	212184	63316
5	208208	63155

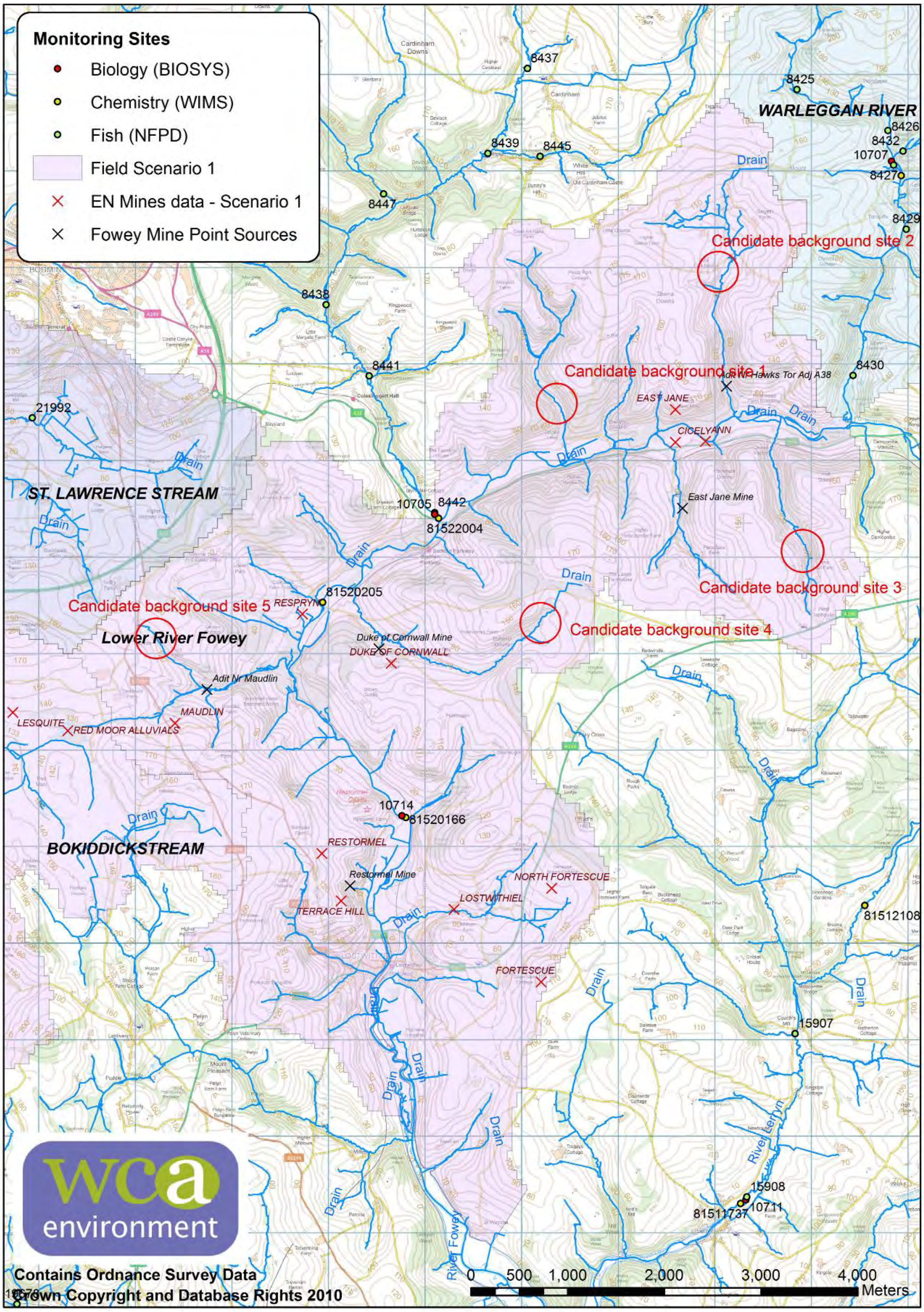

Figure C.1 Map of proposed field programme in the Lower River Fowey (GB108048001420)

C.2 River Cober US Lowertown Bridge

C.2.1 Background

The River Cober upstream of Lowertown Bridge (GB108048001171) was identified as ‘impacted’ by the NoCAM project and Scenario 3 in the initial screening assessment of this project. It is currently classified as meeting good status for ecology (Table C.5) but failing to meet good status for chemistry because of EQS failures for zinc and copper (Table C.6). Application of bioavailability screening tools for zinc and copper do not result in compliance with EQS for copper and zinc. Because data on all the physicochemical input parameters required for the bioavailability screening tool were not available, default values (derived from monitoring conducted in the wider hydrometric area) were used to run the tool. The use of a hydrometric area default ambient background concentration (ABC) for zinc did not result in EQS compliance.

Table C.5 Summary of ecological monitoring data used for classification of GB108048001171 (BQE, biological quality element; EQR, environmental quality ratio)

Site	BQE	Survey	EQR	WB EQR	Status
10894	ASPT	2008	0.98 (H)	0.95 (G)	Good
	NTAXA	2008	1.01 (H)	0.91 (H)	High
	TDI	2008	0.89 (G)	0.89 (G)	Good
10897	ASPT	2006	0.93 (G)	0.95 (G)	Good
		2008	0.95 (G)	0.95 (G)	Good
	NTAXA	2006	0.97 (H)	0.91 (H)	High
		2008	0.75 (G)	0.91 (H)	High
13318	FCS2	2006	0.73 (G)	0.54 (G)	Good
13317		2006	0.35 (M)	0.54 (G)	Good

Macrophyte data are also available for the River Cober from BIOSYS sites 10894 (2008) and 10897 (2007) but were not used for WFD classification (data were supplied by Peter Long, SW region).

Table C.6 Summary of chemical monitoring data used for classification of GB108048001171

Determinand	Mean µg l^{-1} (std dev), number of samples[a]		
	82010156	82010187	8201125
Copper (dissolved Cu)	10.61 (2.25), 35	-	-
Zinc (total Zn)	25.39 (5.22), 35	-	-
Bioavailability screening tool input parameters			
Median DOC	-	-	-
Default DOC (hydrometric area)	1.87	1.87	1.87
Mean pH	7.08	-	-
Mean Ca	9.39	-	-
Default Ca (hydrometric area)	14	14	14

[a]Highlighted cells are “significant” (p<0.05) compliance failures before bioavailability correction (>95% confidence of failure).

Table C.7 Location of known or suspected mine point sources in GB108048001171

Name	Easting	Northing
Wheal Mount	166464	30868
Wheal Fursden	167000	31800
Wheal Christopher	166384	32565
Poldark Mine	168276	31561
Wheal Cock Shaft/Wheal Basset & Gryllis	168839	32825
Tyack's Shaft	169472	32882
North Lovel Mine	169984	32993
Medlyn Moor Mine	170670	33351
Balmynheer Mine	170412	34114
Wheal Enys	168874	33418
Boswin Mine	169358	33890
Wheal Rock	168904	34748
Calvadnack Mine	170030	34809

C.2.2 Objectives

The objectives of the field programme in the River Cober US Lowertown Bridge are to:

1. Undertake macroinvertebrate and diatom surveys to ensure that the current “good ecological status” classification is based on a complete set of ecology data.
2. Obtained measured values for the default input parameters required for the bioavailability screening tool (DOC, pH and Ca) to ensure that default values are not under-protective.
3. Obtain measured values for the full BLM input parameters (temperature, pH, DOC, major cations [Ca, Mg, Na and K], major anions [SO_4, Cl] and alkalinity) to ensure that the bioavailability screening tool is not under-protective.
4. Obtain measured values for dissolved zinc at all the chemical monitoring points in the water body and attempt to establish zinc ABC in the River Cober (by sampling low order tributaries) to ensure that default ABC values are not under-protective.

C.2.3 Sampling required

1. Single macroinvertebrate survey and classification according to NTAXA[16] and ASPT[17] metrics using RICT[18] at, or close to, WIMS[19] sample point 82011025 (Medlyn).
2. Diatom surveys and classification according to TDI[20] at BIOSYS sample point 10897 (Trenear) and WIMS sample point 8201125 (Medlyn).

16 NTAXA: Number of taxa

17 ASPT: Average Score Per Taxa

18 RICT: River Invertebrate Classification Tool

19 WIMS: Water Information Management System

20 TDI: Trophic Diatom Index

3. Chemistry sampling at WIMS sample points 82010156 (River Cober at Lowertown Bridge), 82010187 (River Cober at Trenear Bridge) and 82011025 (Medlyn) for dissolved metals and physicochemical input parameters for bioavailability screening tool and full BLM for copper and zinc:
    - Three sites.
    - Sampling every two weeks for three months.
4. Chemistry sampling at low strahler order sites in the waterbody that are not affected by mine discharge for determination of zinc ambient background concentration.
    - Three to four sites (depending on suitable sites e.g. access/permission).
    - Sampling every two weeks for three months.

Table C.8 Location of candidate background monitoring sites in GB108048001171

Candidate background site	Easting	Northing
1	166945	34526
2	167705	34914
3	168673	35480
4	171504	34124

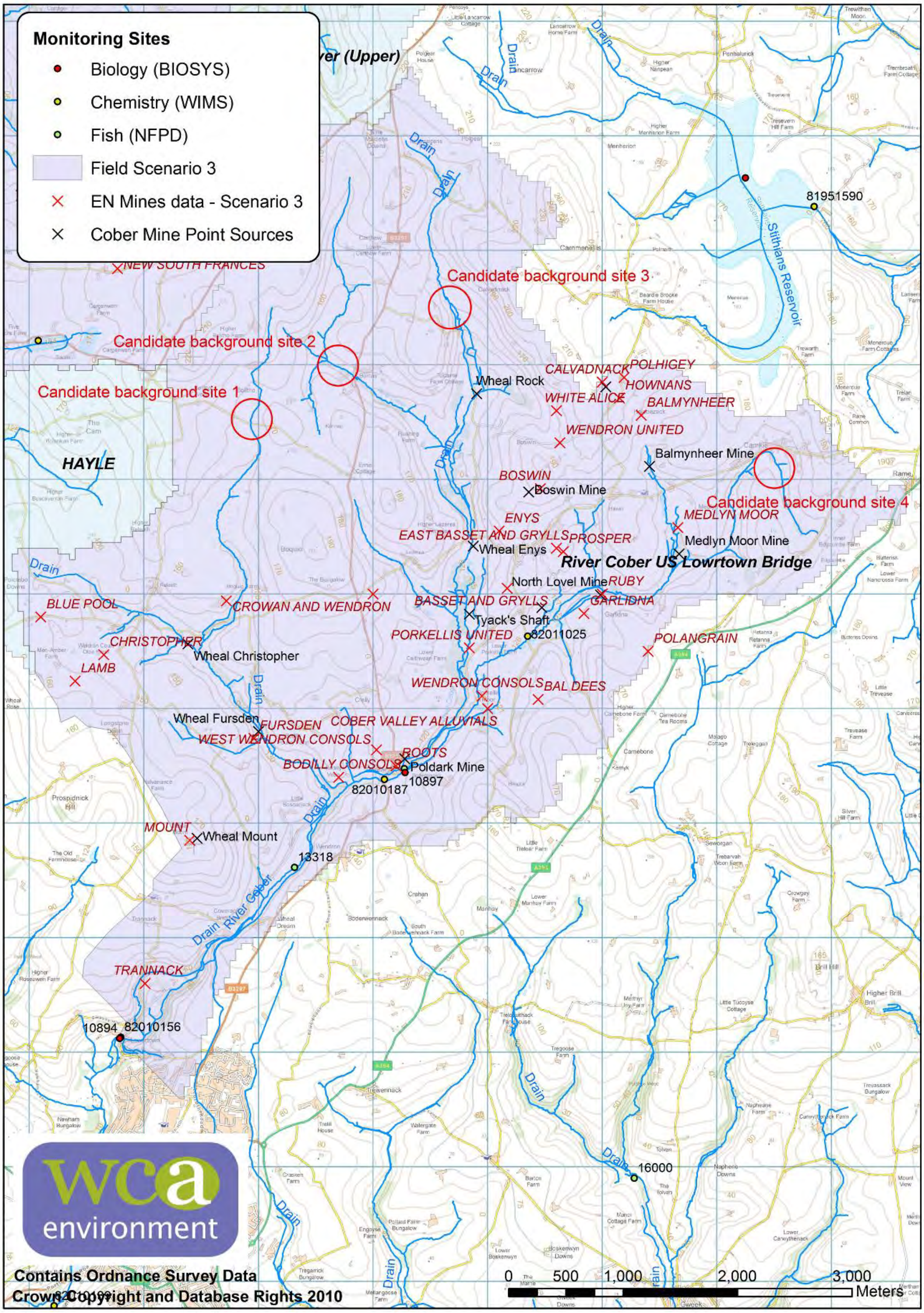

Figure C.2 Map of proposed field programme in the River Cober US Lowertown Bridge (GB108048001171)

C.3 Bow Street Brook - Headwaters to confluence with Clarach

C.3.1 Background

The Bow Street Brook – Headwaters to confluence with Clarach water body (GB110063041630) was identified as 'impacted' by the NoCAM project and Scenario 3 in the initial screening assessment of this project. It is currently classified as meeting good status for ecology (Table C.9) based on field data for invertebrates and fish but failing to meet good status for chemistry because of EQS failures for zinc and copper (Table C.10). Application of bioavailability screening tools for zinc and copper result in compliance with the EQS for copper but not zinc. As data on all the physicochemical input parameters required for the bioavailability screening tool were not available, default values (derived from monitoring conducted in the wider hydrometric area) were used to run the tool. In addition, the use of ABC for zinc was not possible as no default value for the Bow Street Brook was available.

Table C.9 Summary of ecological monitoring data used for classification of GB110063041630 (BQE, biological quality element; EQR, environmental quality ratio)

Site	BQE	Survey	EQR	WB EQR	Status
44440	ASPT	2007	0.86 (G)	0.86 (G)	Good
	NTAXA	2007	1.04 (H)	1.04 (H)	High
16516	FCS2	2005	0.63 (G)	0.63 (G)	Good

Fisheries survey is above the Bow Street sewage treatment works (STW) outfall. Macroinvertebrate survey is below the outfall.

Table C.10 Summary of chemical monitoring data used for classification of GB110063041630

Determinand	Mean µg l^{-1} (std dev), number of samples	
	80009	80010
Copper (dissolved Cu)	1.41 (0.73), 36	1.66 (0.75), 36
Zinc (total Zn)	32.76 (11.45), 36	30.57 (12.47), 36
Bioavailability screening tool input parameters		
Median DOC	-	-
Default DOC (hydrometric area)	1.74	1.74
Mean pH	7.04	7.13
Mean Ca	11.58	11.35
Default Ca (hydrometric area)	5.71	5.71

[a]Highlighted cells are "significant" ($p<0.05$) compliance failures before bioavailability correction (>95% confidence of failure).

Table C.11 Location of known or suspected mine sites/point sources in GB110063041630

Name	Easting	Northing	Top 50 welsh mine
Pwll Glas	262900	286500	No
Llandre	262900	286500	No
Cynull Mawr	265900	287300	No
Mine 22	265200	286100	No
Mine 23	265800	286100	No
Elgar	266200	286000	No
Penycefn East	266200	285700	No
Mynydd Gorddu	266800	286100	Yes
Llanerch	267500	285800	No

C.3.2 Objectives

The objectives of the field programme in the Bow Street Brook are as follows:

1. Undertake a diatom survey to ensure that the current "good ecological status" classification is based on a complete set of ecology data.
2. Obtained measured values for the default input parameters required for the bioavailability screening tool (DOC, pH and Ca) to ensure that default values are not under-protective.
3. Obtain measured values for the full BLM input parameters (temperature, pH, DOC, major cations [Ca, Mg, Na and K], major anions [SO_4, Cl] and alkalinity) to determine if full BLM is less precautionary than bioavailability screening tool.
4. Obtain measured values for dissolved zinc (rather than total zinc) at the WIMS chemical monitoring points in the water body and, in addition, attempt to establish zinc ABC in Bow Street Brook (by sampling low order tributaries) in the water body.

C.3.3 Sampling required

1. Undertake a single diatom survey (according to DARES, Diatoms for Assessing River Ecological Status) at BIOSYS sample point 44440 (downstream of Bow Street STW).
2. Chemistry sampling at WIMS sample points 80009 (Bow Street Brook above Bow Street STW) and 80010 (Bow Street Brook below Bow Street STW) for dissolved metals and physicochemical input parameters for bioavailability screening tool and full BLM for copper and zinc:
    - Two sites.
    - Sampling every two weeks for three months.
3. Chemistry sampling at low strahler order sites within the waterbody that are not affected by mine sites/roads for determination of zinc ABC.
    - Three to four sites (depending on suitable sites e.g. access/permission).
    - Sampling every two weeks for three months.

Table C.12 Location of candidate background monitoring sites in GB110063041630

Candidate background site	Easting	Northing
1	263045	287259
2	263730	286502
3	265550	287025
4	264009	286060

5	262946	284997

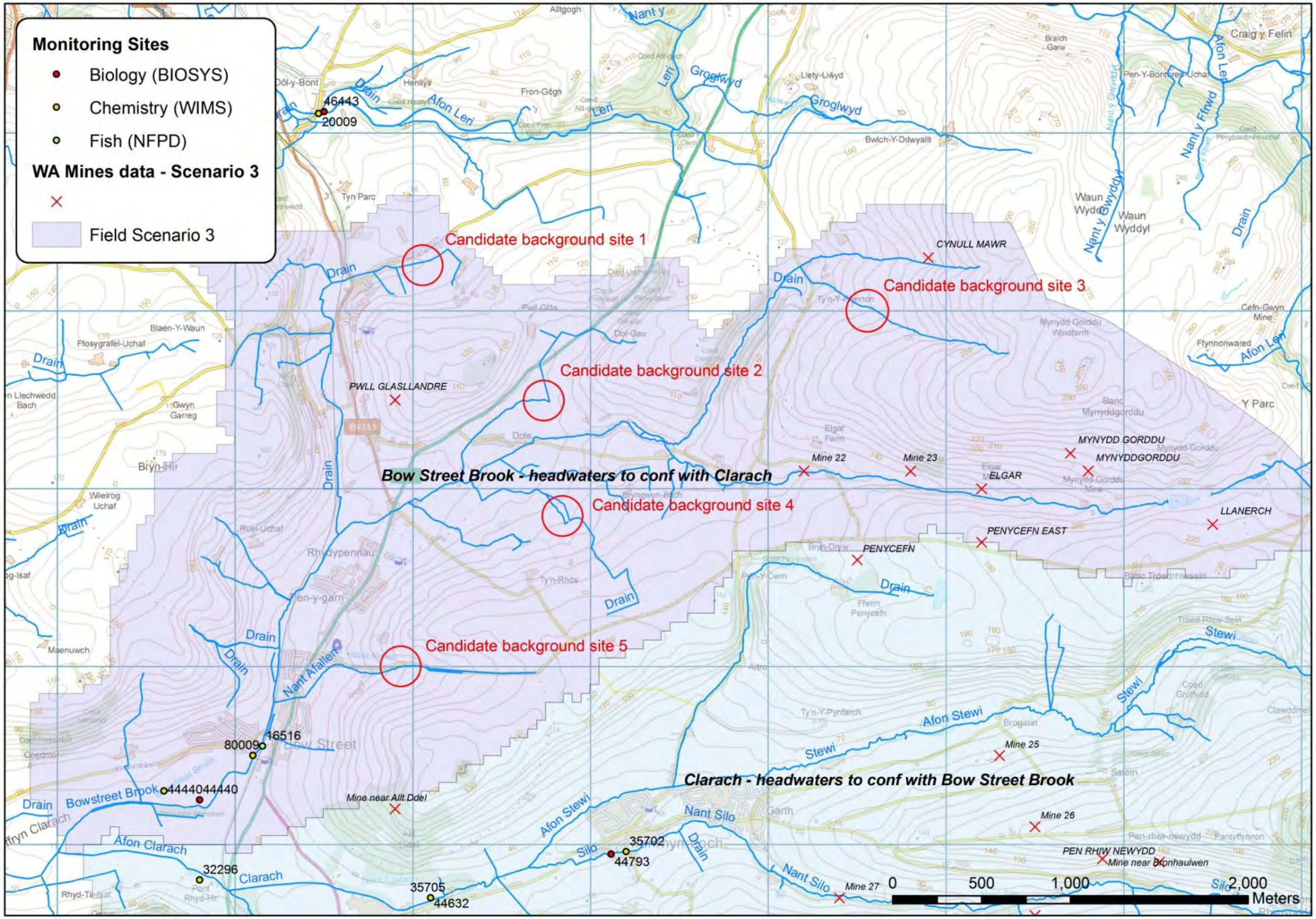

Figure C.3 Map of proposed field programme in the Bow Street Brook (GB110063041630)

C.4 Clarach – headwaters to confluence with Bow Street Brook

C.4.1 Background

The Clarach – headwaters to confluence with Bow Street Brook (GB1100630416) was identified as 'impacted' by the NoCAM project and Scenario 4 in the initial screening assessment. It is currently classified as not meeting good status for ecology (Table C.13) or chemistry (Table C.14). Application of bioavailability screening tools for zinc and copper do not result in compliance with the EQS. As data on all the physicochemical input parameters required for the bioavailability screening tool were not available, default values (derived from monitoring conducted in the wider hydrometric area) were used as tool inputs. The use of ABC for zinc was not possible as no default value for the Clarach was available.

Table C.13 Summary of ecological monitoring data used for classification of GB1100630416

Site	BQE	Survey	EQR	WB EQR	Status
44632	ASPT	2008	0.98 (H)	0.99 (H)	High
	NTAXA	2008	0.61 (M)	0.61 (M)	Moderate
44793	ASPT	2008	0.99 (H)	0.99 (H)	High
	NTAXA	2008	0.62 5(M)	0.62 (M)	Moderate

Fisheries data used for WFD classification is outside of the waterbody (NFDP sites 12197, 12198, 12199, 5380). Sites can be seen in the bottom right of figure 3.1. There is no fisheries, diatom or macrophyte data available in the Clarach for classification.

Table C.14 Summary of chemical monitoring data used for classification of GB1100630416 (BQE, biological quality element; EQR, environmental quality ratio)

Determinand	Mean µg l^{-1} (std dev), number of samples[a]		
	32296	**35705**	**35702**
Copper (dissolved Cu)	4.60 (1.16), 34	5.97 (1.52), 36	8.78 (2.27), 36
Zinc (total Zn)	108.94 (31.64), 34	148.47 (35.72), 36	148.51 (32.64), 36
Bioavailability screening tool input parameters			
Median DOC	-	-	1.94
Default DOC (hydrometric area)	1.74	1.74	1.74
Mean pH	7.19	7.20	7.22
Mean Ca	11.42	9.07	8.62
Default Ca (hydrometric area)	5.71	5.71	5.71

[a]Highlighted cells are "significant" ($p<0.05$) compliance failures before bioavailability correction (>95% confidence of failure).

Table C.15 Location of known or suspected mine sites/point sources in GB1100630416

Name	Easting	Northing	Top 50 welsh mine
Cefnllwyd	265600	282900	no
Cerigyrwyn	268400	283600	no
Roman level	268400	283500	no
Cwmdaren	268200	283400	no
Cwmerfin	269600	282900	no
Daren	267500	282800	yes
Cwmsymlog	269800	283700	yes
Penycefn east	266200	285700	no
Gwaithyrafon	269000	283900	no
Llechweddhelyg	268100	284800	no
Llechweddhen	266268	283549	no
Llettyhen	269400	284900	no
Penycefn	265500	285600	yes
Daren south	268572	283050	no
Bronfloyd	265900	283500	yes
Bwlch consols	270200	282300	no
Bwlchrehennaid	270600	282300	no
Ceunant	270800	282700	no
Pengraigddu	271000	282400	no
Ty'r rhod	270400	283800	no
Bronfloyd east	266500	283600	no
Bwlch united	270300	282400	no
Caenant	270800	282600	no
Gwaith yr afon	269000	284000	no
Gwaithcoch	270500	284200	no
Vaughan	269400	284800	no
Pen rhiw newydd	267200	283900	no
Alltfadog	265700	282100	no
Mine near Allt Ddel	262900	284200	no
Mine 85	270000	283100	no
Rhosgoch	264700	283200	no
Mine 25	266300	284500	no
Mine 26	266500	284100	no
Mine 27	265400	283700	no
Cwm daren	268100	283300	no
Mine 29	265700	282500	no
Mine 30	269300	282700	no
Mine M25	268800	284900	no
Levelyrllch	270600	282200	no
Mine near Bronhaulwen	266879	283920	no

C.4.2 Objectives

The objectives of the field programme in the Clarach are as follows:

1. Undertake a diatom, macroinvertebrate and fisheries survey to ensure that current ecological classification is robust.
2. Obtained measured values for the default input parameters required for the bioavailability screening tool (DOC, pH and Ca) to ensure that default values are not under-protective.
3. Obtain measured values for the full BLM input parameters (temperature, pH, DOC, major cations [Ca, Mg, Na K], major anions [SO_4, Cl] and alkalinity).
4. Background sites monitored in the Bow Street Brook will be used as background sites for the Clarach.

C.4.3 Sampling required (summarised in Table C.16)

1. wca environment to undertake a fisheries survey (according to WFD method [FCS2]) at, or near to, BIOSYS sample site 44632. This is dependent on consents being granted.
2. wca environment to undertake macroinvertebrate surveys (according to RICT) at WIMS sample points 35704 (Nant Peithyll near Capel Dewi), 35703 (Nant Stewy at Penrhyncoch) and 35701 (Nant Silo at Penbont Rhyd Y Be). RICT physicochemical input parameters (e.g. width, depth, substrate) also to be collected.
3. wca environment to undertake a diatom survey (according to DARES) at BIOSYS sample points 44632 (Plas Gogerddan Woodlands) and 44793 (downstream of confluence with Erfin) and WIMS sample points 35704 (Nant Peithyll near Capel Dewi), 35703 (Nant Stewy at Penrhyncoch) and 35701 (Nant Silo at Penbont Rhyd Y Be).
4. wca environment to undertake chemistry sampling at WIMS sample points 32296, 35705, 35704 and 81223:
   - Four sites.
   - Sampling every two weeks for three months.
5. Environment Agency to monitor WIMS sites 35702, 35703, 35701 using analytical suite equivalent to WE281 (for BLM input parameters and metals) every two weeks for three months.

Table C.16 Monitoring summary for GB1100630416

Site	Site type	Chemistry	Macroinvertebrates	Diatoms	Fish
44632	BIOSYS			✓ (wca)	✓ (wca)
44793	BIOSYS			✓ (wca)	
32296	WIMS	✓ (wca)			
35705	WIMS	✓ (wca)			
35704	WIMS	✓ (wca)	✓ (wca)	✓ (wca)	
81223	WIMS	✓ (wca)			
35702	WIMS	✓ (EA)			
35703	WIMS	✓ (EA)	✓ (wca)	✓ (wca)	
35701	WIMS	✓ (EA)	✓ (wca)	✓ (wca)	

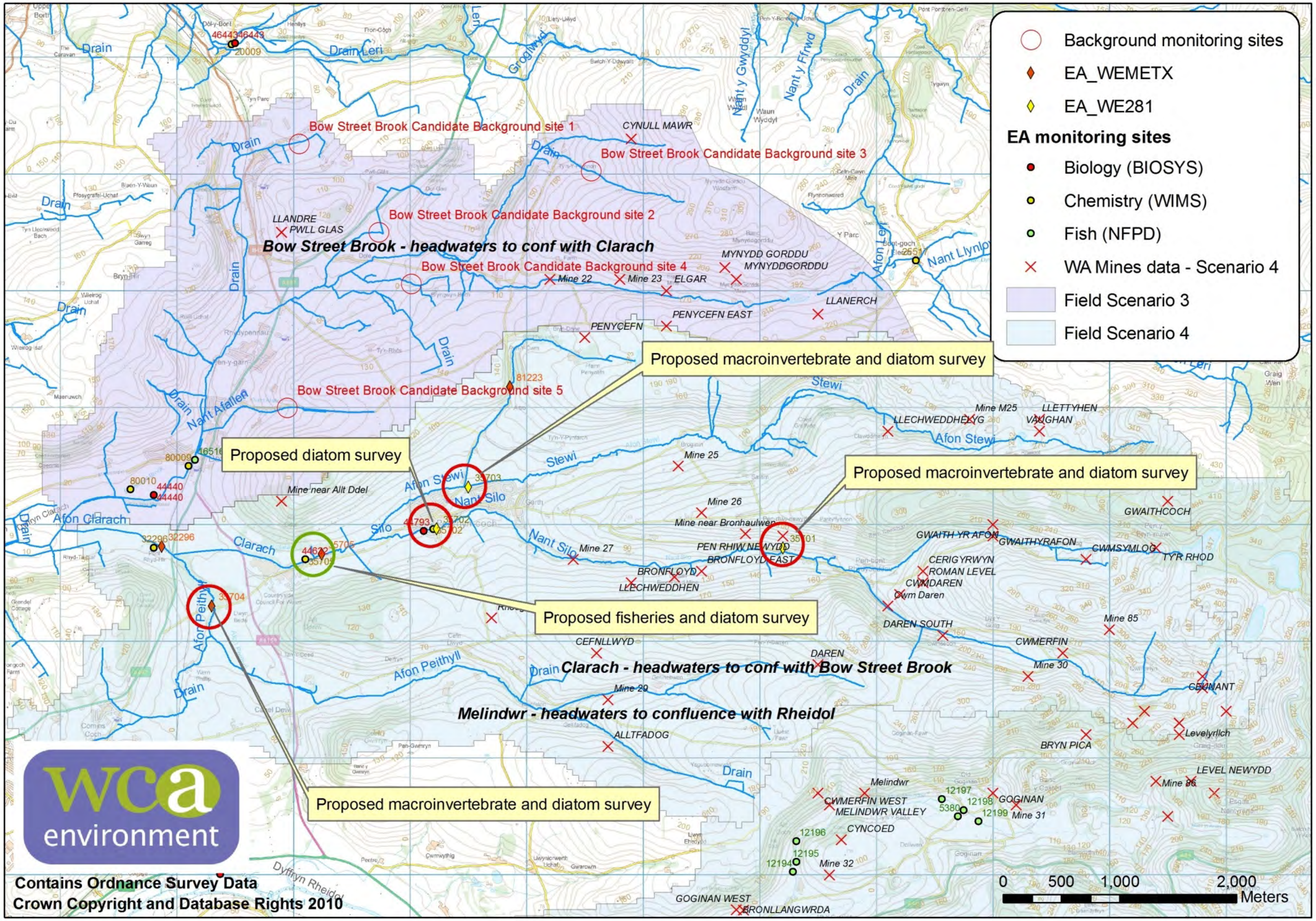

Figure C.4 **Map of proposed field programme in the Clarach (GB1100630416)**

Appendix D – Field programme chemistry data

D.1 Lower River Fowey

D.1.1 WIMS 81520166 (River Fowey at Restormel) NGR SX 1080 6130

Analyte	Units	MRV	20/10/10	03/11/10	17/11/10	01/12/10	14/12/10	14/01/11	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	1.42	2.39	4.85	1.95	1.06	3.98	2.61	1.50	6	2.17
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	14	2.39	8	13	12	11	10.07	4.29	6	11.5
Chloride	mg/l	1	17.4	17	14.2	18.3	17.5	15.2	16.60	1.56	6	17.2
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	3.01	2	3.31	1.71	1.47	2.79	2.38	0.76	6	2.395
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1
Nickel, Dissolved	ug/l	1	1.42	1.02	0.5	0.5	0.5	1.21	0.86	0.41	6	0.76
Zinc, Dissolved	ug/l	5	11.7	8.84	9.76	12	8.56	10.1	10.16	1.43	6	9.93
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0	6	0.05
Copper	ug/l	1	1.9	2.3	15.7	2.5	2.2	5.1	4.95	5.39	6	2.4
Lead	ug/l	2	1	1	11.5	1	1	2.1	2.93	4.22	6	1
Nickel	ug/l	1	0.5	0.5	5.5	1.1	0.5	2.2	1.72	1.97	6	0.8
Zinc	ug/l	5	8.8	9.6	49.2	17.5	11.5	19.3	19.32	15.25	6	14.5
Calcium, Dissolved	mg/l	1	6.9	6.4	3.3	7.2	6.5	5.4	5.95	1.43	6	6.45
Magnesium, Dissolved	mg/l	0.3	2.9	2.67	1.53	2.99	2.78	2.24	2.52	0.55	6	2.725
Potassium, Dissolved	mg/l	0.1	1.69	1.91	2.18	1.85	1.51	1.65	1.80	0.24	6	1.77
Sodium, Dissolved	mg/l	2	10.2	9.8	7.2	10.2	9.8	8.6	9.30	1.18	6	9.8
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5
pH	-		7.21	7.46	6.99	7.63	7.72	7.47	7.41	0.27	6	7.47
Temperature	ºC		9.8	12.8	9.8	4.6	5.7	10.4	8.85	3.09	6	9.80
Width	m		6.5	6.5	6.5	6.5	6.5	6.5	6.5	0	6	6.5
Depth	cm		60	60	100	65	65	100	75	19	6	65
Substrate	Cobble, gravel, boulder											
Weather			60% cloud, dry	100% cloud, dry	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle				

Surrounding land use: pasture, wooded banks, bridge (stone). MRV = minimum reporting value.

D.1.2 WIMS 81520205 (River Fowey Respryn) NGR SX 09920 63530

Analyte	Units	MRV	20/10/10	03/11/10	17/11/10	01/12/10	14/12/10	14/01/11	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	1.54	2.46	4.9	2.19	1.12	4.06	2.71	1.47	6	2.35
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	14	14	11	13	11	11	12.33	1.51	6	12.0
Chloride	mg/l	1	17.5	16.7	13.9	18.1	17.3	15.0	16.42	1.63	6	17.0
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	<MRV
Copper, Dissolved	ug/l	1	1.68	2.18	3.19	1.51	1.57	2.63	2.13	0.67	6	1.93
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	<MRV
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	1.11	0.60	0.50	6	0.5
Zinc, Dissolved	ug/l	5	8.63	9.95	9.74	10.6	8.3	10.4	9.60	0.94	6	9.85
Cadmium	ug/l	0.1	0.05	0.05	0.24	0.05	0.05	0.11	0.09	0.08	6	0.05
Copper	ug/l	1	1.8	2.6	15.1	1.8	2.2	4.6	4.68	5.21	6	2.40
Lead	ug/l	2	1	1	10.9	1	1	1	2.65	4.04	6	1.0
Nickel	ug/l	1	0.5	1.2	5.2	0.5	0.5	2	1.65	1.84	6	0.85
Zinc	ug/l	5	9.3	11.4	49.3	10.7	9.5	21.7	18.65	15.72	6	11.05
Calcium, Dissolved	mg/l	1	6.9	6.2	3.3	6.9	6.3	5.3	5.82	1.37	6	6.25
Magnesium, Dissolved	mg/l	0.3	2.92	2.56	1.48	2.82	2.58	2.13	2.42	0.53	6	2.57
Potassium, Dissolved	mg/l	0.1	1.7	2.01	2.14	1.78	1.53	1.58	1.79	0.24	6	1.74
Sodium, Dissolved	mg/l	2	10.5	9.8	7.1	9.9	9.7	8.5	9.25	1.24	6	9.75
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.0
pH	-		7.3	7.46	7.02	7.36	7.46	7.48	7.35			7.5
Temperature	ºC		9.8	12.7	9.8	4.6	4.3	10.4	8.60			9.80
Width	m		7.5	7.5	In flood	7.5	7.5	7.5	7.5	0		7.41
Depth	cm		40	40	In flood	50	50	100	63			98
Substrate	Cobble, boulder											
Weather			80% cloud, dry	100% cloud, dry	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: pasture, wooded banks. MRV = minimum reporting value.

D.1.3 WIMS 81520595 (Fowey Background Site 1) NGR SX 12432 65373

Analyte	Units	MRV	20/10/10	04/11/10	17/11/10	02/12/10	15/12/10	13/01/11	Mean	SD	N° Samples	Median
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	No access	0.05	0.05	0.05	<MRV	0	5	0.05
Copper, Dissolved	ug/l	1	0.5	0.5	No access	0.5	0.5	0.5	<MRV	0	5	0.5

Analyte	Units	MRV	20/10/10	04/11/10	17/11/10	02/12/10	15/12/10	13/01/11	Mean	SD	N° Samples	Median
Lead, Dissolved	ug/l	2	1	1	No access	1	1	1	<MRV	0	5	1
Nickel, Dissolved	ug/l	1	0.5	1.1	No access	0.5	0.5	1.02	0.72	0.31	5	0.5
Zinc, Dissolved	ug/l	5	9.45	7.9	No access	10.4	9.07	9.08	9.18	0.90	5	9.08
Cadmium	ug/l	0.1	0.05	0.05	No access	0.05	0.05	0.05	<MRV	0	5	0.05
Copper	ug/l	1	0.5	0.5	No access	0.5	0.5	1.7	0.74	0.54	5	0.5
Lead	ug/l	2	1	1	No access	1	1	2.4	1.28	0.63034	5	1
Nickel	ug/l	1	1.2	1.2	No access	1.1	0.5	3.1	1.42	0.98	5	1.2
Zinc	ug/l	5	9.6	8.9	No access	12.8	9.7	19.4	12.08	4.36	5	9.7
pH	-		9.2	12.7	No access	5.2	4.8	10.7	8.52	0.14	5	7.65
Temperature	ºC		9.2	12.7	No access	5.2	4.8	10.7	8.52	3.44	5	9.2
Width	m		1.2	1.2	No access	1.2	1.2	1.2	1.20	0	5	1.2
Depth	cm		25	25	No access	25	25	45	29	0.09	5	25
Substrate	Cobble 70%, gravel 30%											
Weather			20-30% cloud, dry	100% cloud, dry	No access	100% cloud, dry/slight snow	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: Woodland (plantation mixed), near track. MRV = minimum reporting value.

D.1.4 WIMS 81520596 (Fowey Background Site 2) NGR SX 14086 66934

Analyte	Units	MRV	20/10/10	04/11/10	18/11/10	02/12/10	15/12/10	13/01/11	Mean	SD	N° Samples	Median
Cadmium, Dissolved	ug/l	0.1	0.416	0.386	0.396	0.392	0.347	0.494	0.41	0.05	6	0.39
Copper, Dissolved	ug/l	1	1.63	1.85	3.9	2.36	1.38	5.17	2.72	1.50	6	2.11
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	2.97	3.29	3.03	2.86	2.62	3.36	3.02	0.27	6	3.00
Zinc, Dissolved	ug/l	5	46.5	50.3	49.2	52.6	38.5	55.5	48.77	5.88	6	49.75

Analyte	Units	MRV	20/10/10	04/11/10	18/11/10	02/12/10	15/12/10	13/01/11	Mean	SD	N° Samples	Median
Cadmium	ug/l	0.1	0.43	0.37	0.51	0.42	0.42	0.58	0.46	0.08	6	0.43
Copper	ug/l	1	2.1	2.3	5.8	2.1	2.8	7	3.68	2.15	6	2.55
Lead	ug/l	2	1	1	2.2	1	1	1	1.20	0.49	6	1.00
Nickel	ug/l	1	3.2	3.5	3.9	2.9	3.7	4	3.53	0.42	6	3.60
Zinc	ug/l	5	77.3	52.5	57.4	46.3	42.2	65.2	56.82	12.91	6	54.95
pH	-		7.2	7.41	7.04	7.34	7.45	7.15	7.27	0.16	6	7.27
Temperature	ºC		10.2	12.7	11.1	7.1	4.2	10.7	9.33	3.11	6	10.45
Width	m		1.3	1.3	1.3	1.3	1.3	1.3	1.30	0	6	1.30
Depth	cm		10	10	30	20	20	35	21	10	6	20
Substrate	Cobble 80%, gravel 20%											
Weather			20% cloud, dry	100% cloud, dry	50% cloud, drizzle	100% cloud, dry	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: Woodland (plantation mixed), near track. MRV = minimum reporting value.

D.1.5 WIMS 81520597 (Fowey Background Site 3) NGR SX 14969 63954

Analyte	Units	MRV	20/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.114	0.05	0.05	0.05	0.06	0.03	6	0.05
Copper, Dissolved	ug/l	1	0.5	0.5	1.78	0.5	0.5	1.12	0.82	0.53	6	0.50
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	0.5	0.5	1.7	0.5	0.5	1.28	0.83	0.53	6	0.50
Zinc, Dissolved	ug/l	5	2.5	2.5	13.8	7.53	2.5	10.2	6.51	4.82	6	5.02
Cadmium	ug/l	0.1	0.05	0.05	0.17	0.05	0.05	0.14	0.09	0.06	6	0.05
Copper	ug/l	1	1.1	0.5	2.6	0.5	0.5	2.7	1.32	1.06	6	0.80
Lead	ug/l	2	1	1	2.8	1	1	2.7	1.58	0.90	6	1.00
Nickel	ug/l	1	0.5	1.1	2.8	1.2	0.5	2.2	1.38	0.93	6	1.15
Zinc	ug/l	5	6.2	8.5	19.9	11.4	2.5	23.1	11.93	8.03	6	9.95
pH	-		7.68	7.95	7.31	7.89	8.05	7.74	7.77	0.26	6	7.82
Temperature	ºC		10.2	12.5	11.1	6.5	7.1	10.7	9.68	2.37	6	10.45
Width	m		0.8	0.8	0.8	0.8	0.8	0.8	0.80	0.00	6	0.80
Depth	cm		7	7	50	20	20	45	25	19	6	20
Substrate	Cobble, boulder											
Weather			10% cloud, dry	100% cloud, dry	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: Broadleaved woodland (plantation). MRV = minimum reporting value.

D.1.6 WIMS 81520598 (Fowey Background Site 4) NGR SX 12260 63400

Analyte	Units	MRV	20/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.289	0.201	0.05	0.12	0.10	6	0.05
Copper, Dissolved	ug/l	1	2.74	3.85	7.34	4.39	3.21	6.53	4.68	1.85	6	4.12
Lead, Dissolved	ug/l	2	1	1	4.01	6.37	2.75	3.79	3.15	2.05	6	3.27
Nickel, Dissolved	ug/l	1	2.26	2.24	3.04	3.94	4.35	2.18	3.00	0.95	6	2.65
Zinc, Dissolved	ug/l	5	13.2	11.9	16.7	32.3	25.2	19.9	19.87	7.76	6	18.30
Cadmium	ug/l	0.1	0.05	0.18	0.05	0.31	0.2	0.05	0.14	0.11	6	0.12
Copper	ug/l	1	3.3	5.9	8.6	5.1	3.8	8.4	5.85	2.25	6	5.50
Lead	ug/l	2	2.7	8.8	7.3	7	3	6.4	5.87	2.47	6	6.70
Nickel	ug/l	1	2.6	3.9	2.9	4.2	4.6	3.1	3.55	0.80	6	3.50
Zinc	ug/l	5	14.4	20.1	20.4	35.4	26.3	26.4	23.83	7.23	6	23.35
pH	-		6.55	6.83	7.15	7.32	7.35	7.63	7.14	0.39	6	7.24
Temp	ºC		10.8	12.8	10.1	5.9	5.2	10	9.13	2.96	6	10.05
Width	m		0.6	0.6	0.6	0.6	0.6	0.6	0.60	0.00	6	0.60
Depth	cm		6	6	50	15	15	20	19	16	6	0.15
Substrate	Gravel, sand, cobble											
Weather			60% cloud, dry	100% cloud, dry	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: Broadleaved woodland (plantation). MRV = minimum reporting value.

D.1.7 WIMS 81520599 (Fowey Background Site 5) NGR SX 08245 63147

Analyte	Units	MRV	20/10/10	03/11/10	17/11/10	01/12/10	14/12/10	14/01/11	Mean	SD	N° Samples	Median
Cadmium, Dissolved	ug/l	0.1	0.188	0.149	0.14	0.154	0.162	0.161	0.16	0.02	6	0.16
Copper, Dissolved	ug/l	1	0.5	0.5	1.98	0.5	0.5	2.07	1.01	0.79	6	0.50
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	2.7	2.42	2.45	2.19	2.33	2.12	2.37	0.21	6	2.38
Zinc, Dissolved	ug/l	5	22.1	21.2	19.4	19.1	19	19.4	20.03	1.29	6	19.40
Cadmium	ug/l	0.1	0.18	0.49	0.14	0.16	0.16	0.16	0.22	0.14	6	0.16
Copper	ug/l	1	0.5	7.5	3.1	0.5	0.5	3.1	2.53	2.75	6	1.80
Lead	ug/l	2	1	6.4	1	1	1	1	1.90	2.20	6	1.00
Nickel	ug/l	1	3.2	7.8	2.3	2.2	2.4	2.9	3.47	2.16	6	2.65
Zinc	ug/l	5	23.4	62.4	23.7	19.8	19.8	27.8	29.48	16.40	6	23.55
pH	-		6.91	7.33	6.9	7.22	7.35	7.28	7.17	0.21	6	7.25
Temp	ºC		11.9	13.1	10.9	8.9	9.4	10.6	10.80	1.56	6	10.75
Width	m		0.5	0.5	0.5	0.5	0.5	0.5	0.50	0.00	6	0.50
Depth	cm		5	5	40	10	10	20	15	13	6	10
Substrate	Gravel, cobble											
Weather			80% cloud, dry	100% cloud, dry	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: Broadleaved woodland. MRV = minimum reporting value.

D.2 River Cober US Lowertown Bridge

D.2.1 WIMS 82010156 (River Cober at Lowertown Bridge) NGR SW 65815 29130

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	2.08	3.19	7.02	3.92	2.44	5.46	4.02	1.90	6	3.56
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	10	11	14	9	8	11	10.50	2.07	6	10.50
Chloride	mg/l	1	27.4	27.4	25.6	31	27.7	25.2	27.38	2.06	6	27.40
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	8.74	11.3	13.4	8.23	8.09	10.9	10.11	2.11	6	9.82
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Zinc, Dissolved	ug/l	5	19	20.3	24.5	21.6	21.9	18.9	21.03	2.11	6	20.95
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper	ug/l	1	10.7	14.5	20.2	10.4	10.5	14.7	13.50	3.84	6	12.60
Lead	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel	ug/l	1	0.5	0.5	1.1	0.5	0.5	0.5	0.60	0.24	6	0.50
Zinc	ug/l	5	21.7	24.1	33.2	23.4	25.6	24.6	25.43	4.02	6	24.35
Calcium, Dissolved	mg/l	1	9.3	9	7.5	9.5	9.5	8.6	8.90	0.77	6	9.15
Magnesium, Dissolved	mg/l	0.3	3.36	3.4	3.01	3.21	3.27	2.77	3.17	0.24	6	3.24
Potassium, Dissolved	mg/l	0.1	3.17	3.61	4.37	3.29	3.36	3.68	3.58	0.43	6	3.49
Sodium, Dissolved	mg/l	2	15.1	15.2	13.7	16.8	15	13.5	14.88	1.20	6	15.05
Sulphate, Dissolved as SO_4	mg/l	10	12	12	5	12	12	10	10.50	2.81	6	12.00
pH	-		7.37	7.33	7.47	7.43	7.37	7.52	7.42	0.07	6	7.40
Temp	ºC		9.6	12.9	10	5.2	6.9	10.4	9.17	2.73	6	9.80
Width	m		5	5	5	5	5	5	5.00	0.00	6	5.00
Depth	cm		15	15	40	25	25	50	28	14	6	25
Substrate	Cobbles 40%, gravel 60%											
Weather			No cloud, dry	100% cloud, drizzle	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: pasture, gardens. MRV = minimum reporting value.

D.2.2 WIMS 82010187 (River Cober at Trenear Bridge) NGR SW 68091 31368

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	2.19	4.05	8.2	2.71	3.22	5.51	4.31	2.23	6	3.64
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	10	11	26	8	9	11	12.50	6.72	6	10.50
Chloride	mg/l	1	25.5	26.3	31.9	27.3	26.9	23.8	26.95	2.72	6	26.60
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	7.55	8.95	17	7.52	8.38	10.4	9.97	3.61	6	8.67
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc, Dissolved	ug/l	5	21	18.8	14.2	26.6	26.7	20.5	21.30	4.79	6	20.75
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper	ug/l	1	12.2	11.6	22.4	9.7	9.9	13.1	13.15	4.72	6	11.90

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Lead	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc	ug/l	5	23.1	20	17.8	25.3	24.9	27.8	23.15	3.68	6	24.00
Calcium, Dissolved	mg/l	1	7.5	7.5	12.9	8.3	8.3	7.3	8.63	2.13	6	7.90
Magnesium, Dissolved	mg/l	0.3	3.25	3.22	4.17	3.14	3.26	2.61	3.28	0.50	6	3.24
Potassium, Dissolved	mg/l	0.1	2.83	3.28	4.96	3.03	3.26	3.41	3.46	0.76	6	3.27
Sodium, Dissolved	mg/l	2	14.2	14.6	17.2	15	14.7	13.3	14.83	1.30	6	14.65
Sulphate, Dissolved as SO_4	mg/l	10	11	5	5	11	11	5	8.00	3.29	6	8.00
pH	-		6.8	6.77	6.89	6.83	6.84	6.92	6.84	0.06	6	6.84
Temperature	ºC		8.7	12.4	9.4	5.1	6.7	10.2	8.75	2.58	6	9.05
Width	m		4.5	4.5	4.5	4.5	4.5	4.5	4.50	0.00	6	4.50
Depth	cm		45	45	100	45	45	100	63	28	6	45
Substrate	Silt 30%, cobble 60%, boulders 10%											
Weather			No cloud, dry	100% cloud, drizzle	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: Broadleaved woodland. MRV = minimum reporting value.

D.2.3 WIMS 82011025 (Medlyn stream at Chy bridge) NGR SW 69342 32617

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	1.44	1.88	6.06	3.1	1.97	3.58	3.01	1.70	6	2.54
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	8	10	11	8	7	8	8.67	1.51	6	8.00
Chloride	mg/l	1	23.8	23.8	23	24.3	24.5	22.2	23.60	0.86	6	23.80
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.101	0.122	0.05	0.07	0.03	6	0.05
Copper, Dissolved	ug/l	1	9.52	11.1	14.3	10.2	11.5	13	11.60	1.78	6	11.30
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc, Dissolved	ug/l	5	38.7	36.7	36.4	37.9	43.1	34.2	37.83	3.00	6	37.30
Cadmium	ug/l	0.1	0.05	0.12	0.05	0.05	0.12	0.05	0.07	0.04	6	0.05
Copper	ug/l	1	15	21.4	18.1	13.3	15.2	16.1	16.52	2.86	6	15.65
Lead	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc	ug/l	5	42.8	46.8	40.1	41.8	47.6	38.6	42.95	3.60	6	42.30
Calcium,	mg	1	5.6	5.5	5.9	6.1	6.1	6	5.87	0.26	6	5.95

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Dissolved	/l											
Magnesium, Dissolved	mg/l	0.3	3.11	3.14	2.67	2.94	3.16	2.63	2.94	0.24	6	3.03
Potassium, Dissolved	mg/l	0.1	2.48	2.81	3.42	2.93	2.76	2.72	2.85	0.31	6	2.79
Sodium, Dissolved	mg/l	2	13.2	13.4	12.9	13	13.8	12.5	13.13	0.45	6	13.10
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	11	11	5	7.00	3.10	6	5.00
pH	-		6.65	6.67	6.59	6.72	6.67	6.71	6.67	0.05	6	6.67
Temperature	ºC		9.8	12.3	10	5.4	7.3	10.4	9.20	2.45	6	9.90
Width	m		3.5	3.5	3.5	3.5	3.5	2	3.25	0.61	6	3.50
Depth	cm		40	40	50	45	45	55	46	6	6	45
Substrate	Silt 80%, cobbles 20%											
Weather			No cloud, dry	100% cloud, drizzle	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: Grassland, hedgerows. MRV = minimum reporting value.

D.2.4 WIMS 82010193 (Cober Background Site 1) NGR SW 66939 34486

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	1.12	1.37	3.29	1.46	1.22	3.97	2.07	1.23	6	1.42
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc, Dissolved	ug/l	5	11.9	11.4	15.1	13.2	13.1	10.8	12.58	1.55	6	12.50
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.15	0.05	0.05	0.07	0.04	6	0.05
Copper	ug/l	1	2.4	3.8	3.8	10.4	3.3	10.1	5.63	3.61	6	3.80
Lead	ug/l	2	1	2.1	1	8.3	1	5.5	3.15	3.07	6	1.55
Nickel	ug/l	1	0.5	2.2	0.5	2.7	0.5	1.8	1.37	0.99	6	1.15
Zinc	ug/l	5	15.9	21.4	18.5	49	20.1	35.4	26.72	12.87	6	20.75
pH	-		6.36	6.34	6.94	6.78	6.69	7.19	6.72	0.33	6	6.74
Temperature	ºC		11.1	12.8	10.4	5.5	8.2	10.7	9.78	2.57	6	10.55
Width	m		0.55	0.55	0.55	0.55	0.55	0.55	0.55	0	6	0.55
Depth	cm		25	25	25	25	25	40	28	6	6	25
Substrate	Sand 50%, silt 50%											
Weather			90% cloud, dry	100% cloud, dry	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: Pasture, bracken, hedgerow. MRV = minimum reporting value.

D.2.5 WIMS 82010194 (Cober Background Site 2) NGR SW 67601 35061

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	2.26	2.52	3.19	1.72	2.03	3.21	2.49	0.61	6	2.39
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc, Dissolved	ug/l	5	10.4	9.27	11.6	10.6	12	12.2	11.01	1.12	6	11.10
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper	ug/l	1	2.6	3.2	4.3	2.1	2.1	4.4	3.12	1.04	6	2.90
Lead	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc	ug/l	5	11.4	11.8	16.3	11.8	14.3	16.4	13.67	2.32	6	13.05
pH	-		6.82	6.79	6.71	6.76	6.89	7	6.83	0.10	6	6.81
Temperature	ºC		10	12.5	10.1	5.8	7.4	10.1	9.32	2.36	6	10.05
Width	m		1.8	1.8	1.8	1.8	1.8	1.8	1.80	0.00	6	1.80
Depth	cm		8	8	30	20	20	35	20	11	6	20
Substrate	Gravel 40%, cobble 60%											
Weather			90% cloud, dry	100% cloud, dry	No cloud, dry	Clear blue sky	Sunny, no cloud.	100% cloud, drizzle, no wind				

Surrounding land use: Marsh grassland (grazing), marsh. MRV = minimum reporting value.

D.2.6 WIMS 82010195 (Cober Background Site 3) NGR SW 68732 35466

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	2.52	3.72	5.99	2.79	3.56	5.56	4.02	1.44	6	3.64
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc, Dissolved	ug/l	5	24.8	23.7	21.6	23.6	25	21.1	23.30	1.62	6	23.65
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Copper	ug/l	1	2.7	4.8	8.9	3.3	3.3	9.7	5.45	3.07	6	4.05
Lead	ug/l	2	1	1	1	1	1	3.3	1.38	0.94	6	1.00
Nickel	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc	ug/l	5	24.8	26.2	29.6	24.2	28.4	29.2	27.07	2.32	6	27.30
pH	-		6.55	6.74	7.06	6.88	7.03	7.44	6.95	0.31	6	6.96
Temperature	ºC		10	12.1	9.9	6.5	8.2	10.2	9.48	1.92	6	9.95
Width	m		2.2	2.2	2.2	2.2	2.2	2.2	2.20	0.00	6	2.20
Depth	cm		20	20	20	25	25	55	28	14	6	23
Substrate	Gravel 60%, cobble 40%											
Weather			90% cloud, dry	100% cloud, dry	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: grassland, moorland. MRV = minimum reporting value.

D.2.7 WIMS 82010196 (Cober Background Site 4) NGR SW 71589 33805

Analyte	Units	MRV	21/10/10	03/11/10	17/11/10	01/12/10	14/12/10	13/01/11	Mean	SD	N° Samples	Median
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	2.32	3.01	2.84	2.12	2.38	2.78	2.58	0.35	6	2.58
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	1.26	0.5	0.5	0.5	0.5	0.5	0.63	0.31	6	0.50
Zinc, Dissolved	ug/l	5	12.9	12.2	12.3	14.8	15.3	14	13.58	1.31	6	13.45
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper	ug/l	1	2.8	4.5	3.1	2.4	2.8	3.1	3.12	0.73	6	2.95
Lead	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc	ug/l	5	13.5	13.9	13.7	14.8	16.3	14.3	14.42	1.03	6	14.10
pH	-		6.39	6.4	6.48	6.65	6.61	6.72	6.54	0.14	6	6.55
Temperature	ºC		8.9	12.8	10.3	4.3	6.8	10.3	8.90	2.99	6	9.60
Width	m		0.8	0.8	0.8	0.8	0.8	0.8	0.80	0.00	6	0.80
Depth	cm		25	25	25	25	25	35	27	4	6	25
Substrate	Silt 100%											
Weather			90% cloud, dry	100% cloud, dry	No cloud, dry	Clear blue sky	Sunny, no cloud	100% cloud, drizzle, no wind				

Surrounding land use: Marsh, woodland, pasture. MRV = minimum reporting value.

D.3 Bow Street Brook – Headwaters to confluence with Clarach

D.3.1 WIMS 80010 (Bow Street Brook below Bow Street STW) NGR SN 61633 84229

Site adjacent to BIOSYS site 44440 used for ecological classification.

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	07/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	5.42	2.85	1.48	1.33	4.04	1.35	2.75	1.70	6	2.17
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	27	21	20	22	17	20	21.17	3.31	6	20.50
Chloride	mg/l	1	16.3	16.2	16.1	19.2	17	18.9	17.28	1.41	6	16.65
Silver, Dissolved	ng/l	3	5.8	3.1	1.5	1.5	5.4	1.5	3.13	2.01	6	2.30
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	2.67	1.39	0.5	0.5	2.25	0.5	1.30	0.97	6	0.95
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc, Dissolved	ug/l	5	19.1	25.8	25.6	20.8	27.7	23.8	23.80	3.27	6	24.70
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.39	0.05	0.11	0.14	6	0.05
Copper	ug/l	1	3.2	1.7	0.5	0.5	10.2	1.1	2.87	3.73	6	1.40
Lead	ug/l	2	3.4	2.4	1	1	57.3	1	11.02	22.70	6	1.70
Nickel	ug/l	1	1.4	0.5	0.5	0.5	7.3	0.5	1.78	2.73	6	0.50
Zinc	ug/l	5	24.7	30.5	28.2	21.1	111	26	40.25	34.81	6	27.10
Calcium, Dissolved	mg/l	1	10	9.4	9.6	11	8	10.6	9.77	1.05	6	9.80
Magnesium, Dissolved	mg/l	0.3	3.1	3	3.09	3.39	2.43	3.31	3.05	0.34	6	3.10
Potassium, Dissolved	mg/l	0.1	2.6	1.87	1.45	1.67	2.36	1.5	1.91	0.47	6	1.77
Sodium, Dissolved	mg/l	2	9.4	9.8	9.7	11.4	9.6	10.6	10.08	0.77	6	9.75
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.00
pH	-		7.93	7.23	7.29	7.5	7.2	7.42	7.43	0.27	6	7.36
Temperature	ºC		11.7	10.4	8.1	3.3	7.9	6.5	7.983	2.96	6	8.00
Width	m		3	4	3	3	3.5	3	3.25	0.42	6	3.00
Depth	cm		12.5	60	30	20	50	20	32	19	6	25
Substrate	Gravel 30%, silt 70%											
Weather			Dry, clear sky	Dry, 20% cloud	Dry, 40% cloud	Dry, 100% cloud	Rain, 100% cloud	Dry, 100% cloud				

Surrounding land use: Pasture/agriculture, woodland/broadleaved. MRV = minimum reporting value.

D.3.2 WIMS 80009 (Bow Street Brook above Bow Street STW) NGR SN 62112 84518

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	07/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	5.1	2.97	1.46	1.36	4.45	1.35	2.78	1.67	6	2.22
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	27	21	20	22	19	18	21.17	3.19	6	20.50
Chloride	mg/l	1	16.3	17.6	15.9	19	16.7	18.8	17.38	1.30	6	17.15
Silver, Dissolved	ng/l	3	6.5	3.9	1.5	1.5	5.8	1.5	3.45	2.30	6	2.70
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	2.69	1.4	0.5	0.5	2.32	0.5	1.32	0.99	6	0.95
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	1.03	1.05	0.5	0.5	0.5	1.22	0.80	0.34	6	0.77
Zinc, Dissolved	ug/l	5	19.4	27.6	26.2	21.4	30	25.4	25.00	3.94	6	25.80
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.25	0.05	0.08	0.08	6	0.05
Copper	ug/l	1	3	2.1	0.5	1.1	5.7	0.5	2.15	1.99	6	1.60
Lead	ug/l	2	2.6	3.5	1	1	27	1	6.02	10.33	6	1.80
Nickel	ug/l	1	2.1	0.5	1.6	0.5	3.7	0.5	1.48	1.28	6	1.05
Zinc	ug/l	5	23.4	34.4	29	25	67.2	26.4	34.23	16.60	6	27.70
Calcium, Dissolved	mg/l	1	10.1	9.1	9.5	10.7	8.3	12.1	9.97	1.33	6	9.80
Magnesium, Dissolved	mg/l	0.3	3.11	2.87	3.16	3.33	2.52	3.51	3.08	0.35	6	3.14
Potassium, Dissolved	mg/l	0.1	2.59	1.94	1.38	1.64	2.4	1.75	1.95	0.46	6	1.85
Sodium, Dissolved	mg/l	2	9.5	10.8	9.6	11.2	9.3	11.8	10.37	1.04	6	10.20
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.00
pH	-		7.54	7.55	7.8	8.23	7.36	8.23	7.79	0.37	6	7.68
Temperature	ºC		11.6	10.3	7.3	2.9	7.6	2.9	7.10	3.63	6	7.45
Width	m		2.5	2.5	2.5	2	2	2	2.25	0.27	6	2.25
Depth	cm		20	30	30	20	50	20	28	12	6	25
Substrate	Silt, Boulder, Cobble											
Weather			Dry, clear sky	Dry, 100% cloud	Dry, 70% cloud	Dry, 90% cloud	Rain, 100% cloud	Dry, 100% cloud				

Surrounding land use: Dense scrub and industrial. MRV = minimum reporting value.

D.3.3 WIMS 35774 (Bow Street Brook Background Site 1) NGR SN 63025 87262

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	7/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	6.51	3.97	2.16	2.81	4.97	2.07	3.75	1.75	6	3.39

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	7/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	34	29	25	23	18	21	25.00	5.76	6	24.00
Chloride	mg/l	1	12.9	13.3	14.6	17.3	12.7	18	14.80	2.32	6	13.95
Silver, Dissolved	ng/l	3	9.1	6.3	1.5	1.5	8.1	1.5	4.67	3.58	6	3.90
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	3.4	2.14	1.14	1.7	2.83	1.64	2.14	0.84	6	1.92
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Zinc, Dissolved	ug/l	5	2.5	2.5	2.5	2.5	5.95	6.71	3.78	1.99	6	2.50
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper	ug/l	1	4.1	3.1	1.3	2.8	7.4	1.2	3.32	2.29	6	2.95
Lead	ug/l	2	1	2.9	1	3.5	17.7	1	4.52	6.55	6	1.95
Nickel	ug/l	1	0.5	0.5	0.5	1.4	4	0.5	1.23	1.40	6	0.50
Zinc	ug/l	5	5.5	7.5	5	8.5	33.1	5.8	10.90	10.96	6	6.65
Calcium, Dissolved	mg/l	1	11.7	10.5	10.5	10.9	7.8	12.5	10.65	1.60	6	10.70
Magnesium, Dissolved	mg/l	0.3	2.89	2.52	2.55	2.53	1.89	2.87	2.54	0.36	6	2.54
Potassium, Dissolved	mg/l	0.1	2.43	1.85	1.58	1.65	1.66	1.74	1.82	0.31	6	1.70
Sodium, Dissolved	mg/l	2	9.1	9.2	10	10.3	7.5	10.6	9.45	1.13	6	9.60
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.00
pH	-		6.81	6.98	7.44	7.74	7.05	7.18	7.2	0.34	6	7.12
Temperature	ºC		11.5	10.9	7.5	1.3	Fast	5.6	7.36	4.17	5	7.50
Width	m		0.45	0.5	0.4	0.5	0.5	0.88	0.54	0.17	6	0.50
Depth	cm		5	15	15	10	25	10	13	7	6	13
Substrate	Silt 90%, Gravel 10%											
Weather			Dry, clear sky	Dry, 80% cloud	Dry, 70% cloud	Dry, 80% cloud	Rain, 100% cloud	Dry, 100% cloud				

Surrounding land use: Pasture. MRV = minimum reporting value.

D.3.4 WIMS 35775 (Bow Street Brook Background Site 2) NGR SN 63366 86311

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	7/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	4.5	2.77	1.31	1.22	3.84	0.99	2.44	1.50	6	2.04
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	36	29	22	22	26	19	25.67	6.15	6	24.00
Chloride	mg/l	1	32.2	30.8	28	34	34.9	31	31.82	2.48	6	31.60
Silver, Dissolved	ng/l	3	3.4	1.5	1.5	1.5	5.4	1.5	2.47	1.63	6	1.50
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MR	0	6	0.05

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	7/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
									V			
Copper, Dissolved	ug/l	1	2.16	1.5	0.5	0.5	2.4	0.5	1.26	0.88	6	1.00
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	0.5	1.33	0.5	0.5	0.5	0.5	0.64	0.34	6	0.50
Zinc, Dissolved	ug/l	5	2.5	2.5	2.5	2.5	13.5	2.5	4.33	4.49	6	2.50
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper	ug/l	1	2.5	1.8	0.5	0.5	11.2	0.5	2.83	4.18	6	1.15
Lead	ug/l	2	1	1	1	1	41.1	1	7.68	16.37	6	1.00
Nickel	ug/l	1	1.1	0.5	0.5	0.5	6.3	0.5	1.57	2.33	6	0.50
Zinc	ug/l	5	2.5	5.1	2.5	2.5	68.2	2.5	13.88	26.63	6	2.50
Calcium, Dissolved	mg/l	1	12.9	11.8	11	11.2	10.1	10.5	11.25	1.00	6	11.10
Magnesium, Dissolved	mg/l	0.3	4.08	3.75	3.72	3.79	2.85	4.02	3.70	0.44	6	3.77
Potassium, Dissolved	mg/l	0.1	5.12	3.9	2.65	2.65	3.68	2.27	3.38	1.07	6	3.17
Sodium, Dissolved	mg/l	2	18.6	17.8	17.3	21.3	20.5	17.9	18.90	1.62	6	18.25
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	10.1	5	5	5.85	2.08	6	5.00
pH	-		6.88	6.8	6.89	7.28	6.86	7.19	6.98	0.20	6	6.89
Temperature	ºC		11.9	10.9	9.1	4.8	7.8	8	8.75	2.52	6	8.55
Width	m		0.55	1	0.7	0.7	1	1	0.825	0.20	6	0.85
Depth	cm		10	20	20	20	30	20	20	6	6	20
Substrate	Silt 90%, gravel 10%											
Weather			Dry, clear sky	Dry, 100% cloud	Dry, 60% cloud	Dry 80% cloud	Rain, 100% cloud	Dry, 100% cloud				

Surrounding land use: Pasture. MRV = minimum reporting value.

D.3.5 WIMS 35776 (Bow Street Brook Background Site 3) NGR SN 65239 87177

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	7/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	3.56	2.43	1.48	1.33	3.11	1.38	2.22	0.97	6	1.96
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	12	9	8	8	5	7	8.17	2.32	6	8.00
Chloride	mg/l	1	10.4	10.9	10.8	10.6	9	11.4	10.52	0.82	6	10.70
Silver, Dissolved	ng/l	3	1.5	1.5	1.5	1.5	1.5	1.5	<MRV	0	6	1.50
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	0.5	<MRV	0	6	0.50
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/	1	0.5	0.5	0.5	0.5	0.5	0.5	<MR	0	6	0.50

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	7/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
	l								V			
Zinc, Dissolved	ug/l	5	2.5	2.5	2.5	6.4	5.1	5.86	4.14	1.85	6	3.80
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper	ug/l	1	0.5	0.5	0.5	0.5	1.7	0.5	0.70	0.49	6	0.50
Lead	ug/l	2	1	1	1	1	5.4	1	1.73	1.80	6	1.00
Nickel	ug/l	1	0.5	0.5	0.5	0.5	1.2	0.5	0.62	0.29	6	0.50
Zinc	ug/l	5	2.5	2.5	2.5	2.5	8.5	2.5	3.50	2.45	6	2.50
Calcium, Dissolved	mg/l	1	4.2	4.1	4.4	4.52	3.2	4.6	4.17	0.51	6	4.30
Magnesium, Dissolved	mg/l	0.3	2.14	2.05	2.14	2.11	1.65	2.29	2.06	0.22	6	2.13
Potassium, Dissolved	mg/l	0.1	0.81	0.96	0.87	0.772	0.84	0.72	0.83	0.08	6	0.83
Sodium, Dissolved	mg/l	2	6.9	6.9	6.9	6.82	5.7	6.5	6.62	0.48	6	6.86
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.00
pH	-		7.48	7.37	7.52	7.65	7.28	7.46	7.46	0.13	6	7.47
Temperature	ºC		10.9	9.7	7.2	1.7	7.6	4.8	6.98	3.34	6	7.40
Width	m		1	1	0.85	0.85	1	1	0.95	0.08	6	1.00
Depth	cm		10	20	20	15	20	10	16	5	6	18
Substrate	Cobble 80%, boulder 20%											
Weather			Dry, clear sky	Dry, 50% cloud	Dry, 70% cloud	Dry, 100% cloud	Rain, 100% cloud	Dry, 100% cloud				

Surrounding land use: Roadside hedgerow/pasture. MRV = minimum reporting value.

D.3.6 WIMS 35777 (Bow Street Brook Background Site 4) NGR 63932 86105

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	7/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	6.75	5.21	2.34	2.28	5.87	2.07	4.09	2.09	6	3.78
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	22	23	24	22	13	22	21.00	4.00	6	22.00
Chloride	mg/l	1	13.4	14.2	14.1	14.4	13.5	14.8	14.07	0.54	6	14.15
Silver, Dissolved	ng/l	3	4.1	4.5	1.5	1.5	4	1.5	2.85	1.49	6	2.75
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	2.72	2.06	1.02	1.04	2.53	1.1	1.75	0.79	6	1.58
Lead, Dissolved	ug/l	2	1	1	1	1	1	1	<MRV	0	6	1.00
Nickel, Dissolved	ug/l	1	1.04	1.16	0.5	0.5	0.5	1.22	0.82	0.36	6	0.77
Zinc, Dissolved	ug/l	5	2.5	2.5	2.5	2.5	8.22	10.4	4.77	3.58	6	2.50
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper	ug/l	1	3	2.5	1.2	1.2	5.1	1.1	2.35	1.56	6	1.85

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	7/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Lead	ug/l	2	1	1	1	1	11.2	1	2.70	4.16	6	1.00
Nickel	ug/l	1	1.2	1.2	0.5	0.5	3.5	0.5	1.23	1.16	6	0.85
Zinc	ug/l	5	6.4	6.1	2.5	2.5	22.9	7.1	7.92	7.61	6	6.25
Calcium, Dissolved	mg/l	1	9.3	9.6	10.3	10.3	7	10.9	9.57	1.38	6	9.95
Magnesium, Dissolved	mg/l	0.3	2.11	2.05	2.12	2.09	1.66	2.2	2.04	0.19	6	2.10
Potassium, Dissolved	mg/l	0.1	1.95	1.82	1.07	1.16	2.73	1.37	1.68	0.62	6	1.60
Sodium, Dissolved	mg/l	2	7.7	8.1	8	8.07	6.9	8	7.80	0.46	6	8.00
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.00
pH	-		7.04	7.07	7.14	7.41	7.26	7.29	7.20	0.14	6	7.20
Temperature	ºC		11.5	10.1	7.4	2.5	7.5	5	7.33	3.28	6	7.45
Width	m		0.8	1	1	0.85	1	1	0.94	0.09	6	1.00
Depth	cm		15	15	10	10	15	12	13	2	6	14
Substrate	Cobble 80%, Silt 20%											
Weather			Dry, clear sky	Dry, 90% cloud	Dry, 60% cloud	Dry, 100% cloud	Rain, 100% cloud	Dry, 100% cloud				

Surrounding land use: Pasture. MRV = minimum reporting value.

D.3.7 WIMS 35778 (Bow Street Brook Background Site 5) NGR 63076 85002

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	7/12/2010	12/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	6.78	4.53	1.94	2.26	5.83	1.77	3.85	2.17	6	3.40
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	23	25	17	23	23	18	21.50	3.21	6	23.00
Chloride	mg/l	1	9.2	13.3	14.1	15.7	13.3	15.5	13.52	2.36	6	13.70
Silver, Dissolved	ng/l	3	8.9	5.6	1.5	1.5	8.5	1.5	4.58	3.56	6	3.55
Cadmium, Dissolved	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	2.18	2.07	0.5	1.11	2.31	0.5	1.45	0.85	6	1.59
Lead, Dissolved	ug/l	2	1	1	1	1	2.6	1	1.27	0.65	6	1.00
Nickel, Dissolved	ug/l	1	0.5	1.45	0.5	0.5	0.5	0.5	0.66	0.39	6	0.50
Zinc, Dissolved	ug/l	5	2.5	8.35	5.93	5.69	13.6	9.32	7.57	3.79	6	7.14
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper	ug/l	1	2.4	3.6	1.1	1.2	3.5	0.5	2.05	1.32	6	1.80
Lead	ug/l	2	4.4	14	1	1	11.6	1	5.50	5.86	6	2.70
Nickel	ug/l	1	0.5	2.9	0.5	0.5	2.8	0.5	1.28	1.21	6	0.50
Zinc	ug/l	5	5.7	21.1	6.4	6.1	20.4	8.7	11.40	7.32	6	7.55
Calcium, Dissolved	mg/l	1	7.8	10.1	9.6	11	8.1	10	9.43	1.24	6	9.80
Magnesium,	mg	0.	1.87	2.89	2.82	2.97	2.27	2.83	2.61	0.44	6	2.83

Analyte	Units	MRV	27/10/2010	11/11/2010	23/11/2010	7/12/2010	12/01/2011	24/01/2011	Mean	SD	Nº Samples	Median
Dissolved	/l	3										
Potassium, Dissolved	mg/l	0.1	0.35	0.99	0.63	0.741	1.54	0.65	0.82	0.41	6	0.70
Sodium, Dissolved	mg/l	2	6.7	8	8.2	8.46	7.2	8.1	7.78	0.68	6	8.05
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.00
pH	-		7.5	7.34	7.2	7.42	7.1	7.33	7.32	0.15	6	7.34
Temperature	ºC		11.4	10.4	8.5	3.8	7.5	5.6	7.87	2.87	6	8.00
Width	m		1	1.5	1.5	1.5	1.5	0.75	1.29	0.33	6	1.50
Depth	cm		15	15	10	15	10	10	12.5	3	6	13
Substrate	Gravel, silt, cobble											
Weather			Dry, clear sky	Dry, 40% cloud	Dry, 50% cloud	Dry, 100% cloud	Rain, 100% cloud	Dry, 100% cloud				

Surrounding land use: Pasture. MRV = minimum reporting value.

D.4 Clarach – headwaters to confluence with Bow Street Brook

D.4.1 WIMS 32296 (Clarach at Rhydir Uchaf) NGR SN 61864 83826

Analyte	Units	MRV	26/10/2010	10/11/2010	22/11/2010	06/12/2010	11/01/2011	24/01/2011	Mean	SD	Nº Samples	Median
Dissolved organic carbon as C	mg/l	0.2	2.06	1.42	1.27	1.2	1.59	1.04	1.43	0.36	6	1.35
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	23	18	17	20	16	16	18.33	2.73	6	17.50
Chloride	mg/l	1	18.2	12.7	13.2	16.7	15.6	16.9	15.55	2.18	6	16.15
Silver, Dissolved	ng/l	3	20.4	13.7	11.5	9.8	17.5	14	14.48	3.89	6	13.85
Cadmium, Dissolved	ug/l	0.1	0.222	0.226	0.209	0.189	0.218	0.239	0.22	0.02	6	0.22
Copper, Dissolved	ug/l	1	4.32	2.79	2.7	2.6	3.29	3.01	3.12	0.64	6	2.90
Lead, Dissolved	ug/l	2	27.8	18.3	15.4	11.3	22	18.8	18.93	5.64	6	18.55
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	1.48	0.5	0.66	0.40	6	0.50
Zinc, Dissolved	ug/l	5	86.9	100	91.1	85.7	89.6	98.7	92.00	6.02	6	90.35
Cadmium	ug/l	0.1	0.23	0.28	0.24	0.19	0.22	0.24	0.23	0.03	6	0.24
Copper	ug/l	1	5.8	6.1	3.9	2.8	4.8	3.6	4.50	1.30	6	4.35
Lead	ug/l	2	49.3	85.4	33.4	16.1	56.4	30.8	45.23	24.30	6	41.35
Nickel	ug/l	1	1.4	1.7	0.5	0.5	0.5	0.5	0.85	0.55	6	0.50
Zinc	ug/l	5	96.5	121	102	91.3	102	106	103.13	10.14	6	102.00
Calcium, Dissolved	mg/l	1	9.4	8	8.2	9.73	8.5	9.6	8.91	0.76	6	8.95
Magnesium, Dissolved	mg/l	0.3	2.95	2.62	2.64	3.01	2.68	3.04	2.82	0.20	6	2.82
Potassium, Dissolved	mg/l	0.1	1.8	1.1	1.13	1.26	1.44	1.21	1.32	0.26	6	1.24

Analyte	Units	MRV	26/10/2010	10/11/2010	22/11/2010	06/12/2010	11/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Sodium, Dissolved	mg/l	2	11.7	8.4	8.5	10.4	9.1	9.6	9.62	1.26	6	9.35
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.00
pH	-		7.35	7.35	7.73	7.86	7.4	7.91	7.60	0.26	6	7.57
Temperature	ºC		10.2	8.3	8.4	1.9	7	5.6	6.90	2.89	6	7.65
Width	m		4.5	4.5	4.5	4.5	4	3.5	4.25	0.42	6	4.50
Depth	cm		25	30	40	20	40	30	31	8	6	30
Substrate	Cobble 70%, gravel/silt 30%											
Weather			Wet, 100% cloud	Dry, clear sky	Dry, 100% cloud	Dry, clear sky	Dry, 90% cloud	Dry, 50% cloud				

Surrounding land use: Coniferous wood, bracken, pasture. MRV = minimum reporting value.

D.4.2 WIMS 35704 (Nant Peithyll near Capel Dewi) NGR SN 62301 83288

Analyte	Units	MRV	26/10/2010	10/11/2010	22/11/2010	06/12/2010	11/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	2.58	1.98	1.69	1.63	2.21	1.33	1.90	0.45	6	1.84
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	30	21	23	27	22	20	23.83	3.87	6	22.50
Chloride	mg/l	1	31.8	16.6	16.8	23.7	22.2	21.7	22.13	5.57	6	21.95
Silver, Dissolved	ug/l	3	5	3.4	1.5	1.5	1.5	1.5	2.40	1.48	6	1.50
Cadmium, Dissolved	ng/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper, Dissolved	ug/l	1	1.55	0.5	0.5	0.5	1.31	0.5	0.81	0.49	6	0.50
Lead, Dissolved	ug/l	2	6.82	2.19	2	2	3.95	2.53	3.25	1.90	6	2.36
Nickel, Dissolved	ug/l	1	0.5	0.5	0.5	0.5	0.5	1.66	0.69	0.47	6	0.50
Zinc, Dissolved	ug/l	5	2.5	2.5	2.5	2.5	2.5	2.5	<MRV	0	6	2.50
Cadmium	ug/l	0.1	0.05	0.05	0.05	0.05	0.05	0.05	<MRV	0	6	0.05
Copper	ug/l	1	2.5	1.5	1.1	1.3	1.7	1	1.52	0.55	6	1.40
Lead	ug/l	2	12.9	12.8	9.6	5.9	18.3	6.5	11.00	4.66	6	11.20
Nickel	ug/l	1	1.2	0.5	0.5	0.5	0.5	0.5	0.62	0.29	6	0.50
Zinc	ug/l	5	7.8	2.5	2.5	2.5	5.6	2.5	3.90	2.28	6	2.50
Calcium, Dissolved	mg/l	1	12.8	10.2	10.7	12.2	11.8	11.9	11.60	0.97	6	11.85
Magnesium, Dissolved	mg/l	0.3	4.05	3.11	3.27	3.81	3.36	3.69	3.55	0.36	6	3.53
Potassium, Dissolved	mg/l	0.1	2.41	1.57	1.54	1.59	1.8	1.55	1.74	0.34	6	1.58
Sodium, Dissolved	mg/l	2	18	10.3	10.8	14.1	12.7	12.1	13.00	2.80	6	12.40
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.00
pH	-		7.07	7.08	7.35	7.56	7.12	7.57	7.29	0.24	6	7.24

Analyte	Units	MRV	26/10/2010	10/11/2010	22/11/2010	06/12/2010	11/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Temperature	ºC		10.6	9.2	8.7	3.4	6.9	5.6	7.4	2.63	6	7.80
Width	m		3	3	2	2	3	3	2.67	0.52	6	3.00
Depth	cm		35	40	30	30	40	20	33	8	6	33
Substrate	Silt 80%, Gravel 15%, Cobble 5%											
Weather			Wet, 100% cloud	Dry, clear sky	Dry, 100% cloud	Dry, clear sky	Dry, 90% cloud	Dry, 50% cloud				

Surrounding land use: Coniferous wood/ford. MRV = minimum reporting value.

D.4.3 WIMS 35705 (Clarach at Plas Gogerddan) NGR SN 63243 83747

Site adjacent to BIOSYS site 44632 used for ecological classification.

Analyte	Units	MRV	26/10/2010	10/11/2010	22/11/2010	06/12/2010	11/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	1.88	1.23	1.15	1.08	1.25	0.94	1.26	0.33	6	1.19
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	19	16	16	15	12	14	15.33	2.34	6	15.50
Chloride	mg/l	1	12.2	11.1	11	13	12.5	13.6	12.23	1.03	6	12.35
Silver, Dissolved	ng/l l	3	24.5	18.4	15.2	15.2	21.5	21.2	19.33	3.74	6	19.80
Cadmium, Dissolved	ug/	0.1	0.334	0.313	0.312	0.289	0.317	0.322	0.31	0.01	6	0.32
Copper, Dissolved	ug/l	1	5.62	3.48	3.8	3.72	3.94	4.13	4.12	0.77	6	3.87
Lead, Dissolved	ug/l	2	42.6	24.8	24.4	21.4	31	30.1	29.05	7.57	6	27.45
Nickel, Dissolved	ug/l	1	1.07	0.5	0.5	0.5	0.5	0.5	0.60	0.23	6	0.50
Zinc, Dissolved	ug/l	5	124	133	133	134	133	140	132.83	5.12	6	133.00
Cadmium	ug/l	0.1	0.76	0.33	0.33	0.31	0.33	0.34	0.40	0.18	6	0.33
Copper	ug/l	1	38	5	5	4.1	6.3	4.7	10.52	13.48	6	5.00
Lead	ug/l	2	727	46.8	44.7	28.5	85.7	43.2	162.65	277.13	6	45.75
Nickel	ug/l	1	4.9	0.5	0.5	0.5	1.1	1.6	1.52	1.72	6	0.80
Zinc	ug/l	5	254	147	137	141	142	151	162.00	45.33	6	144.50
Calcium, Dissolved	mg/l	1	8.1	7.2	7.1	8.21	6.8	8.2	7.60	0.64	6	7.65
Magnesium, Dissolved	mg/l	0.3	2.57	2.38	2.33	2.48	2.31	2.64	2.45	0.13	6	2.43
Potassium, Dissolved	mg/l	0.1	1.46	0.9	0.96	1.07	1.17	1.05	1.10	0.20	6	1.06
Sodium, Dissolved	mg/l	2	8.2	7.6	7.5	8.23	7.2	7.8	7.76	0.41	6	7.70
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.00
pH	-		7.4	7.33	7.37	7.64	7.31	7.56	7.44	0.13	6	7.39
Temperature	ºC		9.8	8.7	8.5	2	7.1	5.6	6.95	2.83	6	7.80
Width	m		3.5	4	4	3	4	3	3.58	0.49	6	3.75
Depth	cm		15	35	35	25	50	25	31	12	6	30

Analyte	Units	MRV	26/10/2010	10/11/2010	22/11/2010	06/12/2010	11/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Substrate	Boulder 40%, cobble 60%											
Weather			Wet, 100% cloud	Dry, clear sky	Dry, clear sky	Dry, clear sky	Dry, 90% cloud	Dry, 50% cloud				

Surrounding land use: Coniferous wood, ford. MRV = minimum reporting value.

D.4.4 WIMS 35702 (Nant Silo at Penrhyncoch) NGR SN 64229 83969 – data from EA sampling programme

Site adjacent to BIOSYS site 44793 used for ecological classification.

Analyte	Units	MRV	02/07/2010	06/08/2010	10/09/2010	04/10/2010	03/11/2010	06/12/2010	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	-	0.87	1.57	1.02	0.99	0.73	1.04	0.32	5	0.99
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	18	16	19	16	15	14	16.33	1.86	6	16.00
Chloride	mg/l	1	13.1	12.2	12.6	11.2	10.7	12.7	12.08	0.94	6	12.40
Silver, Dissolved	ng/l	0	-	-	-	-	-	-	-	-	-	-
Cadmium, Dissolved	ug/l	0.1	0.243	0.31	0.23	0.28	0.26	0.259	0.26	0.03	6	0.26
Copper, Dissolved	ug/l	1	17.6	7.71	11.5	7.99	7.74	6.3	9.81	4.19	6	7.87
Lead, Dissolved	ug/l	2	91.5	67.7	69.5	66.9	63.5	47.4	67.75	14.14	6	67.30
Nickel, Dissolved	ug/l	1	1.59	1.46	1.22	1.2	1.25	1.05	1.30	0.20	6	1.24
Zinc, Dissolved	ug/l	5	98.4	151	95.7	140	129	131	124.18	22.43	6	130.00
Cadmium	ug/l	0.1	0.255	0.35	0.25	0.29	0.26	0.263	0.28	0.04	6	0.26
Copper	ug/l	1	19.9	8.73	14.4	9.53	9.19	7.05	11.47	4.81	6	9.36
Lead	ug/l	2	131	90.5	128	100	77.3	60.2	97.83	27.95	6	95.25
Nickel	ug/l	1	1.65	1.48	1.56	1.41	1.43	1.19	1.45	0.16	6	1.46
Zinc	ug/l	5	106	144	112	146	134	136	129.67	16.75	6	135.00
Calcium, Dissolved	mg/l	1	8.49	7.23	8	7.08	6.7	7.44	7.49	0.65	6	7.34
Magnesium, Dissolved	mg/l	0.3	2.92	2.46	2.68	2.44	2.27	2.46	2.54	0.23	6	2.46
Potassium, Dissolved	mg/l	0.1	1.42	0.767	1.09	0.724	0.759	0.76	0.92	0.28	6	0.76
Sodium, Dissolved	mg/l	2	8.68	7.57	8.24	8.27	6.98	8.4	8.02	0.63	6	8.26
Sulphate, Dissolved as SO_4	mg/l	10	11.9	5	5	5	5	5	6.15	2.82	6	5.00
pH	-		-	-	-	-	-	-	-	-	-	-
Temperature	ºC		-	-	-	-	-	-	-	-	-	-
Width	m		-	-	-	-	-	-	-	-	-	-
Depth	cm		-	-	-	-	-	-	-	-	-	-
Substrate	-											
Weather			-	-	-	-	-	-	-	-	-	-

D.4.5 WIMS 35703 (Nant Stewi at Penrhyncoch) NGR SN 64500 84320 – data from EA sampling programme

Analyte	Units	MRV	06/08/10	10/09/10	04/10/10	03/11/10	06/12/10	05/02/11	11/02/11	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	1.59	2.39	1.66	1.55	0.94	1.91	0.92	1.57	0.52	7	1.59
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	18	23	16	18	17	16	14	17.43	2.82	7	17.00
Chloride	mg/l	1	11.2	11.7	10.1	10.2	11.7	11.4	11.2	11.07	0.66	7	11.20
Silver, Dissolved	ng/l	3											
Cadmium, Dissolved	ug/l	0.1	0.46	0.35	0.42	0.38	0.42	0.44	0.5	0.42	0.05	7	0.42
Copper, Dissolved	ug/l	1	1.69	1.86	1.76	1.55	1.03	1.7	1.31	1.56	0.29	7	1.69
Lead, Dissolved	ug/l	2	5.32	5.89	4.99	4.47	4.64	5.53	3.52	4.91	0.79	7	4.99
Nickel, Dissolved	ug/l	1	0.68	0.56	0.25	0.57	0.25	0.57	0.25	0.45	0.19	7	0.56
Zinc, Dissolved	ug/l	5	170	122	146	148	153	158	159	150.86	15.02	7	153.00
Cadmium	ug/l	0.1	0.52	0.42	0.47	0.42	0.44	0.46	0.52	0.46	0.04	7	0.46
Copper	ug/l	1	2.13	2.4	2.21	2.13	1.16	2.24	1.63	1.99	0.44	7	2.13
Lead	ug/l	2	11.6	13.6	12.3	9.07	7.61	13.4	6.45	10.58	2.86	7	11.60
Nickel	ug/l	1	0.7	0.73	0.58	0.73	0.59	0.64	0.99	0.71	0.14	7	0.70
Zinc	ug/l	5											
Calcium, Dissolved	mg/l	1	7.68	9.08	7.26	7.35	8.38	7.37	7.4	7.79	0.69	7	7.40
Magnesium, Dissolved	mg/l	0.3	2.44	2.6	2.27	2.28	2.53	2.28	2.32	2.39	0.14	7	2.32
Potassium, Dissolved	mg/l	0.1	1.35	1.83	1.22	1.31	1.15	1.53	1.12	1.36	0.25	7	1.31
Sodium, Dissolved	mg/l	2	7.12	7.18	6.86	6.66	7.49	6.69	6.65	6.95	0.32	7	6.86
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	5	5.00	0.00	7	5.00
pH	-		-	-	-	-	-	-	-	-	-	-	-
Temperature	ºC		-	-	-	-	-	-	-	-	-	-	-
Width	m		-	-	-	-	-	-	-	-	-	-	-
Depth	cm		-	-	-	-	-	-	-	-	-	-	-
Substrate	-												
Weather			-	-	-	-	-	-	-	-	-	-	-

D.4.6 WIMS 81223 (Nant Penycefn) NGR SN 64859 85085

Analyte	Units	MRV	26/10/2010	10/11/2010	22/11/2010	06/12/2010	11/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	4.62	3.76	3.11	3.32	4.14	2.69	3.61	0.71	6	3.54
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	33	30	29	31	26	24	28.83	3.31	6	29.50
Chloride	mg/l	1	14.2	11.8	12.8	15	15.9	16.5	14.37	1.81	6	14.60
Silver, Dissolved	ng/l	3	49	37.1	32.9	41.3	37.3	30	37.93	6.68	6	37.20
Cadmium, Dissolved	ug/l	0.1	0.591	0.499	0.53	0.659	0.52	0.533	0.56	0.06	6	0.53

Analyte	Units	MRV	26/10/2010	10/11/2010	22/11/2010	06/12/2010	11/01/2011	24/01/2011	Mean	SD	N° Samples	Median
Copper, Dissolved	ug/l	1	2.04	2.02	1.87	1.94	2.27	1.69	1.97	0.19	6	1.98
Lead, Dissolved	ug/l	2	17.7	17.4	16	14.9	28.8	15.7	18.42	5.20	6	16.70
Nickel, Dissolved	ug/l	1	1.26	1.15	1.12	1.44	1.08	1.15	1.20	0.13	6	1.15
Zinc, Dissolved	ug/l	5	289	258	275	358	250	300	288.33	38.88	6	282.00
Cadmium	ug/l	0.1	0.88	0.57	0.59	0.69	0.58	0.59	0.65	0.12	6	0.59
Copper	ug/l	1	3	2.5	2.6	2.2	2.8	2.1	2.53	0.34	6	2.55
Lead	ug/l	2	57.6	46.6	34.8	28.6	51.2	34	42.13	11.35	6	40.70
Nickel	ug/l	1	1.8	1.3	1.2	1.3	1.3	1.3	1.37	0.22	6	1.30
Zinc	ug/l	5	379	293	294	382	282	316	324.33	44.89	6	305.00
Calcium, Dissolved	mg/l	1	12.5	11.1	11.2	12	10.3	11.7	11.47	0.77	6	11.45
Magnesium, Dissolved	mg/l	0.3	2.67	2.47	2.58	2.59	2.34	2.79	2.57	0.16	6	2.59
Potassium, Dissolved	mg/l	0.1	3.31	2.62	2.82	3.54	4.22	3.04	3.26	0.58	6	3.18
Sodium, Dissolved	mg/l	2	8.5	8.4	8.7	9.11	7.9	9.1	8.62	0.46	6	8.60
Sulphate, Dissolved as SO_4	mg/l	10	5	5	5	5	5	5	<MRV	0	6	5.00
pH	-		7.13	7.25	7.28	7.45	7.21	7.43	7.29	0.13	6	7.27
Temperature	ºC		9.1	8.4	7.8	3.5	6	5	6.63	2.17	6	6.90
Width	m		2	1.5	1.25	1	1	1	1.29	0.40	6	1.13
Depth	cm		5	10	10	10	20	10	11	5	6	10
Substrate												
Weather			Wet, 100% cloud	Dry, clear sky	Dry, clear sky	Dry, clear sky	Dry, 50% cloud	Dry, 50% cloud				

Surrounding land use: Grazed pasture, bracken, woodland. MRV = minimum reporting value.

D.4.7 WIMS 35701 (Nant Silo at Penbont Rhyd Y Be) NGR SN 67200 83800 - data from EA sampling programme

Analyte	Units	MRV	02/07/2010	06/08/2010	10/09/2010	04/10/2010	03/11/2010	06/12/2010	Mean	SD	N° Samples	Median
Dissolved organic carbon as C	mg/l	0.2	-	0.87	1.39	0.91	1	0.67	0.97	0.26	5	0.91
Alkalinity to pH 4.5 as $CaCO_3$	mg/l	5	20	15	18	16	14	14	16.17	2.40	6	15.50
Chloride	mg/l	1	14.5	11.8	12	12.1	10.2	14.4	12.50	1.66	6	12.05
Silver, Dissolved	ng/l	3	-	-	-	-	-	-	-	-	-	-
Cadmium, Dissolved	ug/1	0.1	0.275	0.39	0.29	0.36	0.33	0.301	0.32	0.04	6	0.32
Copper, Dissolved	ug/l	1	8.4	5.4	9.09	5.25	5.99	4.27	6.40	1.91	6	5.70
Lead, Dissolved	ug/l	2	88.3	87.3	120	70.9	68.1	55.5	81.68	22.49	6	79.10
Nickel, Dissolved	ug/l	1	1.41	1.62	1.34	1.28	1.51	1.2	1.39	0.15	6	1.38

Analyte	Units	MRV	02/07/2010	06/08/2010	10/09/2010	04/10/2010	03/11/2010	06/12/2010	Mean	SD	N° Samples	Median
Zinc, Dissolved	ug/l	5	123	185	135	171	162	158	155.67	22.96	6	160.00
Cadmium	ug/l	0.1	0.28	0.4	0.3	0.35	0.33	0.316	0.33	0.04	6	0.32
Copper	ug/l	1	10.5	6.2	10.6	5.58	5.93	4.68	7.25	2.61	6	6.07
Lead	ug/l	2	131	90.5	128	100	77.3	60.2	97.83	27.95	6	95.25
Nickel	ug/l	1	1.7	1.84	1.53	1.41	1.48	1.25	101.83	0.21	6	1.51
Zinc	ug/l	5	114	105	148	95.1	82.9	66	1.54	28.20	6	100.05
Calcium, Dissolved	mg/l	1	8.77	6.56	7.12	6.25	5.86	6.99	6.93	1.02	6	6.78
Magnesium, Dissolved	mg/l	0.3	3.06	2.35	2.51	2.3	2.14	2.43	2.47	0.32	6	2.39
Potassium, Dissolved	mg/l	0.1	1.2	0.715	1.05	0.69	0.686	0.715	0.84	0.22	6	0.72
Sodium, Dissolved	mg/l	2	8.58	6.9	7.26	7.66	6.51	9.2	7.69	1.03	6	7.46
Sulphate, Dissolved as SO_4	mg/l	10	12.5	5	5	5	5	10.2	7.12	3.36	6	5.00
pH	-		-	-	-	-	-	-	-	-	-	-
Temperature	ºC		-	-	-	-	-	-	-	-	-	-
Width	m		-	-	-	-	-	-	-	-	-	-
Depth	cm		-	-	-	-	-	-	-	-	-	-
Substrate	-											
Weather			-	-	-	-	-	-	-	-	-	-

Appendix E – Field programme ecology data

E.1 River Cober US Lowertown Bridge

E.1.1 WIMS 82011025 (Medlyn stream at Chy Bridge) NGR SW 69342 32617. Sample date 21/10/2010

Table E.1 WIMS 82011025 Macroinvertebrate survey data

Taxa	Family	Common name		Nº found	BMWP Score
Leuctra fusca	Leuctridae	A stonefly		3	**10**
Protonemura sp. (poor specimen)	Nemouridae	A stonefly		1	**7**
Polycentropus flavomaculatus	Polycentropodidae	A caseless caddis fly		1	**7**
Rhyacophila dorsalis	Rhyacophilidae	A caseless caddis fly		1	**7**
Limnephilidae (early instars)	Limnephilidae	Cased caddis flies		10	**7**
Chaetopteryx villosa	Limnephilidae	A cased caddis fly		3	
Crangonyx pseudogracilis	Crangonyctidae	A freshwater shrimp		2	**6**
Hesperocorixa sahlbergi	Corixidae	A water boatman		1	**5**
Limnius volckmari	Elmidae	A riffle beetle		9	**5**
Limoniidae	Limoniidae	Crane-fly larvae		1	**5**
Dicranota	Tipulidae	Crane-fly larvae		1	
Simuliidae	Simuliidae	Black-fly larvae		1	**5**
Hydropsyche siltalai	Hydropsychidae	A caseless caddis fly		6	**5**
Chironomidae	Chironomidae	Non-biting midges		3	**2**
Oligochaeta	Oligochaeta	Aquatic worms		2	**1**
			Observed	**Expected**	**EQI**
		Bmwp	**72**	**50.2**	**0.48**
		Ntaxa	**13**	**23.5**	**0.55**
		Aspt	**5.54**	**6.39**	**0.87**

EQI = environmental quality indicator. BMWP: biological monitoring working party. Ntaxa: number of taxa. ASPT: average score per taxa.

Table E.2 WIMS 82011025 Diatom survey data

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Achnanthidium minutissimum type	312	8.67	26.06	13.33	**0.85**
Brachysira neoexilis	2				
Encyonema gracile	1				
Eunotia naegelii	1				
Eunotia sp.	2				
Fragilaria capucina	4				

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Gomphonema parvulum	2				
Gomphonema parvulum var. exilissimum	3				
Meridion circulare	3				
Nitzschia acicularis	1				

DARES = Diatoms for Assessing River Ecological Status. EQR = environmental quality ratio. TDI = trophic diatom index. eTDI: expected trophic diatom index.

E.1.1 WIMS 82010187 (River Cober at Trenear Bridge) NGR SW 68091 31368. Sample date 21/10/2010

Table E.3 WIMS 82010187 Diatom survey data

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Achnanthes oblongella	6	12.5	49.5	18.17	**0.62**
Achnanthidium minutissimum type	77				
Brachysira neoexilis	6				
Cymbella naviculiformis	1				
Eunotia bidentula	4				
Eunotia implicata	5				
Eunotia minor	3				
Eunotia naegelii	2				
Eunotia sp.	3				
Eunotia subarcuatoides	13				
Fragilaria capucina	3				
Fragilaria intermedia	1				
Fragilariforma exigua	1				
Frustulia rhomboides	3				
Frustulia saxonica	2				
Frustulia vulgaris	3				
Frustulia weinholdii	1				
Gomphonema parvulum	11				
Gomphonema parvulum var. exilissimum	45				
Gomphonema sp.	4				
Hantzschia amphioxys	1				
Meridion circulare var. constrictum	14				
Navicula cryptocephala	1				
Navicula minima	10				
Navicula sp.	3				
Navicula suchlandtii	4				
Nitzschia dissipata	25				
Nitzschia palea	2				
Nitzschia palea var. debilis	1				
Nitzschia recta	10				
Nitzschia sp.	5				

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Peronia fibula	1				
Pinnularia appendiculata	5				
Pinnularia sp.	2				
Pinnularia subcapitata	7				
Psammothidium subatomoides	2				
Pseudostaurosira brevistriata	2				
Surirella roba	13				

DARES = Diatoms for Assessing River Ecological Status. EQR = environmental quality ratio. TDI = trophic diatom index. eTDI: expected trophic diatom index.

E.2 Bow Street Brook – Headwaters to confluence with Clarach

E.2.1 WIMS 35776 (Bow Street Brook Background Site 3) NGR SN 65239 87177

Table E.4 WIMS 35776 Macroinvertebrate survey data. Sample date 11/11/2010

Taxa	Family	Common name	N^{o} found	BMWP Score
Ecdyonurus sp.	Heptageniidae	A mayfly	1	**10**
Rhithrogena semicolorata	Heptageniidae	The olive upright mayfly	17	
Leuctra sp.	Leuctridae	A stonefly	7	**10**
Isoperla grammatica	Perlodidae	A stonefly	1	**10**
Perlodes microcephala	Perlodidae	A stonefly	3	
Sericostoma personatum	Sericostomatidae	A cased caddis fly	1	**10**
Odontocerum albicorne	Odontoceridae	A cased caddis fly	1	**10**
Cordulegaster boltonii	Cordulegasteridae	The golden-ringed dragonfly	1	**8**
Philopotamus montanus	Philopotamidae	A caseless caddis fly	5	**8**
Wormaldia subnigra	Philopotamidae	A caseless caddis fly	3	
Protonemura meyeri	Nemouridae	A stonefly	9	**7**
Rhyacophila dorsalis	Rhyacophilidae	A caseless caddis fly	9	**7**
Potamophylax cingulatus	Limnephilidae	A cased caddis fly	1	**7**
Ancylus fluviatilis	Anclylidae	The river limpet	2	**6**
Gammarus pulex	Gammaridae	A freshwater shrimp	37	**6**
Limnius volckmari (adult)	Elmidae	A riffle beetle	1	**5**
Limnius sp. (larvae)	Elmidae	Riffle beetles	1	
Elmis aenea (adult)	Elmidae	A riffle beetle	3	
Elmis sp. (larvae)	Elmidae	Riffle beetles	2	
Hydraena gracilis (adult)	Hydraenidae	A scavenger water beetle	1	**5**
Scirtidae (larvae)	Scirtidae	Marsh beetles	41	**5**
Tipula sp.	Tipulidae	Crane-fly larvae	8	**5**
Dicranota sp.	Tipulidae	Crane-fly larvae	5	
Simuliidae	Simuliidae	Black-fly larvae	18	**5**

Diplectrona felix	Hydropsychidae	A caseless caddis fly	9	**5**
Hydropsyche instabilis	Hydropsychidae	A caseless caddis fly	2	
Hydropsyche siltalai	Hydropsychidae	A caseless caddis fly	2	
Hydropsyche sp.	Hydropsychidae	A caseless caddis fly	3	
Baetis rhodani	Baetidae	The large dark olive mayfly	5	**4**
Pisidium sp.	Sphaeriidae	Pea mussels	1	**3**
Chironomidae	Chironomidae	Non-biting midges	8	**2**
Oligochaeta	Oligochaeta	Aquatic worms	1	**1**
Lumbricidae	Lumbricidae	Aquatic worms	2	
Dixa puberula	Dixidae	A meniscus midge	6	

			Observed	**Expected**	**EQI**
		Bmwp	**139**		
		Ntaxa	**22**		
		Aspt	**6.32**		

EQI = environmental quality indicator. BMWP: biological monitoring working party. Ntaxa: number of taxa. ASPT: average score per taxa.

Table E.5 WIMS 35776 Diatom survey data

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Achnanthes oblongella	263	8.17	9.63	12.49	**1.03**
Achnanthidium minutissimum type	10				
Fragilaria vaucheriae	2				
Gomphonema angustum/pumilum type	1				
Gomphonema parvulum var. exilissimum	3				
Navicula minima	1				
Nitzschia sp.	8				
Placoneis clementis	1				
Reimeria sinuata	20				

DARES = Diatoms for Assessing River Ecological Status. EQR = environmental quality ratio. TDI = trophic diatom index. eTDI: expected trophic diatom index.

E.2.2 WIMS 35777 (Bow Street Brook Background Site 4) NGR 63932 86105. Sample date 11/11/2010

Table E.6 WIMS 35777 Macroinvertebrate survey data

Taxa	Family	Common name	N^{o} found	BMWP Score
Beraea pullata	Beraeidae	A cased caddis fly	3	**10**
Philopotamus montanus	Philopotamidae	A caseless caddis fly	1	**8**
Rhyacophila dorsalis	Rhyacophilidae	A caseless caddis fly	10	**7**
Potamophylax sp.	Limnephilidae	A cased caddis fly	1	**7**
Coenagriidae	Coenagriidae	Damselflies	1	**6**
Elmis aenea (adult)	Elmidae	A riffle beetle	1	**5**

Dytiscidae (larvae)	Dytiscidae	A diving water beetle		2	**5**
Scirtidae (larvae)	Scirtidae	Marsh beetles		7	**5**
Tipula sp.	Tipulidae	Crane-fly larvae		1	**5**
Dicranota sp.	Tipulidae	Crane-fly larvae		5	
Simuliidae	Simuliidae	Black-fly larvae		23	**5**
Diplectrona felix	Hydropsychidae	A caseless caddis fly		1	**5**
Baetis rhodani	Baetidae	The large dark olive mayfly		5	**4**
Potamopyrgus antipodarum	Hydrobiidae	The jenkins' spire shell		1	**3**
Glossiphonia complanata	Glossiphoniidae	A leech		1	**3**
Helobdella stagnalis	Glossiphoniidae	A leech		1	
Chironomidae	Chironomidae	Non-biting midges		19	**2**
Oligochaeta	Oligochaeta	Aquatic worms		19	**1**
Pericoma sp.	Psychodidae	Owl midges		1	
Stratiomyiidae	Stratiomyidae	Soldier flies		2	
			Observed	**Expected**	**EQI**
		Bmwp	**81**		
		Ntaxa	**16**		
		Aspt	**5.06**		

EQI = environmental quality indicator. BMWP: biological monitoring working party. Ntaxa: number of taxa. ASPT: average score per taxa.

E.2.3 WIMS 35778 (Bow Street Brook Background Site 5) NGR 63076 85002. Sample date 11/11/2010

Table E.7 WIMS 35778 Macroinvertebrate survey data

Taxa	**Family**	**Common name**	**N° found**	**BMWP Score**
Ecdyonurus sp.	Heptageniidae	A mayfly	2	**10**
Rhithrogena semicolorata	Heptageniidae	The olive upright mayfly	2	
Isoperla grammatica	Perlodidae	A stonefly	3	**10**
Leuctra sp.	Leuctridae	A stonefly	1	**10**
Crunoecia irrorata	Lepidostomatidae	A cased caddis fly	2	**10**
Psychomyiidae	Psychomyiidae	A caseless caddis fly	1	**8**
Philopotamus montanus	Philopotamidae	A caseless caddis fly	1	**8**
Wormaldia subnigra	Philopotamidae	A caseless caddis fly	2	
Plectrocnemia conspersa	Polycentropodidae	A caseless caddis fly	1	**7**
Rhyacophila dorsalis	Rhyacophilidae	A caseless caddis fly	1	**7**
Potamophylax cingulatus	Limnephilidae	A cased caddis fly	2	**7**
Limnephilidae	Limnephilidae	A cased caddis fly	1	
Ancylus fluviatilis	Anclylidae	The river limpet	1	**6**
Elmis aenea (adult)	Elmidae	A riffle beetle	1	**5**
Elmis sp. (larvae)	Elmidae	Riffle beetles	1	
Scirtidae (larvae)	Scirtidae	Marsh beetles	11	**5**
Tipula sp.	Tipulidae	Crane-fly larvae	5	**5**
Dicranota sp.	Tipulidae	Crane-fly larvae	5	

Simuliidae	Simuliidae	Black-fly larvae		71	**5**
Diplectrona felix	Hydropsychidae	A caseless caddis fly		44	**5**
Baetis rhodani	Baetidae	The large dark olive mayfly		2	**4**
Potamopyrgus antipodarum	Hydrobiidae	The jenkins' spire shell		106	**3**
Pisidium sp.	Sphaeriidae	Pea mussels		1	**3**
Chironomidae	Chironomidae	Non-biting midges		2	**2**
Oligochaeta	Oligochaeta	Aquatic worms		14	**1**
Lumbricidae	Lumbricidae	Aquatic worms		6	
			Observed	**Expected**	**EQI**
		Bmwp	**121**		
		Ntaxa	**20**		
		Aspt	**6.05**		

EQI = environmental quality indicator. BMWP: biological monitoring working party. Ntaxa: number of taxa. ASPT: average score per taxa.

Table E.8 WIMS 35778 Diatom survey data

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Achnanthes oblongella	231	21.5	16.34	24.14	**1.10**
Achnanthidium minutissimum type	6				
*Chamaepinnualria sp **	1				
Cymbella affinis	2				
Denticula tenuis	1				
Eunotia minor	4				
Fragilariforma sp.	3				
Gomphonema angustatum	1				
Gomphonema parvulum	3				
Gomphonema parvulum var. exilissimum	9				
Navicula [small species]	2				
Navicula cryptocephala	1				
Navicula gregaria	2				
Navicula minima	6				
Navicula tenelloides	1				
Navicula veneta	1				
Nitzschia hantzschiana	4				
Nitzschia palea	2				
Nitzschia pusilla	1				
Nitzschia sp.	2				
Pinnularia sp.	1				
Placoneis clementis	7				
Planothidium frequentissimum	2				
Reimeria sinuata	11				
Achnanthes oblongella	231				

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Achnanthidium minutissimum type	6				

DARES = Diatoms for Assessing River Ecological Status. EQR = environmental quality ratio. TDI = trophic diatom index. eTDI: expected trophic diatom index.

E.2.4 BIOSYS 44440 (Bow Street Brook below Bow Street STW) NGR SN 61838 84207. Sample date 27/10/2010

Table E.9 BIOSYS 44440 Diatom survey data

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Achnanthes oblongella	41	21.2	57.13	23.9	**0.56**
Achnanthidium minutissimum type	19				
Cocconeis placentula var. lineata	5				
Diadesmis contenta fo. biceps	2				
Diatoma mesodon	4				
Encyonema minutum	1				
Eunotia minor	2				
Eunotia naegelii	1				
Fragilaria capucina	1				
Fragilaria capucina	50				
Fragilaria vaucheriae	6				
Fragilariforma exigua	2				
Fragilariforma sp.	3				
Frustulia vulgaris	1				
Gomphonema olivaceum	8				
Gomphonema parvulum	4				
Gomphonema parvulum var. exilissimum	8				
Gomphonema sp.	3				
Luticola goeppertiana	1				
Meridion circulare	3				
Navicula [small species]	4				
Navicula capitata	1				
Navicula cryptocephala	1				
Navicula gregaria	11				
Navicula lanceolata	15				
Navicula minima	31				
Navicula rhynchocephala	3				
Navicula sp.	1				
Navicula suchlandtii	1				
Nitzschia archibaldii	1				
Nitzschia capitellata	1				
Nitzschia fonticola	1				
Nitzschia hantzschiana	2				
Nitzschia inconspicua	1				

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Nitzschia linearis	1				
Nitzschia palea	4				
Nitzschia palea var. debilis	7				
Nitzschia paleacea	1				
Nitzschia recta	1				
Nitzschia sp.	2				
Pinnularia sp.	1				
Pinnularia subcapitata	1				
Placoneis clementis	16				
Planothidium frequentissimum	6				
Psammothidium helveticum	1				
Reimeria sinuata	17				
Sellaphora seminulum	5				
Staurosira construens	1				
Surirella brebissonii	1				
Synedra ulna	1				

DARES = Diatoms for Assessing River Ecological Status. EQR = environmental quality ratio. TDI = trophic diatom index. eTDI: expected trophic diatom index.

E.3 Clarach – headwaters to confluence with Bow Street Brook

E.3.1 WIMS 35704 (Nant Peithyll near Capel Dewi) NGR SN 62301 83288. Sample date 26/10/2010

Table E.10 WIMS 35704 Macroinvertebrate survey data

Taxa	Family	Common name	N^o found	BMWP Score
Rhithrogena semicolorata	Heptageniidae	The olive upright mayfly	66	**10**
Ecdyonurus sp.	Heptageniidae	A mayfly	4	
Sericostoma personatum	Sericostomatidae	A cased caddis fly	1	**10**
Leuctra fusca	Leuctridae	A stonefly	8	**10**
Perlodes microcephala	Perlodidae	A stonefly	1	**10**
Limnephilidae (early instars)	Limnephilidae	Cased caddis flies	1	**7**
Protonemura meyeri	Nemouridae	A stonefly	4	**7**
Ancylus fluviatilis	Anclylidae	The river limpet	3	**6**
Gammarus pulex	Gammaridae	A freshwater shrimp	3	**6**
Limnius volckmari (adult)	Elmidae	A riffle beetle	1	**5**
Limnius sp. (larvae)	Elmidae	Riffle beetles	13	
Elmis sp. (larvae)	Elmidae	Riffle beetles	1	
Hydraena gracilis (adult)	Hydraenidae	A scavenger water beetle	1	**5**
Tipula sp.	Tipulidae	Crane-fly larvae	1	**5**
Simuliidae	Simuliidae	Black-fly larvae	55	**5**
Hydropsyche siltalai	Hydropsychidae	A caseless caddis fly	5	**5**

Baetis rhodani	Baetidae	The large dark olive mayfly	13	**4**
Potamopyrgus antipodarum	Hydrobiidae	The jenkins' spire shell	24	**3**
Lymnaea peregra	Lymnaeidae	The wandering snail	1	**3**
Asellus aquaticus	Asellidae	The water hog louse	2	**3**
Chironomidae	Chironomidae	Non-biting midges	2	**2**
Oligochaeta	Oligochaeta	Aquatic worms	21	**1**

			Observed	**Expected**	**EQI**
		Bmwp	**107**	**143.1**	**0.75**
		Ntaxa	**19**	**24.2**	**0.78**
		Aspt	**5.63**	**5.90**	**0.95**

EQI = environmental quality indicator. BMWP: biological monitoring working party. Ntaxa: number of taxa. ASPT: average score per taxa.

E.3.2 BIOSYS 44632 (Clarach at Plas Gogerddan) NGR SN 63049 83670. Sample date 26/10/2010

Table E.11 BIOSYS 44632 Diatom survey data

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Achnanthes sp.	1	15.33	63.24	20.58	**0.46**
Achnanthidium minutissimum type	101				
Diatoma mesodon	18				
*Encyonema perpusillum **	1				
Eunotia implicata	1				
Fragilaria capucina	2				
Fragilaria vaucheriae	1				
Fragilariforma exigua	1				
Fragilariforma virescens	1				
Gomphonema angustatum	1				
Gomphonema parvulum	11				
Gomphonema parvulum var. exilissimum	3				
Meridion circulare	5				
Navicula difficillima	2				
Navicula joubaudii	1				
Navicula minima	113				
Nitzschia archibaldii	4				
Nitzschia palea	6				
Pinnularia subcapitata	2				
Placoneis clementis	14				
Psammothidium sp.	2				
Psammothidium subatomoides	1				
Reimeria sinuata	6				
Sellaphora seminulum	1				
Surirella brebissonii	4				

DARES = Diatoms for Assessing River Ecological Status. EQR = environmental quality ratio. TDI = trophic diatom index. eTDI: expected trophic diatom index.

E.3.3 BIOSYS 44793 (Nant Silo at Penrhyncoch) NGR SN 64149 83958. Sample data 26/10/2010

Table E.12 BIOSYS 44793 Diatom survey data

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Achnanthidium minutissimum type	139	16.33	62.87	21.30	**0.47**
Diatoma mesodon	7				
Eunotia sp.	2				
Fragilariforma exigua	1				
Fragilariforma virescens	1				
Gomphonema parvulum	2				
Navicula joubaudii	1				
Navicula minima	149				
Nitzschia palea	2				
Placoneis clementis	1				
Psammothidium helveticum	1				
Reimeria sinuata	1				

DARES = Diatoms for Assessing River Ecological Status. EQR = environmental quality ratio. TDI = trophic diatom index. eTDI: expected trophic diatom index.

E.3.4 WIMS 35703 (Nant Stewy at Penrhyncoch) NGR SN 64500 84320. Sample date 26/10/2010

Table E.13 WIMS 35703 Macroinvertebrate survey data

Taxa	Family	Common name	N^o found	BMWP Score
Rhithrogena semicolorata	Heptageniidae	The olive upright mayfly	47	**10**
Ecdyonurus sp.	Heptageniidae	A mayfly	1	
Sericostoma personatum	Sericostomatidae	A cased caddis fly	5	**10**
Odontocerum albicorne	Odontoceridae	A cased caddis fly	3	**10**
Chloroperla tripunctata	Chloroperlidae	A stonefly	2	**10**
Leuctra fusca	Leuctridae	A stonefly	4	**10**
Perlodes microcephala	Perlodidae	A stonefly	1	**10**
Limnephilidae (early instars)	Limnephilidae	Cased caddis flies	2	**7**
Potamophylax latipennis	Limnephilidae	A cased caddis fly	3	
Protonemura meyeri	Nemouridae	A stonefly	18	**7**
Rhyacophila dorsalis	Rhyacophilidae	A caseless caddis fly	10	**7**
Ancylus fluviatilis	Anclylidae	The river limpet	3	**6**
Limnius sp. (larvae)	Elmidae	Riffle beetles	8	**5**
Elmis aenea (adult)	Elmidae	A riffle beetle	1	
Elmis sp. (larvae)	Elmidae	Riffle beetles	1	
Gyrinidae (larvae)	Gyrinidae	Whirligig beetles	2	**5**
Scirtidae (larvae)	Scirtidae	Marsh beetles	1	**5**

Dicranota sp.	Tipulidae	Crane-fly larvae	7	**5**
Hydropsyche siltalai	Hydropsychidae	A caseless caddis fly	5	**5**
Baetis rhodani	Baetidae	The large dark olive mayfly	61	**4**
Chironomidae	Chironomidae	Non-biting midges	3	**2**
Oligochaeta	Oligochaeta	Aquatic worms	6	**1**

			Observed	**Expected**	**EQI**
		Bmwp	**119**	**-**	**-**
		Ntaxa	**18**	**-**	**-**
		Aspt	**6.61**	**-**	**-**

Expected values for BMWP, NTAXA and ASPT metrics could not be calculated as the site could not be matched with statistical confidence to any reference site in the RIVPACS III+ database. EQI = environmental quality indicator. BMWP: biological monitoring working party. Ntaxa: number of taxa. ASPT: average score per taxa.

Table E.14 WIMS 35703 Diatom survey data

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Achnanthidium minutissimum type	71	11.5	59.01	17.13	**0.49**
Caloneis sp.	1				
Diatoma mesodon	15				
Diploneis oblongella	1				
Eunotia implicata	1				
Eunotia minor	7				
Eunotia sp.	1				
Fragilaria capucina	14				
Fragilaria vaucheriae	4				
Fragilariforma exigua	1				
Gomphonema gracile	1				
Gomphonema parvulum	28				
Gomphonema parvulum var. exilissimum	8				
Meridion circulare	6				
Navicula cryptocephala	2				
Navicula minima	48				
Navicula sp.	1				
Nitzschia archibaldii	3				
Nitzschia hantzschiana	1				
Nitzschia palea	3				
Nitzschia sp.	2				
Placoneis clementis	9				
Psammothidium marginulatum	2				
Psammothidium sp.	2				
Reimeria sinuata	25				
Sellaphora seminulum	4				
Surirella brebissonii	6				
Synedra ulna	5				

DARES = Diatoms for Assessing River Ecological Status. EQR = environmental quality ratio. TDI = trophic diatom index. eTDI: expected trophic diatom index.

E.3.5 WIMS 35701 (Nant Silo at Penbont Rhyd Y Be) NGR SN 67200 83800. Sample date 26/10/2010

Table E.15 WIMS 35701 Macroinvertebrate survey data

Taxa	Family	Common name		N° found	BMWP Score
Rhithrogena semicolorata	Heptageniidae	The olive upright mayfly		51	**10**
Silo pallipes	Goeridae	A cased caddis fly		1	**10**
Leuctra fusca	Leuctridae	A stonefly		1	**10**
Perlodes microcephala	Perlodidae	A stonefly		7	**10**
Protonemura meyeri	Nemouridae	A stonefly		39	**7**
Rhyacophila dorsalis	Rhyacophilidae	A caseless caddis fly		7	**7**
Limnius sp. (larvae)	Elmidae	Riffle beetles		6	**5**
Elmis aenea (adult)	Elmidae	A riffle beetle		1	
Elmis sp. (larvae)	Elmidae	Riffle beetles		2	
Tipula sp.	Tipulidae	Crane-fly larvae		1	**5**
Dicranota sp.	Tipulidae	Crane-fly larvae		1	
Simuliidae	Simuliidae	Black-fly larvae		2	**5**
Hydropsyche instabilis	Hydropsychidae	A caseless caddis fly		10	**5**
Baetis rhodani	Baetidae	The large dark olive mayfly		82	**4**
Chironomidae	Chironomidae	Non-biting midges		1	**2**
Zonitoides sp.	Zonitidae	Glass snails		1	
			Observed	**Expected**	**EQI**
		Bmwp	**80**	**142.6**	**0.56**
		Ntaxa	**12**	**22.4**	**0.54**
		Aspt	**6.67**	**6.36**	**1.05**

EQI = environmental quality indicator. BMWP: biological monitoring working party. Ntaxa: number of taxa. ASPT: average score per taxa.

Table E.16 WIMS 35701 Diatom survey data

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Achnanthidium minutissimum type	149	16.17	56.86	21.19	**0.55**
Brachysira neoexilis	1				
Caloneis bacillum	2				
Cocconeis placentula var. lineata	1				
Diatoma mesodon	6				
Eunotia implicata	4				
Eunotia naegelii	3				
Fragilariforma exigua	1				
Gomphonema parvulum var. exilissimum	5				
Navicula joubaudii	1				

DARES taxon name	N	Alkalinity	TDI	eTDI	EQR
Navicula minima	116				
Navicula suchlandtii	3				
Nitzschia frustulum	1				
Nitzschia palea	1				
Nitzschia palea var. debilis	3				
Pennate undif.	2				
Pinnularia subcapitata	2				
Placoneis clementis	2				
Psammothidium sp.	4				

DARES = Diatoms for Assessing River Ecological Status. EQR = environmental quality ratio. TDI = trophic diatom index. eTDI: expected trophic diatom index.

Appendix F - BIOSYS 44632 (Clarach at Plas Gogerddan) Fisheries Survey

Report begins on the next page

Fish Survey for the River Clarach at Penrhyn-Coch, Aberystwyth, Wales

On behalf of: Dr Kat
Liney Cascade
Consulting

October 2010

Fish Survey for the River Clarach at Penrhyn-Coch, Aberystwyth, Wales

OHES Team:
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CONTENTS

SUMMARY

This fishery survey was commissioned by Dr. Kat Liney, Senior Environmental Scientist for Cascade Consulting in September 2010. The objective of the survey was to collect and examine fisheries data for a single site; looking at species composition, a population estimate, and fish biomass and density.

The survey site is on the River Clarach near Penrhyn-coch, directly behind the Innovis (breeding centre) which was previously owned by the Forestry Commission. The survey section was between the footbridge and ford; a distance of 102 metres. Fishing took place using standard electric fishing techniques using three-run catch-depletion methodology, allowing a population estimate to be formulated.

The fish population consisted of brown trout (*Salmo trutta*) ranging in size from 68 mm to 322 mm. In total 113 trout were caught, which gave a brown trout population estimate of 125 fish. A single eel was also caught during the survey. The biomass of 7.40 g m^{-2} and density of 0.272 n m^{-2} were recorded. No minor species were caught or observed during the survey.

The brown trout population can generally be considered reasonable in a small river such as the Clarach. There was a distinct paucity of fish in the size range 200 mm to 260 mm (2+) which represents a poorly represented year class.

1. INTRODUCTION AND OBJECTIVES

1.1 Introduction

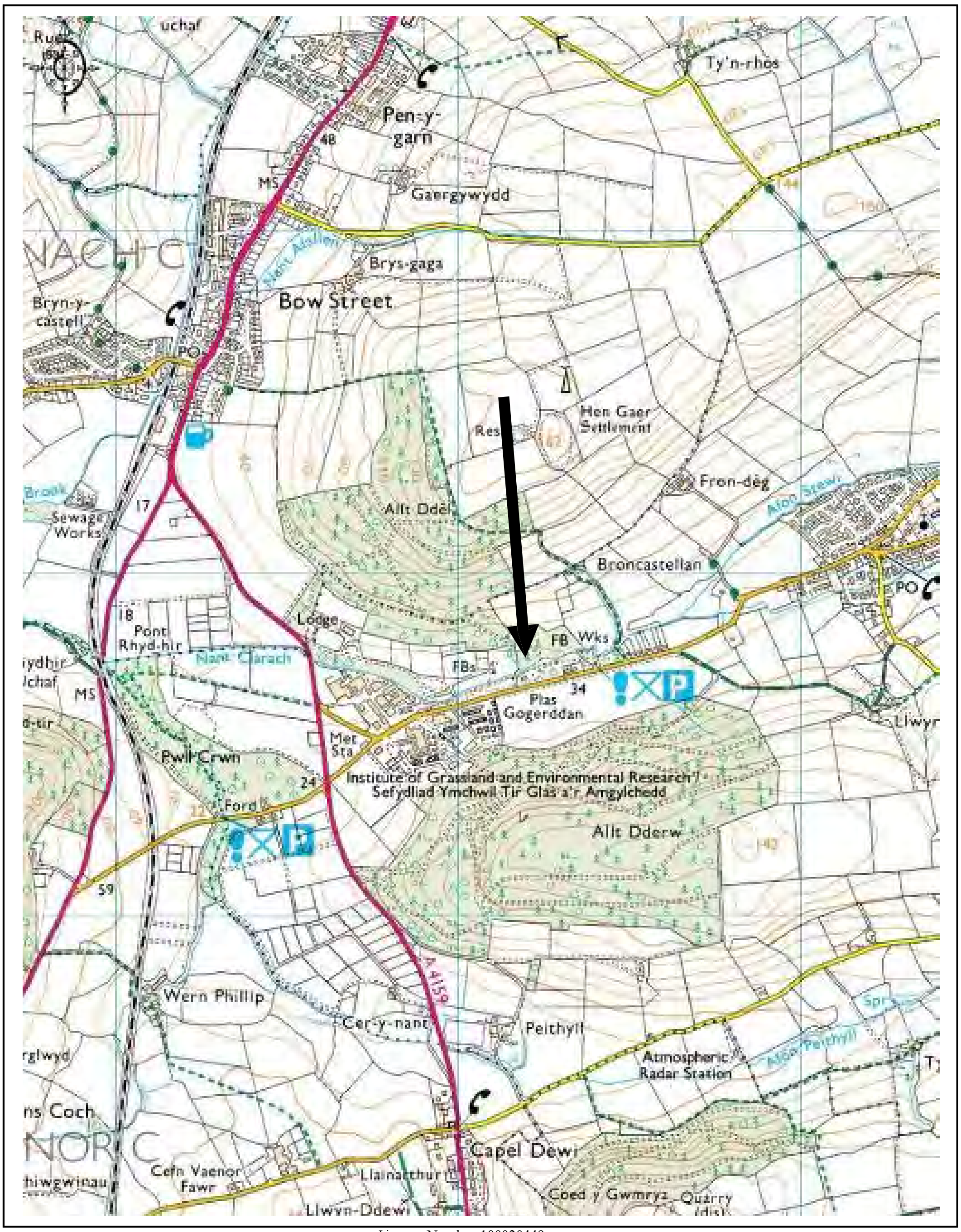
Cascade Consulting commissioned OHES Environmental to complete the fisheries element of a monitoring programme on the River Clarach. This report details the findings of the fisheries survey undertaken on 26 October 2010 on Cascade's behalf.

1.2 Objectives

The objective of this study is primarily to provide baseline fisheries monitoring data and an understanding of the nature of fish populations in the River Clarach near Penrhyn-coch. The survey will also provide additional physical and environmental information relating to the presence of suitable fish habitat, vegetation types and provide general indicators of the site's ecological quality.

2. THE STUDY AREA

The plan below shows the location of the survey site as specified in the project brief.



Licence Number 100020449

Figure 1: Survey location on the River Clarach.

3. METHODS

3.1 Fishery Survey

The survey took place during October 2010, and was undertaken using standard electric fishing methodology. Standard quantitative catch-depletion methods using electric fishing equipment with non-independently switched, pulsed DC equipment, fishing at 0.5 amps and 150 volts were employed at this site. The survey site was specified by Cascade Consulting (see Figure 2).

The survey section was enclosed using appropriate stop nets at each end of the section. Captured fish were removed quickly from the river and placed into oxygenated water tanks to assist their recovery. Tank water quality was monitored throughout, and water was changed as required. Fish were identified, weighed (to the nearest gram) and their fork lengths were measured to the nearest millimetre, prior to being returned safely to the river after the survey was completed.

Minor species such as bullhead (*Cottus gobio*), stoneloach (*Noemacheilus barbatulus*), minnow (*Phoxinus phoxinus*) and stickleback (*Gastersteus aculeatus*) were noted and their presence was recorded in terms of their relative abundance on a scale of 1-9, 10-99, 100-999, etc. Any brook lamprey (*Lampetra planeri*) observed would only have their numbers recorded.

Site information such as width and depth ranges were recorded, along with major habitat features, channel substrate composition and other relevant details which are presented in the Results section of this report.

3.2 Data Analysis

Data collected for each species, and the site-specific information was entered into a formatted spreadsheet to produce figures for fish biomass and density using standard formulae employed by the Environment Agency. Population estimates were also calculated and are provided in the Results section of this report. The raw data is included in Appendix 1.

4. RESULTS

4.1 Survey Reports – 26 October 2010

4.1.1 Site 1 – River Clarach at Penryhn-Coch

Licence Number 100020449

Figure 2: Survey area behind Innovis.

Watercourse:	River Clarach
Site Name:	Site 1 – Innovis breeding centre
Location:	Immediately behind the breeding centre, between the footbridge and ford
NGR:	SN6310 8360
Date Fished:	26 October 2010
Method:	Electric fishing by wading – 2 anodes, 1 net
Weather:	Moderate temperature, cloudy and wet

Plate 1: Mid-river view of the survey section.

<u>Survey Parameters</u>

Site length:	102 m
Total fishable area:	477.36 m^2
Mean width (range):	4.68 m (3.45-10.3 m)
Mean depth (range):	0.27 m (0.22-0.44 m)
Water level:	Normal level (indicated by the moss line)
Water clarity:	Excellent
Air temperature:	12˚C
Water temp:	9.8˚C
Flow Rate:	Moderate
Conductivity:	77.4 μscm^{-1}
Dissolved oxygen:	10.5 mg/l (91.8% saturation)

<u>Substrate Composition (%)</u>

Bare (clay): 0 Silt: 5 Sand: 5 Gravel: 40 Pebble: 45 Cobble: 5

<u>Vegetation (% Cover)</u>

Submerged: 5 Floating: 0 Emergent: 0 Shade: 80

Dominant Plant Species (Aquatic): *Fontinalis antipyretica* (Willow moss), Algal spp. (mainly diatoms)

Dominant Plant Type (Bankside): Ruderal, shrubs and trees

Adjacent Land Use: LB: Scrub RB: Woodland

Comments:

Physical Characteristics
This site is located immediately downstream of the ford at the rear of the Innovis Breeding Centre. The upstream stop net was positioned across the ford, and the downstream net was placed by the wooden bridge footbridge, some 102 metres downstream from the ford.

The site is heavily shaded through a wooded valley with the river flowing in a westerly direction. The section is characterised by a series of shallow runs with a small number of deeper pools and riffles. Trees and woody debris have caused scour in areas and there is a modest meander within the survey site. There is a large, deep pool immediately downstream of the ford which has undercut banks on the right hand bank. In-stream and marginal vegetation is limited as a result of the heavy canopy shading provided by trees, but willow moss and tree roots combined with woody debris are providing some areas of cover and habitat for fish.

The bed comprises of mix of cobble, pebble, gravel and sand with a few slack areas which are permitting silt deposition. Tree roots are also present to some degree, and the dominant substrates are gravel and pebbles.

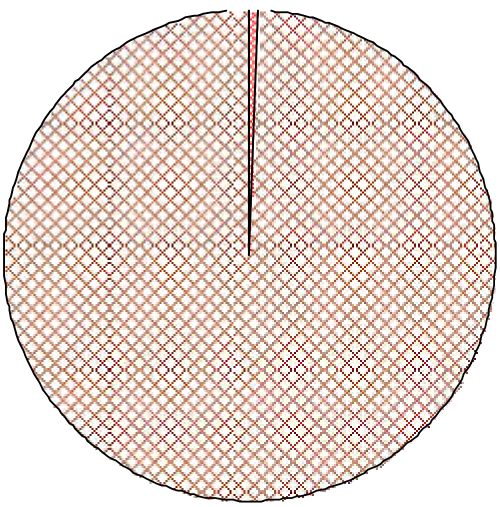
Catch Remarks:
The catch was dominated by brown trout (*Salmo trutta*), and a single eel was caught on the second survey run. No minor species (e.g. bullhead, stoneloach, and minnow) were caught or observed during the three runs of the survey. The biomass of 7.40 g m^{-2} and density 0.272 n m^{-2} is considered reasonable; however the lack of fish diversity is rather surprising, particularly with the habitat and conditions found which would suit species such as bullhead.

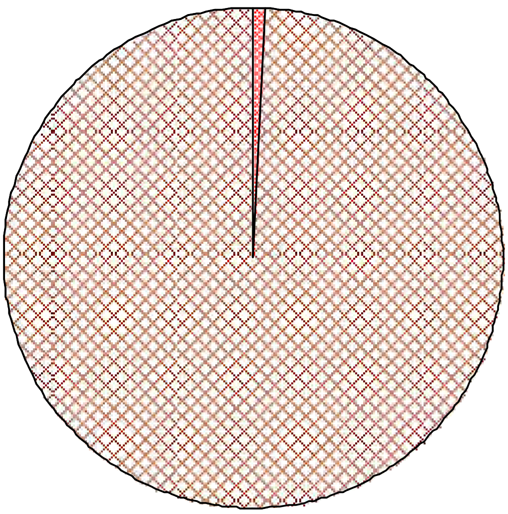
There was a high representation of juvenile trout in this survey. The length frequency graph indicates there are four distinct cohorts of trout. There was a notable paucity of fish in the size range 200 mm to 260 mm (age 2+). If the information and data was available it would be interesting to investigate any records relating to this site that could highlight the reasons for the lack of brown trout of this size or any other factors that may have affected the recruitment success of trout in this year class.

Health and Safety Note:
The banks are slippery to ascend/descend so care must be taken. Old barbed wire fencing was found in the section and removed. Broken glass was also observed and removed to prevent injury or damage to the equipment. The river bed was comprised of very smooth gravel and pebbles which made them very slippery, and again care must be taken when wading, and appropriate footwear must be worn.

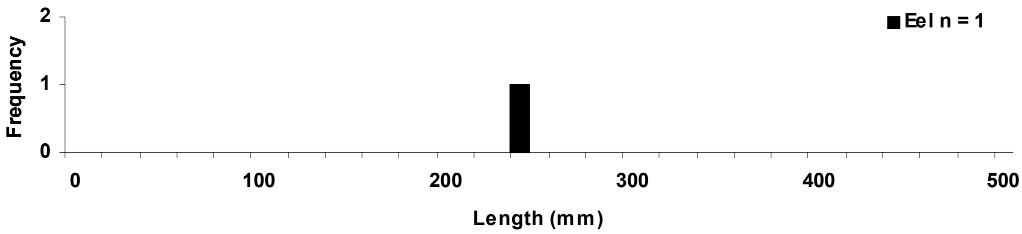
Biomass and Density

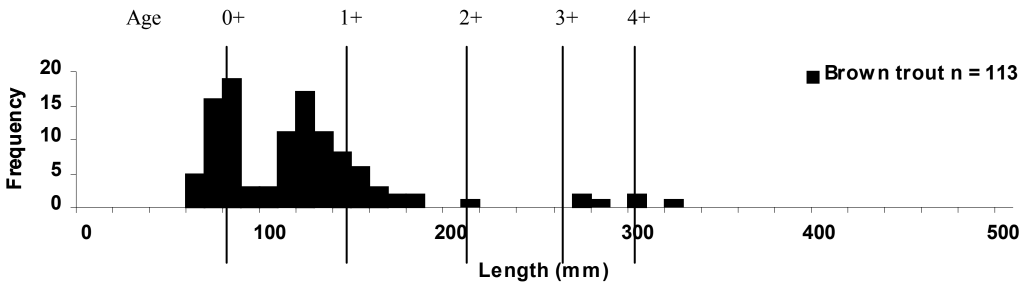
	Species	Biomass (g m^{-2})	Density (n m^{-2})
	European eel	0.05	0.002
	Brown trout	7.35	0.27
	Total	7.40	0.272



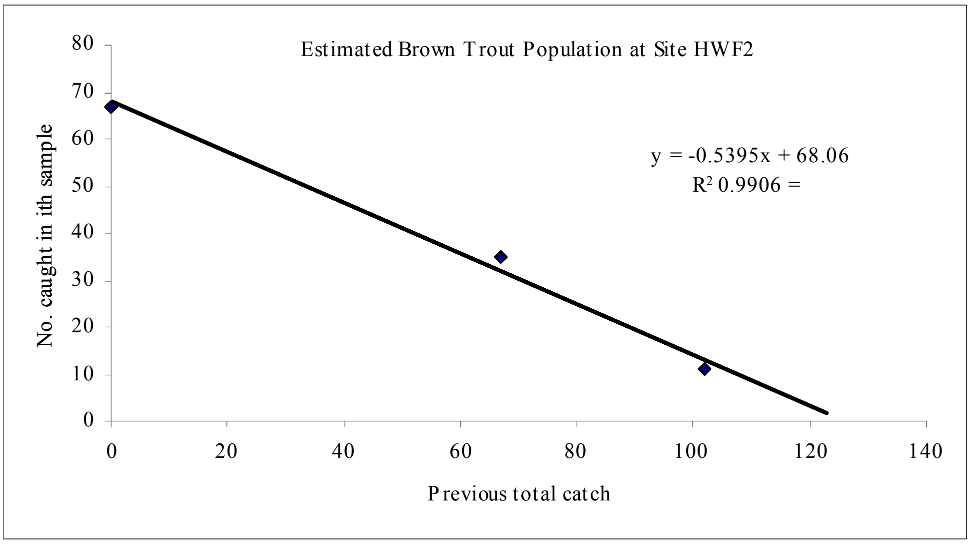


Length-Frequency Distributions





Population Estimates



Note: This population estimate graph has been produced for brown trout only, as the single eel encountered is believed to be the only individual in this survey section.

The population of brown trout has been calculated using standard depletion regression statistics and is represented by the graph above. The point at which the line intersects the x-axis is the estimated total population number. The total estimated population for brown trout in this section was 125 fish.

Appendix G – Development of site-specific (community-based) quality targets for zinc

G.1 Introduction

The general principle for deriving an aquatic environmental quality standard (EQS) for a substance is to define a concentration which will not result in adverse (long-term) effects on the most sensitive species in the community. Under the Water Framework Directive (WFD), EQS are usually based on a threshold for "no effects" obtained from laboratory ecotoxicity tests which is then subject to an additional assessment/safety factor (the size of which depends on the quality and quantity of ecotoxicity data). This No Effects Threshold can either be based on test data from a particularly sensitive species (the lowest result in the dataset) or from a low percentile (usually five percent of species affected) from a species sensitivity distribution (SSD). It is assumed that protecting the most sensitive species will protect biological community structure, which will in turn ensure protection of biological community function[21]. The WFD technical guidance[22] for deriving EQS also allows targets to be derived from mesocosm studies, but very few of these targets have been adopted and higher tier data are more generally used in a weight-of-evidence process in assigning the assessment factor. Under the WFD, "good or better" status can only be achieved in a waterbody if all relevant EQS are met. This paradigm assumes that sensitive species will always be present in any ecological community. Whilst this is a conservative, precautionary position, it could potentially result in a situation where an EQS is more stringent than necessary to protect the naturally occurring biological community, as the community does not contain any particularly sensitive species or taxa. Under the WFD, this could result in a situation where ecological quality is determined to be at good or high status, whilst simultaneously chemical EQS are exceeded, even after accounting for bioavailability.

This following section describes a method for deriving site-specific quality targets for zinc, based on the macroinvertebrate community observed, or predicted to occur using RIVPACS (River Invertebrate Prediction and Classification System), at a site. The rationale for the development of such targets is that they are more closely related to the WFD ecological protection goals than toxicologically based EQS (either conventional or bioavailability-adjusted) and could reduce the frequency of chemical and biological mismatches during classification. Whilst not of equivalent standing to either conventional or bioavailability-based EQS, site-specific targets could potentially

[21] ECB 2003 Technical Guidance Document on risk assessment in support of Commission Directive 93/67/EEC on risk assessment for new notified substances, Commission Regulation (EC) No 1488/94 on risk assessment for existing substances, Directive 98/8/EC of the European parliament and the Council concerning the placing of biocidal products on the market. Part II. European Commission Joint Research Centre, Ispra, Italy.

[22] EC 2010 Technical guidance for deriving environmental quality standards. WG E(9) -10-03e – TGD-EQS (final draft). European Commission, Brussels, Belgium.

be adopted as “alternative objectives” for water bodies under several scenarios. For example, where ecological quality is determined as good or better but conventional and bioavailability-based chemical EQS are exceeded, site-specific targets based on observed or predicted macroinvertebrate taxa offer the potential to derive a less stringent standard that is still protective of the ecology at a site; rationalising the chemical and biological elements of WFD classification. Similarly, where the ecological status of a water body does not achieve good status, a site-specific target based on the predicted ecology at a site could offer a more readily achievable quality target for improving status than the conventional or bioavailability-based EQS. This could then inform measures to decrease metal inputs to the water body. Equally, a site-specific quality target based on the ecology observed at a site failing to achieve good ecological status would allow the derivation of a target to protect against “no further deterioration”.

G.2 Methods

There are 25 species in the SSD that was used to derive the Zn EQS, of which three are algal species, nine are fish or amphibian species, and 13 are invertebrate species. Of the invertebrate species represented, there are four sponges, three cladocerans (daphnids), two rotifers, one amphipod, one snail, one mussel, and one midge larvae.

Two potential approaches were identified for establishing a SSD for zinc whose composition is based on the community predicted to be present at a site by RIVPACS. The first approach applies the F_{BL} no observed effect concentration (NOEC) (fractional occupancy of Zn at the biotic ligand (target receptor) associated with no observed effects) derived from ecotoxicity tests to the most taxonomically similar RIVPACS scoring families. The second approach simply estimates a distribution of taxa sensitivities based on the observed distribution of sensitivities from ecotoxicity testing and an empirical ranking of taxa sensitivity derived from macroinvertebrate monitoring data at zinc-impacted sites.

The first approach is limited by the range of invertebrates tested in the laboratory compared to the range of RIVPACS scoring families, and the dissimilarity of the riverine RIVPACS families to some of the more typically lacustrine species used for laboratory ecotoxicity testing, such as daphnids (water fleas). Identifying which of the tested laboratory species best represents a relatively dissimilar family, which could be from an entirely different insect order is a difficult judgement, and the resulting assignment of F_{BL}NOEC values to RIVPACS scoring families is likely to be rather arbitrary. In addition, there is a limited range of F_{BL}NOEC values from which to select an appropriate one.

The second approach requires an appropriate basis for assigning relative sensitivities of different RIVPACS scoring families, and information about the distribution of sensitivities of species included in the SSD. This approach can either use all species, or just invertebrate species. In Europe, the sensitivity of a tested species is considered to be representative of the sensitivity of an untested species, even if the tested species is not directly relevant to the assessment. Thus, non-European species are taken as being representative of untested European species. Adopting this approach suggests that taking the distribution of all species may provide a better reflection of a more diverse invertebrate ecosystem in the field.

To derive this distribution of relative sensitivities, RIVPACS taxa were ranked in order of their expected sensitivity to zinc by calculating observed (O)/expected (E) ratios for each taxon, at individual sites, in a database of matched field data for chemistry and benthic invertebrate ecology monitoring. Over 1,350 samples were analysed for which dissolved zinc monitoring data was also available. Zn bioavailability could be estimated for 1,066 of these samples, allowing risk characterisation ratios to be calculated for these samples.

Eighty samples with estimated risk characterisation ratios for Zn in excess of three, and a further 61 samples with dissolved Zn concentrations in excess of 50 $\mu g\ l^{-1}$, but for which Zn bioavailability could not be estimated, were considered as potentially "zinc-impacted sites". To establish a ranking of taxa according to Zn sensitivity, the average O/E value was calculated for each taxon across all of these sites.

Ranking of the sensitivity of RIVPACS scoring families was initially attempted based on the presence or absence of taxa at sites with elevated Zn exposures. This approach was limited by the fact that only taxa whose predicted probability of capture was 0.5 or greater were included; some taxa were not found at any of the sites, meaning that their relative sensitivity could not be ranked. Additionally, several families were not sufficiently common at the sites (their predicted probability of capture was less than 0.5 at all sites), and consequently these taxa could not be ranked. It could not be assumed that these taxa were either sensitive or insensitive.

To address these limitations, an alternative ranking was performed based on the abundance of taxa relative to their expected abundance. The selection of high Zn exposure sites used for the ranking was refined by removing sites with elevated levels of other contaminants, which could have confounded the ranking due to Zn. This left 29 sites where Zn was likely to be the main contaminant. The maximum levels of other potential pressures are shown in Table G.1. Dissolved Zn concentrations at these sites ranged from 3.6 to 284 $\mu g\ l^{-1}$, with mean and median concentrations of 79 and 61 $\mu g\ l^{-1}$, respectively.

Following this approach, it was possible to define a ranking on the basis of O/E for abundance at the 29 Zn-impacted sites for 64 of the RIVPACS scoring families. In several cases very similar values of O/E for abundance were calculated for several different families, and in order to take account of this fact that some taxa have very similar sensitivities the taxa were sorted into categories, each covering 0.02 O/E units. This resulted in 32 groups with different sensitivity, with each group containing between one and five families.

Table G.1 Maximum concentrations of contaminants at the sites used for ranking the Zn sensitivity of RIVPACS scoring taxa

Substance	Maximum*
Total ammonia	0.84
Total arsenic	0.83
Biological oxygen demand $(BOD)_5$	5.05
Dissolved cadmium	0.51

Dissolved chromium	2.07
Dissolved copper	8.11
Total iron	375.67
Total mercury	0.14
Total manganese	44.83
Dissolved nickel	5.37
Nitrite nitrogen	0.13
Dissolved oxygen*	7.28
Oxygen saturation*	70.00
Dissolved lead	9.27
Phosphate	0.09
pH (range)	5.8 to 7.8
Suspended solids	98.75
Temperature	20.66

*Minimum concentrations for dissolved oxygen and oxygen saturation

The overall ranking of each of the 64 ranked RIVPACS scoring families is shown in Table G.2, along with the average O/E value at the 29 Zn-impacted sites, the rank group to which they were assigned and the F_{BL}NOEC assigned to them. F_{BL}NOEC were fitted to the same log-normal distribution that was derived from the ecotoxicity test SSD. The actual data used in the SSD suggest that there is less difference between the sensitivities of the most sensitive taxa than would be expected from a log-normal distribution, see Figure G.1.

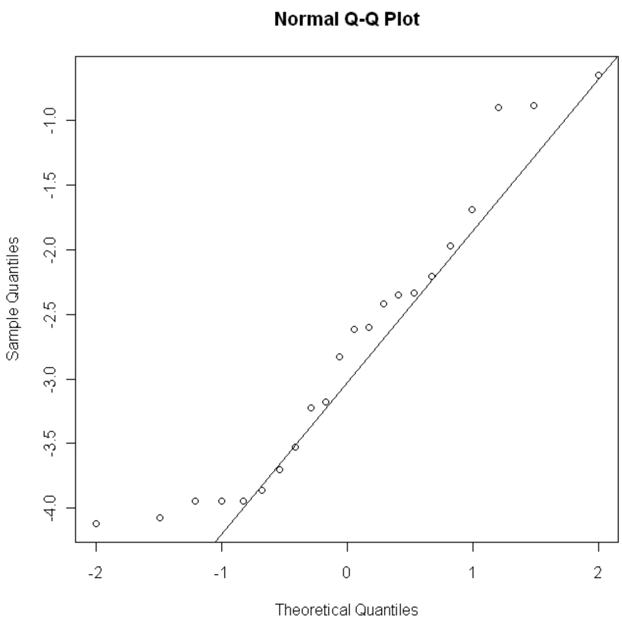


Figure G.1 Quantile Quantile plot of log transformed F_{BL}NOEC values for invertebrate and vertebrate species in the Zn SSD. The solid line indicates the log normal distribution.

Table G.2 Ranking of the sensitivity of BMWP scoring families to Zn toxicity

Taxon	O/E Average	Rank	Rank Group	F_{BL}NOEC
Hydrobiidae	0.184	1	1	0.010

Taxon	O/E Average	Rank	Rank Group	F_{BL}NOEC
Caenidae	0.216	2	1	0.010
Ephemeridae	0.367	3	2	0.013
Heptageniidae	0.373	4	2	0.013
Taeniopterygidae	0.403	5	3	0.016
Nemouridae	0.431	6	4	0.019
Gammaridae	0.432	7	4	0.019
Polycentropodidae	0.436	8	4	0.019
Planorbidae	0.437	9	4	0.019
Brachycentridae	0.463	10	5	0.022
Erpobdellidae	0.489	11	6	0.025
Piscicolidae	0.505	12	7	0.028
Glossiphoniidae	0.506	13	7	0.028
Perlidae	0.512	14	7	0.028
Elmidae	0.514	15	7	0.028
Gyrinidae	0.550	16	8	0.031
Chloroperlidae	0.560	17	9	0.034
Rhyacophilidae	0.571	18	9	0.034
Valvatidae	0.571	19	9	0.034
Sphaeriidae	0.574	20	9	0.034
Perlodidae	0.581	21	10	0.037
Dendrocoelidae	0.601	22	11	0.041
Hydroptilidae	0.605	23	11	0.041
Leptophlebiidae	0.606	24	11	0.041
Goeridae	0.607	25	11	0.041
Aphelocheiridae	0.607	26	11	0.041
Sialidae	0.651	27	12	0.045
Hydropsychidae	0.657	28	12	0.045
Neritidae	0.664	29	13	0.049
Corixidae	0.673	30	13	0.049
Simuliidae	0.697	31	14	0.053
Hydrophilidae	0.705	32	15	0.058
Haliplidae	0.709	33	15	0.058
Tipulidae	0.710	34	15	0.058
Dytiscidae	0.727	35	16	0.063
Lymnaeidae	0.737	36	16	0.063
Oligochaeta	0.761	37	17	0.068
Baetidae	0.772	38	17	0.068
Astacidae	0.783	39	18	0.074
Unionidae	0.797	40	18	0.074
Ancylidae	0.811	41	19	0.080
Sericostomatidae	0.817	42	19	0.080
Scirtidae	0.823	43	20	0.088
Calopterygidae	0.824	44	20	0.088
Beraeidae	0.829	45	20	0.088

Taxon	O/E Average	Rank	Rank Group	F_{BL}NOEC
Chironomidae	0.846	46	21	0.096
Capniidae	0.867	47	22	0.105
Dryopidae	0.870	48	22	0.105
Potamanthidae	0.880	49	22	0.105
Lepidostomatidae	0.889	50	23	0.115
Limnephilidae	0.892	51	23	0.115
Psychomyiidae	0.949	52	24	0.127
Physidae	0.953	53	24	0.127
Planariidae	0.962	54	25	0.141
Hirudinidae	0.967	55	25	0.141
Leuctridae	1.024	56	26	0.158
Leptoceridae	1.032	57	26	0.158
Odontoceridae	1.060	58	27	0.179
Coenagriidae	1.076	59	27	0.179
Asellidae	1.101	60	28	0.206
Cordulegasteridae	1.277	61	29	0.243
Ephemerellidae	1.376	62	30	0.297
Gerridae	2.230	63	31	0.393
Philopotamidae	2.641	64	32	0.659

Site specific SSDs were developed depending upon the expected community composition predicted by RIVPACS for each site. The SSDs based on the expected community composition were compiled following two different approaches. In the first approach those families with a predicted probability of capture of greater than 0.5 were used as the basis for the SSD, and in the second approach those families with a predicted log abundance of greater than 0.5 were used as the basis for the SSD. The second approach results in an SSD with a greater number of taxa. In both cases the same, bioavailability normalised, NOEC values were applied to each taxon. Site specific SSDs were also derived for some sites based on the community which was observed to be present in the biological samples. In these cases taxa with an observed log abundance score of 1 or greater were included in the SSD (except for non-BMWP scoring taxa and any taxa which were not included in the ranking system).

The different approaches used to derive the SSD typically resulted in only small differences between the various HC5 values derived for each site.

G.3 Limitations of the approach

G.3.1 Exclusion of plants and vertebrates

The approach used here to derive site specific SSDs only includes invertebrate taxa, and does not include any vertebrates (fish or amphibians) or plants (algae or macrophytes). For the purposes of the specific cases to which the approach has been applied in this study this is not considered to be a significant problem due to the limited range of water chemistry conditions encountered across these sites. This is because there is considerable overlap between the sensitivities of invertebrates and fish in the EQS ecotoxicity database, and because algae are particularly sensitive under high pH conditions, which are not encountered at these sites.

The sites for which bioavailability calculations were performed covered a range of pH values between 6.7 and 7.6, Ca concentrations between 2 and 12 mg l^{-1} (Ca), and DOC concentrations between 1 and 4 mg l^{-1}. The conditions at these sites result in relatively high sensitivity of invertebrates to Zn due to the low Ca and DOC concentrations. ZnBLM calculations for each of the sites indicate that, whilst some algae are amongst the most sensitive tested organisms to Zn toxicity their site specific NOEC values are within the range of sensitivities of invertebrate species in the EQS database at most of these sites. *P. subcapitata* are the most sensitive algal species tested in the EQS database, and are the most sensitive species in the SSD only at a single site, where the pH was highest (pH 7.55). Figure G.2 shows an “algal sensitivity ratio”, which is calculated as the NOEC for *P. subcapitata* divided by the minimum NOEC, as a function of pH for the study sites.

Whilst the simplification of the site specific SSDs to include only invertebrate taxa may be acceptable under the conditions of the sites included within this study, such simplifications of the approach may limit the utility of site specific targets such as these for more general application, due to the likely variability in water quality conditions which may mean that plants (and possibly also vertebrates) need to be included to ensure sufficient sensitivity.

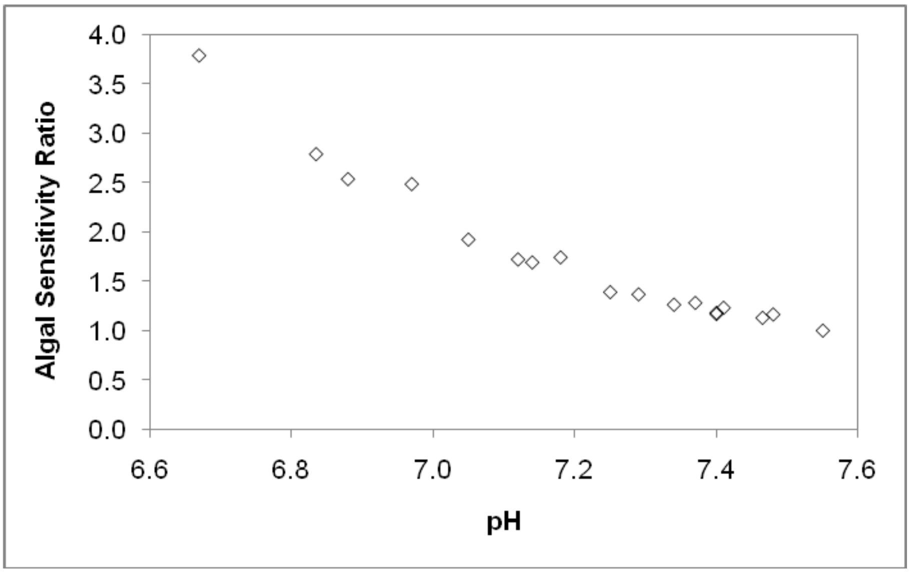


Figure G.2 Algal sensitivity ratio as a function of pH for study sites

G.3.2 Validity of the ranking of invertebrate taxon sensitivity

The validity of the sensitivity ranking for RIVPACS scoring invertebrate taxa to Zn is key to the approach taken towards deriving site specific quality targets in this study. Any discrepancy between the sensitivity rank of any individual taxon and its true sensitivity to Zn may lead to inaccuracies in the derived SSD. Table

G.1 shows the maximum concentrations of several potential contaminants that were measured at the sites used for the ranking. Approaches such as these are limited by the extent of the available information on the presence and levels of other contaminants at the sites used. Very few of the other potential contaminants were measured at all sites, and there are also numerous other potential contaminants that could affect the abundance of invertebrates that were not included in the analysis. Unknown contaminants could potentially result in reduced O/E values for taxa which are interpreted as Zn sensitivity in this assessment.

For example, the maximum dissolved lead (Pb) concentration measured at one of the sites used for the ranking was 9.3 $\mu g\ l^{-1}$, which is considerably higher than the recently proposed EQS of 1.2 $\mu g\ l^{-1}$, although this EQS is expressed as available, rather than dissolved, Pb. There is a significant correlation between Pb and Zn concentrations in the dataset used for the ranking of invertebrate taxa to Zn ($p<0.001$, adjusted r^2 0.51, see Figure G.3). It is possible, therefore, that some of the taxa which have been identified as being sensitive to Zn are actually sensitive to Pb.

A study of impacts on invertebrate communities in mining impacted sites in North West England (Environment Agency 2008) found caddisflies, mayflies, beetles, a mite, a limpet, and a muscid fly to occur at lower than expected frequencies at five highly metal contaminated sites in a preliminary survey. One caddisfly was, however, found to occur more frequently at these contaminated sites than expected. The sites were all affected by a mixture of metals, although Zn was the dominant contaminant at most of the sites. These finding are broadly consistent with the finding of this study, which suggest that some mayflies, stoneflies, and caddisflies tend to be amongst the most sensitive taxa to Zn, although they also indicate that all taxa in these groups cannot necessarily be assumed to be sensitive.

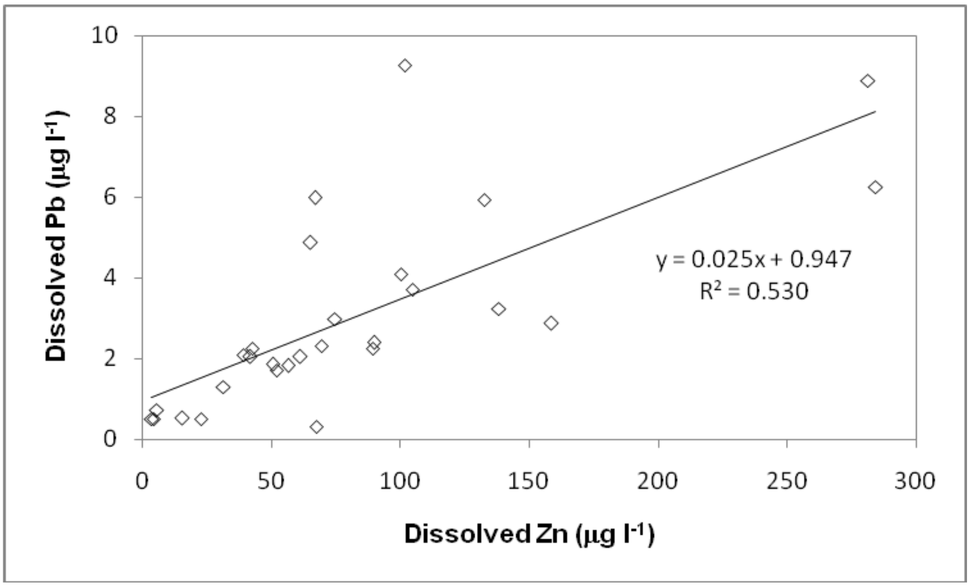


Figure G.3 Co-variation between dissolved Pb and Zn at sites used for ranking of invertebrate sensitivity to Zn

Heptageniidae, a mayfly family, were identified in this study as being one of the most sensitive of the invertebrate taxa to Zn (4th out of 64 ranked taxa).

However, they were also found to be present at several sites with high dissolved Zn exposures. Hydrobiidae, a mollusc family, were identified as the taxon most sensitive to Zn toxicity, but were not found to occur at many of the sites so are likely to have a more limited influence on the site specific targets derived here.

It has been suggested that both molluscs and ephemeroptera (mayflies) are more sensitive to Pb toxicity than Zn toxicity (Wang et al. 2010, Crane et al. 2007). It is possible, therefore, that interferences such as these in the dataset used to derive the ranking of the sensitivity of RIVPACS scoring taxa to Zn may have resulted in errors in the sensitivity ranking. It must also be borne in mind that the least sensitive taxa also include mayfly and mollusc families such as ephemerellidae and physidae.

G.3.3 Recommendations for further development

Further development of this approach for the derivation of site specific quality targets should focus on the two key areas outlined above:

1. Inclusion of other trophic levels (algae, plants, and fish).
2. Validation of the sensitivity ranking approach employed.

The current assessment tools for diatom, plant, and fish communities under the Water Framework Directive are currently less well developed than RIVPACS, which is used for macroinvertebrate communities. The ability to make predictions of the abundance for an individual diatom, plant, or fish taxon or species is much more limited than is currently possible with RIVPACS. Whilst predictions of the community composition may not necessarily be required where site specific targets are based on the community which is found to be present at a site, they are likely to be required for assigning the relative sensitivity of each taxon.

Combining all of the taxa, from all trophic levels, which could potentially be present at a site, and ranking them in terms of their sensitivity to Zn, or any other contaminant, may prove to be challenging. It may not be necessary to consider all possible taxa in such an approach, although the relevance and applicability of an approach which is not able to include all of the taxa or species which are considered to be important at a site may be questionable. The overall approach for deriving a distribution of species or taxa sensitivities in practice may be very similar to the approach employed in this study, although it would include a much broader variety of organisms. Essentially the approach is based on assigning an O/E value for each individual taxon at a selection of sites which are judged to be affected by the contaminant of interest, but are not affected to any significant extent by any other potential contaminants or toxicants.

It may be necessary to consider whether or not the available database of laboratory ecotoxicity tests adequately reflect the overall distribution of sensitivities in real ecosystems. Most validation of PNEC and EQS values by mesocosm and field studies considers only whether or not the proposed standard would be adequately protective of field communities, and does not consider the less sensitive organisms. It is possible that exposure levels in the field may not be sufficiently high to enable to sensitivity of relatively insensitive species (or taxa) to be distinguished.

Such modifications to the derivation of site specific quality targets would increase the ecological relevance of the derived targets and ensure that the whole ecosystem was considered.

G.3.4 References

Crane M, Kwok K, Wells C, Whitehouse P, Lui G, 2007. Use of field data to support European Water Framework Directive quality standards for dissolved metals. *Environmental Science and Technology*, 41: 5014-5021.

Environment Agency, 2008. *Environmental quality standards for trace metals in the aquatic environment.* Science Report SC030194. Environment Agency, Bristol, UK.

Wang N, Ingersol C, Ivey C, Hardesty D, May T, Augspurger T, Roberts A, van Genderen E, Barnhart C, 2010. Sensitivity of early life stages of freshwater mussels (unionidae) to acute and chronic toxicity of lead, cadmium, and zinc in water. *Environmental Toxicology and Chemistry,* 29: 2053-2063.

Appendix H – Proposed Guidance

H1 Accounting for failed metal EQS in water bodies with good biological status

Note: This proposed guidance has not been adopted by the Environment Agency and is included for information only.

Objective

The principal aim of this guidance is to describe the process for addressing situations where waterbodies that are affected by abandoned non-coal mines have failures for conventional metal EQS but biological metrics indicate good or high status. This process is largely based on accounting for the bioavailable fraction of dissolved metal and includes the development of “alternative” objectives or targets where existing Annex X or Annex VIII EQS for metals cannot be achieved. This guidance can also assist when investigating EQS exceedance for some metals within the Water Framework Directive (WFD) more generally.

Scope

This guidance is applicable to those metals (currently copper, zinc, nickel, manganese) where a correction for bioavailability can be made when assessing compliance with EQS. The scenarios covered by this guidance are where one or more of the conventional (such as hardness-banded) metal EQS have failed to comply but the ecological status, as determined by biological metrics, is good or better. It is probably not appropriate to use this guidance for low confidence metal EQS failures, that is, marginal EQS failures probably due only to sampling error, for which further monitoring data should be collected.

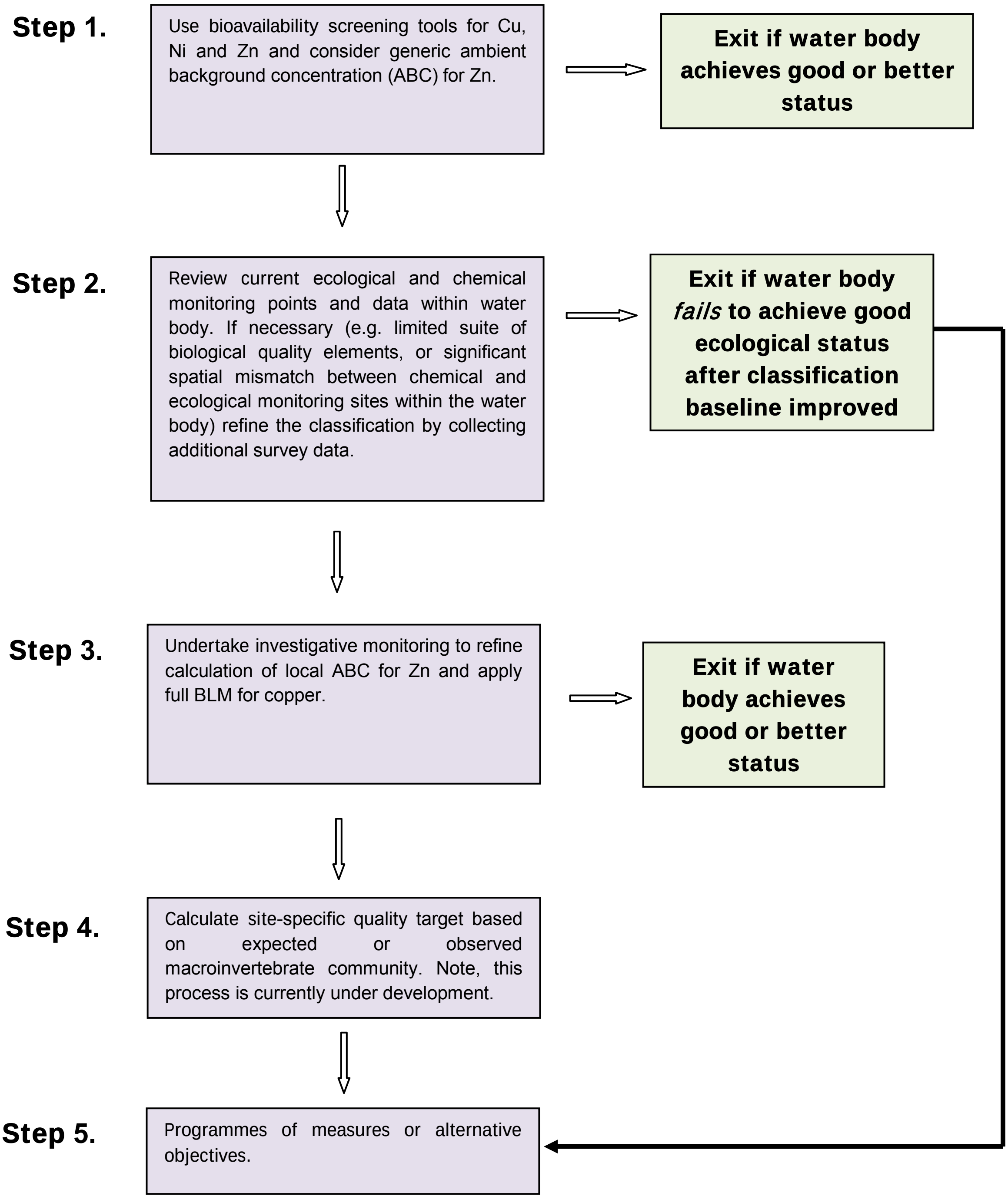
The guidance covers failures of hardness-banded EQS or generic bioavailable EQS for metals. The measured good biological elements should include either macroinvertebrate or fish quality elements, as these are the metrics most likely to react to pressures from metals[23]. This does not prevent the use of this guidance where failures of macrophyte or diatom metrics have occurred. However, the response of these quality elements to metals is unclear and it is possible that additional monitoring of fish and macroinvertebrates may confirm the water body is at less than good status.

Although this guidance is intended principally for use in waters affected by abandoned non-coal mine discharges, it may be helpful in other instances where failure of the relevant metals EQS are the sole cause of a water body not achieving good status.

[23] Whilst algae, including diatoms, are sensitive to metals in the environment the DARLEQ (Diatoms for Assessing River and Lake Ecological Quality) tool used for WFD surface water classification is designed to respond to nutrient enrichment rather than toxic stress.

Procedure

The recommended process is presented as a tiered assessment, with each step requiring increasing regulatory effort and associated cost. At each step of refinement, if compliance with the EQS is demonstrated or chemical and ecological measures of status are in agreement, then no further action is required. The general approach is illustrated in Figure H.1 with details provided below on how to implement each step.



Notes: The use of generic ABC as noted in Step 1 is still under consideration. Due to the uncertainty associated with the defaults derived, the current proposal is that background concentrations would only be considered in more refined assessments, for example, Step 3. Further development and consideration is needed before an approach to calculate site-specific values based on biological data can be adopted in guidance.

Figure H.1 Stepwise process for treating metal EQS failure in water bodies affected by abandoned non-coal mines

Step 1 – Consider bioavailability and ambient background concentrations (ABC) for Zn

Excel-based bioavailability screening tools (also called simplified biotic ligand models or BLM) can be used to calculate the concentration of bioavailable dissolved metal at a site, which is compared against the relevant EQS. This comparison can only be made against the new bioavailability-based EQS whose draft values are:

Copper 1 µg l^{-1}

Zinc 10.9 µg l^{-1} (or 12 µg l^{-1} with generic background included)

Nickel 2 µg l^{-1}

Manganese 123 µg l^{-1}

The bioavailability screening tools are available from the Environment Agency's Evidence Directorate. Bioavailability correction using the screening tools requires values for dissolved calcium, dissolved organic carbon (DOC) and pH. If these monitoring data are not available, the Evidence Directorate may be able to provide "default" values. However, this will result in a precautionary assessment that may falsely indicate failure of the EQS. Default values should be based on the data available at the most local scale. Often, only hydrometric area-scale default values can be calculated due to the absence of local monitoring data and this is very likely to lead to an inaccurate assessment. Therefore, wherever possible site-specific measurements should be obtained.

Monitoring programmes in rivers affected by abandoned non-coal mines should use the Environment Agency national suite METSTR (or where Zn concentrations are less than 100 µg l^{-1}, METLOW) which includes all the determinands required to calculate bioavailable metals. The necessary bioavailability determinand codes, in addition to the dissolved metals, are given in Table H.1.

Table I.1 Bioavailability determinand codes (codes are subject to change)

Det	Description	Unit
4815	BLM input Data Code	Coded
4816	Manganese: BLM BioF	ug/l

4817	Copper: BLM BioF	ug/l
4820	Manganese: BLM Bioavailable	ug/l
4821	Copper: BLM Bioavailable	ug/l
4822	Zinc: BLM Bioavailable	ug/l
0301	Dissolved Organic Carbon	mg/l
0239	Dissolved Calcium	mg/l
0061	pH	

The WFD allows a consideration of the naturally occurring concentrations of metals to be taken into account when assessing compliance. This is especially important for zinc where the new EQS has been derived in such a way that it explicitly requires the ambient background concentration (ABC) to be treated separately. ABC will be dependent on local geology but a first tier assessment of ABC for zinc can be accommodated by adding 1.1 $\mu g\ l^{-1}$ to the generic EQS. Therefore, compliance for zinc can be assessed by comparing the result for "Zinc: BLM Bioavailable" (Detcode: 4822) against an EQS of 12 $\mu g\ l^{-1}$ (10.9 + 1.1).

A generic correction for ABC for other metals is unlikely to be helpful at this stage due to the relatively low default background concentrations compared to the EQSs.

If compliance with the generic metal EQS is demonstrated after accounting for bioavailability using a bioavailability screening tool and/or the use of generic ABC for Zn then a water body can be considered to be at good or better status for these metals.

Step 2 – Review monitoring sites

Mining pressures can be localised in minor tributaries and their impact on biological quality elements (BQE) may not be detected if ecological monitoring occurs in a part of the waterbody away from mine discharges or operational chemical monitoring points. Therefore, the location of chemical and BQE monitoring points used for classification should be examined in relation to mining pressures in a waterbody as they may be some distance apart or be subject to different pressures (for example, ecological monitoring points may be upstream of the mining-related inputs). If ecological monitoring data is absent at a location within the waterbody with identified metals pressures (for example, in a tributary with mining impacts) additional ecological monitoring data (preferably with macroinvertebrates) should be gathered at this location and the classification reassessed. This reassessment may reconcile the inconsistency between chemical and biological measures of surface water status (for example, the waterbody does actually have less than good ecological status). If the inconsistency between chemical and biological measures of surface water status not reconciled (for example, good ecological status is confirmed) then the waterbody could be subject to the subsequent steps in the process described below.

Step 3 – Derive local ABC for Zn and apply full BLM for Cu

It is possible that local ABC for Zn are naturally elevated due to geological conditions and generic or default values for Zn ABC may not be sufficiently high to avoid spurious failure of the Zn EQS. Derivation of locally relevant ABC requires investigative monitoring of headwater (first order) or second-order streams within a water body. Local ABC should be derived with considerable care to avoid inadvertently deriving an ABC affected by an unknown mine impact.

Local ABC can be considered within the compliance assessment in two ways, with the same end result (although supporting data for calculating bioavailable metal is required for the second method).

1. A background value expressed as dissolved metal is subtracted from the dissolved metal monitoring results. The remaining dissolved metal is assessed for how much is bioavailable before comparing with the EQS.
2. A background concentration is converted to bioavailable metal and then added to the EQS. This second approach is recommended for zinc in Step 1 when a simple generic background is used.

Method 1 is recommended as the preferred approach, as it reduces the need for data on the parameters required to assess bioavailable metal.

The recommended process for deriving local ABC is:

- Sample dissolved zinc at a minimum of four ABC sites in tributary streams and headwaters of the affected water body, avoiding any locations affected by anthropogenic inputs (such as adits, spoil tips, abandoned mine buildings). [24]
- Sites in adjacent water bodies with similar geology and land use can be used if no suitable streams are identified within the water body of interest.
- Preferably, the sampling should consist of six to eight repeat samples over a period of not less than three months, although a longer sampling period is recommended.
- The median dissolved metal concentration at the site with lowest metal concentrations can be used as the local background concentration. If the calculated background concentration is of similar magnitude to the operational monitoring data (from the main stem of the water body), further investigation is required before this approach can be justified.

[24] Mining features are identified on various national GIS layers or from the British Geological Survey (BritPits Geodatabase), but care must be taken as not all features may be identified.

- Subtract the local background concentration from the operational monitoring data and assess compliance as in Step 1.

The screening bioavailability tools described above have been derived from more complex bioavailability correction systems called biotic ligand models (BLM). BLM have been developed for copper, zinc, nickel and manganese and guidance on their use can be obtained from the Evidence Directorate. Using a BLM in place of a bioavailability screening tool can theoretically provide a more accurate assessment of the bioavailable fraction of metal at a site. However, they require data for a greater number of input parameters (although, in the first instance, these can be estimated from relationships derived from dissolved Ca concentrations or pH) and, with the exception of the BLM for copper, require complex metal speciation calculations to be performed. It should be noted that the Excel-based bioavailability screening tools produce outputs that closely match the BLM, except perhaps for copper. Therefore, use of BLM is unlikely to be helpful, except where a failure of the copper EQS is still indicated (probably by no more than 50 per cent of the EQS) after use of the bioavailability screening tool.

Step 4 – Derive site-specific quality targets based on predicted or observed community ecology

Where the preceding steps do not affect the outcome of EQS compliance, it may be possible to derive a threshold metal concentration specifically tailored to be protective of the bioavailability conditions and macroinvertebrate fauna present (or predicted to be present) at individual BIOSYS monitoring sites in a water body. This approach has been piloted for Zn and further details can be obtained from the Evidence Directorate. In water bodies where ecology is considered to be at good status, such a metal concentration could potentially be used as an alternative objective or quality target for a water body. Compliance with this alternative target in a waterbody may be consistent with achieving a chemical quality sufficient to achieve good ecological status as determined by BQE.

In water bodies where macroinvertebrate ecology is not considered to be at good status, a site-specific target concentration based on the predicted fauna could be used as a clean-up target when designing remedial intervention measures, and potentially as an “alternative objective”. In the same water body, a site-specific target based on the observed fauna could be used as an alternative objective against which the requirement for “no further deterioration” could be assessed.

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