



Ricardo
Energy & Environment

Dŵr Cymru Welsh Water

Environmental Assessment of Afon Lwyd Drought Permit (8109-4)

Final

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Produced By

Authorised for Release By



.....
Dr Anne Fairhead
Principal Environmental Scientist

.....
John Sanders
Technical Director

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CONTACT DETAILS:

Ricardo Energy & Environment
Bright Building, First Floor
Manchester Science Park
Pencroft Way
Manchester
M15 6SGZ

Tel: +44 (0)1235 753000



NON-TECHNICAL SUMMARY

INTRODUCTION AND PURPOSE OF THIS REPORT

Welsh Water's Drought Plan provides a comprehensive statement of the actions Welsh Water will consider implementing during drought conditions to safeguard essential water supplies to customers and minimise environmental impact. It encompasses a number of drought management options that will only be implemented if and when required and includes drought permit options.

A drought permit is a management action that, if granted, can allow more flexibility to manage water resources and the effects of drought on public water supply and the environment.

The objective of this report is to provide an independent and robust assessment of the potential environmental effects of implementing a drought permit at the Afon Lwyd, over and above those arising due to natural effects of drought and those which would occur under "normal" abstraction licence conditions.

Afon Lwyd is located in Welsh Water's South-East Wales Conjunctive Use System (SEWCUS) Water Resource Zone (WRZ) which covers the large conurbations of Cardiff and Newport as well as the towns and villages of the South Wales valleys as far west as the Rhondda Valley and as far east as Chepstow. The Afon Lwyd is a component of the River Usk SAC / SSSI therefore consideration has been given to the potential impacts of drought permit implementation on the features and species of these designated sites.

The assessment also considers how the proposed drought permit may affect the environment in combination with the effects of other existing abstraction licences, environmental permits and other drought management plans.

This report is a 'shelf-copy' report which would be updated to support an application to Natural Resources Wales for a drought permit at the Afon Lwyd, which may be required by Welsh Water in the future.

PROPOSED DROUGHT PERMIT DETAILS

In order to protect public water supplies within Welsh Water's SEWCUS WRZ in the event of a future severe drought, Welsh Water would make an application to Natural Resources Wales (NRW) for a drought permit to vary the conditions of abstraction from the Afon Lwyd.

If granted, the drought permit involves a new, unsupported emergency river abstraction of up to 12Ml/d from a temporary intake at New Inn on the Afon Lwyd, for

transfer either to Llandegfedd Reservoir or direct to Sluvad WTW. To enable the abstraction, a low, temporary weir constructed of sandbags, would be required across the Afon Lwyd. A modest volume of water would be available from this drought permit scheme during a drought, and there is benefit to supply locally through provision of an immediate additional water resource to an existing WTW.

The drought permit is most likely to occur during the summer and autumn period, and is considered not to extend outside the period September to November. This has been confirmed by Welsh Water's water resources modelling.

The revised abstraction arrangements would legally be authorised for three months but would be removed sooner if water resources have returned to adequate levels to safeguard future water supplies, as agreed with the Welsh Ministers / NRW.

NEED FOR THE DROUGHT PERMIT

Application for a drought permit is a precautionary approach. Due to the time needed to determine a drought permit application, Welsh Water will potentially apply for a drought permit more frequently than it will be used.

The justification for the drought permit sought will be set out in a "Needs Statement". This will be produced by Welsh Water at the time of a potential future application, and will form part of the full drought permit application.

ALTERNATIVE SOURCES CONSIDERED

Details of alternative sources considered by Welsh Water will be completed at the time of application for the drought permit at the Afon Lwyd. This will demonstrate justification for the proposed drought option details applied for.

POTENTIAL IMPACTS OF DROUGHT PERMIT IMPLEMENTATION

The scope of the assessment has been defined by a screening and scoping exercise.

Summary of the Hydrological Assessment

The assessment has concluded that there is a **minor** impact on flows in headwater streams and a **major** impact on flows in the Afon Lwyd as a result of implementing the drought permit. These hydrological impacts are assessed as leading to **negligible** impacts on the physical environment of the river, including water quality.

Summary of the Environmental Features Screening

Environmental assessment is required and included for features where screening has identified a major or moderate impact.

Screening identified River Usk SAC/SSSI, notable fish species, WFD status and Community Assessment / Environment (Wales) Act Section 7 Species, landscape and visual amenity and recreation as environmental features for which an environmental assessment was required.

The assessment has concluded that there are **major** impacts on fish, **moderate** impacts on macrophytes, white-clawed crayfish, macroinvertebrates and phytobenthos and minor impacts on the Lower Usk SSSI.

The HRA Screening could not conclude that implementation of a drought permit would not result in likely significant effects on Atlantic populations within the River Usk SAC.

Cumulative Impacts

No cumulative effects of implementing the drought permit with other existing licences, consents and plans are currently anticipated. However, this should be reviewed at the time of any future application for a drought permit at the Afon Lwyd.

MITIGATION AND MONITORING

The environmental assessment has identified significant impacts of implementation of a drought permit at the Afon Lwyd. Consequently, in line with the DPG, an Environmental Monitoring Plan has been proposed. Potential mitigation measures have also been proposed and further discussion with NRW is required in order to develop suitable mitigation measures.

CONCLUSIONS

In summary, it has been concluded that the environmental effects on river flows, water quality and ecology of implementing a drought permit at the Afon Lwyd during September to November inclusive, over and above those conditions that already exist under "normal", i.e. licensed, baseline conditions, with the onset of a natural drought, would be **major**.

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1 INTRODUCTION

1.1 PURPOSE OF THE ENVIRONMENTAL ASSESSMENT

The objective of this Environmental Assessment Report (EAR) is to provide an independent and robust assessment of the potential environmental effects of the implementation of a drought permit by Dŵr Cymru Welsh Water (Welsh Water) to abstract up 2Ml/d from a temporary intake at New Inn on the Afon Lwyd for up to three months, for transfer either to Llandegfedd Reservoir or direct to Sluvad WTW. Water abstracted from the Afon Lwyd would be used to provide public water supplies to Welsh Water's SEWCUS Water Resource Zone (WRZ) (see Section 2.1).

This EAR is a 'shelf-copy' report which would be updated in the event that Welsh Water needs to make an application during any future drought to NRW for a drought permit of the Afon Lwyd. A drought permit is a management action that, if granted, can help ensure essential water supplies are maintained to homes and businesses. The circumstances under which a drought permit may be required is set out in the Welsh Water Drought Plan.

The assessment presented in this EAR considers the effects of implementation of the drought permit over the months of September to November inclusive, the period for which Welsh Water has determined it might require a drought permit for this water source. The purpose of the assessment is to determine the environmental impacts of the drought permit over and above any effects arising from natural drought conditions.

The study area and focus of this environmental assessment of the Afon Lwyd drought permit, covers the following waterbodies:

- Afon Lwyd - below Mon and Brecon Canal (GB109056032911)
- Afon Lwyd - source to Mon and Brecon Canal (GB109056032912)

This EAR includes discussion of the following:

- an assessment of the likely changes in river flow / water level regime due to implementing the proposed drought permit (**for a summary, see Section 4 of this report**)
- identification of the environmental features that are sensitive to these changes and an assessment of the likely impacts on these features (**see Section 5 of this report**)
- identification of mitigation measures that may be required to prevent or reduce impacts on sensitive features (**see Section 6 of this report**)
- recommendations for baseline, in-drought and post-drought permit monitoring requirements (**see Section 10 of this report**).

The environmental assessment has been conducted in accordance with Government regulations and using NRW Drought Plan Guideline¹ (DPG); specifically Section 5 and Appendices I and J, and Welsh Government / Defra / NRW / Environment Agency guidance on drought permits.

Consideration has been given to the potential impacts of drought permit implementation on statutory designated sites, including those designated under international law (Habitats Directive, Birds Directive and the Ramsar Convention) and national legislation (notably Sites of Special Scientific Interest (SSSIs)).

In accordance with the DPG, the assessment also considers how the proposed drought permit may affect the environment in combination with the effects of existing abstraction licences, environmental permits and other relevant activities and plans. This is discussed further in Sections 3 and 7.

1.2 SUPPORTING STUDIES

The DPG identifies in Section 5.4 that EARs are required as supporting documents to any drought permit application. The circumstances for which an environmental assessment is required are set out in **Box 1** below.

Box 1: Drought Plan Guidance - requirement for environmental assessment

The DPG requires that all features that could be affected by implementation of a drought permit are listed in the EAR and that an assessment is made of how sensitive each feature is to the likely changes in hydrology, hydrogeology and geomorphology, due to implementing the drought permit.

The DPG requires a detailed environmental assessment for applications where sensitive features are likely to be subject to a major or moderate impact, or a minor impact where this applies to environmentally designated features. Further environmental assessment is **not** required for those drought permits where there is certainty that there are no such impacted sensitive features.

This environmental assessment is based on data available at the time of writing and includes the environmental features and data types determined by Box 1 in Appendix I of the DPG (except where these are considered not to be relevant to this drought permit). Data were requested from key consultees (including NRW).

Where appropriate, this report also identifies areas where there are deficiencies in data availability and makes recommendations for future data / information gathering and monitoring. Welsh Water will continue to engage closely with NRW to ensure that

¹ Natural Resources Wales (2017) *Water Company Drought Plan Technical Guideline*. Available at <https://cdn.naturalresources.wales/media/684414/final-wc-drought-plan-guidance-2017.pdf?mode=pad&rnd=131656713580000000>, Accessed 04 February 2019.

adequate and sufficient data / information are collated and kept up-to-date in subsequent years to inform future environmental assessments.

1.3 CONSULTATION

Consultation is identified as an essential exercise in the preparation of the EAR. In preparing this 'shelf-copy' EAR for a drought permit of the Afon Lwyd, consultation with regulators and wider stakeholders has been undertaken to gain feedback on potential adverse effects, gather data and discuss any required monitoring and / or mitigation measures.

Further consultation will be also be undertaken at the time of any future applications for the drought permit.

1.4 STRUCTURE AND CONTENT OF THE REPORT

This EAR comprises the following sections:

Section 1: Introduction

Section 2: Background to the Drought Permit

Section 3: Approach

Section 4: Hydrology and the Physical Environment

Section 5: Environmental Features Assessment

Section 6: Mitigation

Section 7: Cumulative Impacts

Section 8: Summary of Residual Impacts

Section 9: Habitats Regulations Assessment: Stage 1 Screening

Section 10: Environmental Monitoring Plan (EMP)

Section 11: Conclusions

2 BACKGROUND TO THE DROUGHT PERMIT

2.1 WELSH WATER'S SUPPLY SYSTEM

Welsh Water supplies water to more than 3 million people. The Welsh Water supply area covers the majority of Wales and a small part of England. It is split into 24 WRZs (see **Figure 2.1**).

Figure 2.1 Welsh Water Water Resource Zones

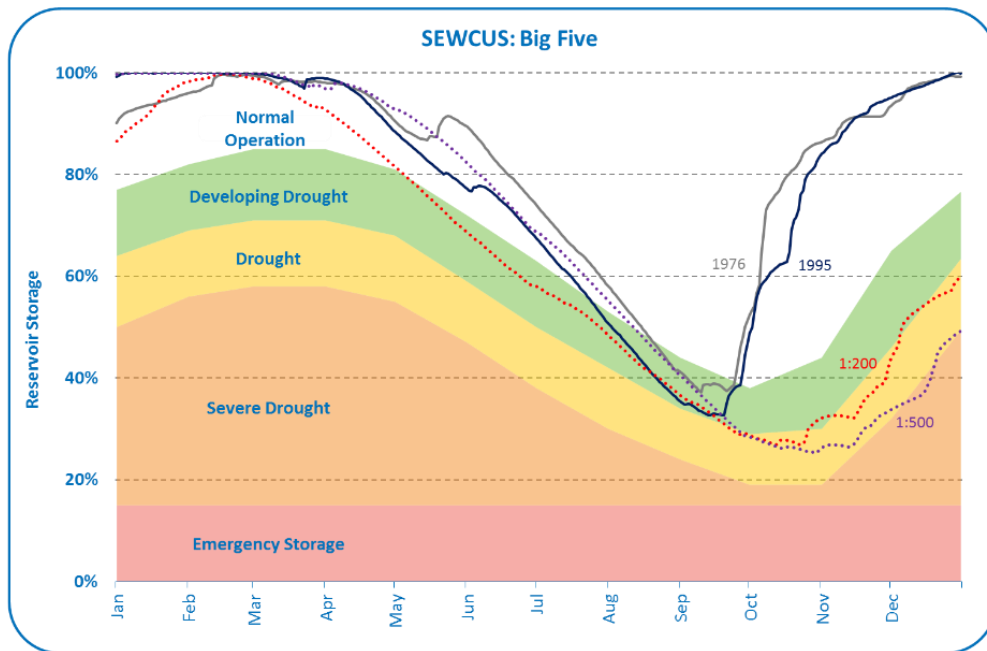


The SEWCUS WRZ is the largest of all Welsh Water's water resource zones and serves some 1.3 million domestic customers. It covers the large conurbations of Cardiff and Newport as well as the towns and villages of the South Wales valleys as far west as the Rhondda Valley and as far east as Chepstow.

The trigger levels for applying for a drought permit at the Afon Lwyd are based on water levels in five major reservoir systems (the 'Big Five') falling below a defined threshold level as shown in **Figure 2.2** (orange shading labelled 'severe drought'). Welsh Water's assessment in its draft Drought Plan 2020 indicates that drought

conditions severe enough to require an application for this drought option are unlikely to occur more frequently than at a return period of around once every 200 to 500 years. Fuller details of the work undertaken to assess this risk are provided in Annex 1 to the draft Drought Plan 2020.

Figure 2.2 SEWCUS WRZ : The Big Five Drought Action Zones and Historic Droughts



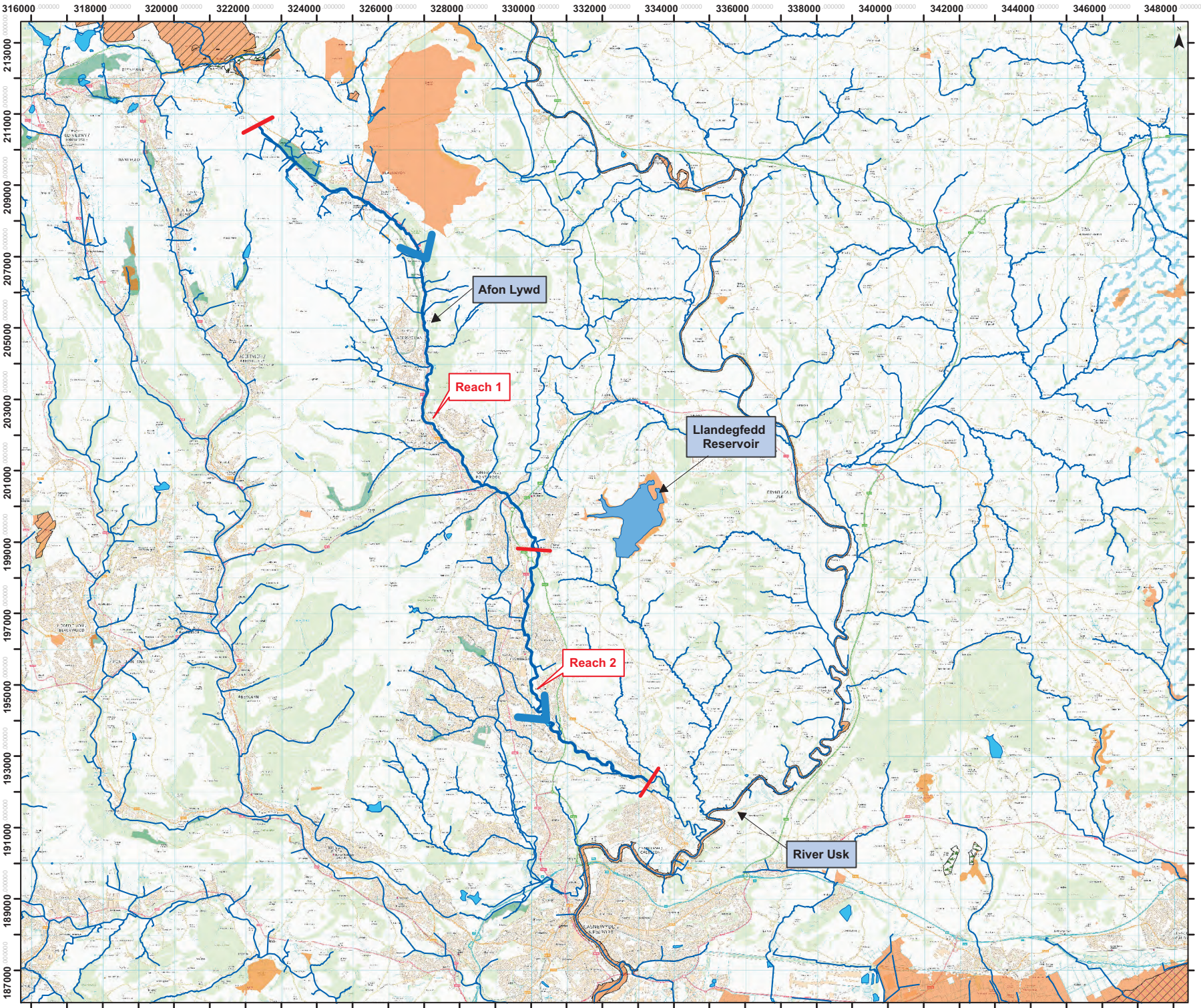
2.2 DESCRIPTION OF EXISTING ARRANGEMENTS AT THE AFON LWYD

Welsh Water have six licences in the Afon Lwyd catchment to abstract water under the Water Resources Act 1991, some of which have not been used for a number of years:



- Blaenavon (No.2) spring (licence no. 20/56/12/0031)
- Cwmavon Reservoir, springs and artesian well (licence no. 20/56/12/0046)
- Cwmyravon filter station, Nant-y-Mailor Reservoir and spring (licence no. 20/56/12/0047)
- Abersychan spring (licence no. 20/56/12/0048)
- Cwmsychan Reservoir spring (licence no. 20/56/12/0050)
- Penyrheol Reservoir intake chamber (licence no. 20/56/12/0051).

The total daily abstraction licensed from all of these sources is in the order of 12Ml/d. No direct abstraction is currently made by Welsh Water from the Afon Lwyd.

The study area is illustrated on **Figure 2.3**.



- Legend**
- Hydrological Reach
 - Water Courses
 - Flow Direction
 - Waterbody
 - RAMSAR Site
 - Site of Special Scientific Interest
 - Special Area of Conservation
 - Local Nature Reserve
 - National Nature Reserve
 - Area of Outstanding Natural Beauty



1:100,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey Information
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Project Title: Welsh Water Drought Plan
Environmental Assessment

Figure Title: Study Area: 8109-4
Afon Lwyd
Increase in the aggregate abstraction

Figure Number: Figure 2.3	Date: February 2019
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2.3 WELSH WATER'S DROUGHT PLANNING PROCESS

Water companies in England and Wales are required to prepare and maintain Statutory Drought Plans under Sections 39B and 39C of the Water Industry Act 1991, as amended by the Water Act 2003, which set out the management and operational steps a water company will take before, during and after a drought. The Water Industry Act 1991 defines a drought plan as '*a plan for how the water undertaker will continue, during a period of drought, to discharge its duties to supply adequate quantities of wholesome water, with as little recourse as reasonably possible to drought orders or drought permits*'.

The Drought Direction (Wales) 2017 states that revised Drought Plans should be submitted according to the following schedule:

4(b) for a revised drought plan –

if section 39B(6)(a) of the Act applies, within 6 months after the date on which the material change of circumstances occurs; and

if section 39B(6)(c) of the Act(c) applies, no later than 4 years after the date on which its drought plan, or its last revised drought plan, is published.

2.4 STATEMENT OF THE NEED FOR DROUGHT PERMIT

This section will be completed at the time of application for a drought permit.

2.5 DROUGHT PERMIT – REGULATORY ARRANGEMENTS

In periods of unusually low rainfall, when water resources become scarce, the Water Resources Act 1991, as amended by the Environment Act 1995 and the Water Act 2003, allows for three mechanisms for temporarily augmenting water supplies from rivers, lakes, reservoirs and groundwaters: drought permits; ordinary drought orders; emergency drought orders.

Drought permits are granted by NRW, and allow a water company powers to abstract from specified water sources, or to modify or suspend the conditions set out in existing abstraction licences. Drought orders are granted by the Welsh Ministers and not only give powers either to a water company or to NRW to abstract from specified water sources, or to modify or suspend the conditions set out in existing abstraction licences, but also to allow the discharge of water to specified places, modify or suspend conditions relating to a discharge or prohibit or limit particular non-essential uses of water as set out in the Drought Plan (Wales) Direction 2017. Emergency drought orders grant the same powers as a drought orders, but in addition, confer powers to prohibit or limit water uses as specified by the water company and allow the set up and supply of water by means of standpipes and/or water tanks or rota cuts.

Drought permits and orders may be granted for a period of up to six months and they can be extended for up to a further six months.

As part of the drought permit application process, water companies are required to prepare an Environmental Report setting out anticipated effects of the proposal, including the effect on other abstractors and sufficient information to inform assessments, where applicable, in relation to the Habitats Directive, Countryside and Rights of Way Act (CRoW), and the Water Framework Directive (WFD).

Further information on the requirements for the environmental assessment and reporting according to legislation and national guidance are provided in Section 3.

2.6 REVIEW OF ALTERNATIVE OPTIONS

This section will be completed at the time of application for a drought permit, setting out the alternative options to the drought permit that Welsh Water has considered in addressing the risks to essential public water supplies due to drought.

2.7 PROPOSED DROUGHT PERMIT DETAILS

The drought permit involves a new, unsupported emergency river abstraction of 12Ml/d from the Afon Lwyd, which is proposed to be located at New Inn, between Pontypool and Cwmbran (see Figure B1.1). The drought permit abstraction would not be for additional water, but would transfer the sum of the existing abstraction licences (see Section B.1.1 above) to the proposed location. The exact location of the unsupported emergency river abstraction would need to be determined through further investigations by Welsh Water. The abstraction is required to support raw water supply to either Llandegfedd Reservoir or direct to the nearby Sluvad WTW. To enable abstraction a low, temporary weir, probably constructed of sandbags, would be required across the Afon Lwyd. At this stage, it is not envisaged that the temporary weir will incorporate a fish pass.

A modest volume of water would be available from this drought permit scheme during a drought and there is benefit to supply through provision of an immediate additional water resource to an existing WTW.

The timing of the drought permit is most likely to occur during the summer and autumn period, from September to November inclusive. This is based on water resources modelling undertaken by Welsh Water. The drought permit scheme will influence the Afon Lwyd downstream of the abstraction to its tidal limit during ongoing low flow conditions. It will also act as an impassable physical barrier upstream of the temporary weir. Details of the existing and proposed drought permit abstraction at the Afon Lwyd are presented in **Table 2.1**.

Table 2.1 Afon Lwyd Existing and Proposed Drought Permit Abstraction

Abstraction Water Source	NGR	Normal Abstraction	Proposed Drought Permit Abstraction	Benefit Ml/d
Afon Lwyd	SO26980265	<p>Welsh Water have six licences in the Afon Lwyd catchment to abstract water under the Water Resources Act 1991, some of which have not been used for a number of years:</p> <ul style="list-style-type: none"> Blaenavon (No.2) spring (licence no. 20/56/12/0031) Cwmavan Reservoir, springs and artesian well (licence no. 20/56/12/0046) Cwmyravon filter station, Nant-y-Mailor Reservoir and spring (licence no. 20/56/12/0047) Abersychan spring (licence no. 20/56/12/0048) Cwmsychan Reservoir spring (licence no. 20/56/12/0050) Penyrheol Reservoir intake chamber (licence no. 20/56/12/0051). <p>The total daily abstraction licensed from all of these sources is in the order of 12Ml/d. No direct abstraction is currently made by Welsh Water from the Afon Lwyd.</p>	<p>The drought permit involves a new, unsupported emergency river abstraction of 12Ml/d from the Afon Lwyd, which is proposed to be located at New Inn, between Pontypool and Cwmbran. The drought permit abstraction would not be for additional water, but would transfer the sum of the existing abstraction licences to the proposed location. The exact location of the unsupported emergency river abstraction would need to be determined through further investigations by Welsh Water. The abstraction is required to support raw water supply to either Llandegfedd Reservoir or direct to the nearby Sluad WTW. To enable abstraction a low, temporary weir, probably constructed of sandbags, would be required across the Afon Lwyd. At this stage, it is not envisaged that the temporary weir will incorporate a fish pass.</p>	12 Ml/d

[Note: it will probably be necessary to remove the NGR for any public domain version]

2.8 DROUGHT PERMIT PROGRAMME

Drought permits may remain in force for a period of up to six months, and they can be extended for up to a further six months. However, the period of implementation for this drought permit is restricted to September to November, as confirmed by water resources modelling carried out by Welsh Water.

Prevailing weather conditions and rainfall in the intervening period may delay the requirement for applications, or even result in no requirement to apply. A permit may be granted but not actually implemented if weather conditions improve or, equally, the permit may only be partially implemented.

2.9 DROUGHT PERMIT BASELINE

It is important for the assessment to establish the environmental "baseline" conditions that would exist in drought conditions but in the absence of the drought permit being implemented. For the purposes of this assessment, the "without drought permit" baseline excludes any abstraction from the Afon Lwyd River, as there is currently no licence in place.

3 APPROACH

3.1 INTRODUCTION

The DPG states that the environmental report must include:

- i. the likely changes in flow, level, channel/riparian form and sediment due to implementing the action;
- ii. the features that are sensitive to these changes;
- iii. potential impacts on sensitive features;
- iv. a plan of baseline, in-drought and post-drought monitoring; and
- v. mitigation or compensation measures that may be required

Items i and ii above were subject to an initial screening process as part of the scoping exercise. Section 3.2 below describes the approach taken. This has provided the relevant study area and a list of features scoped into the environmental assessment which are the subject of this EAR.

Section 3.3 describes how the environmental assessment has been undertaken, including discussion of the general approach, guidance used, provision of data, assessment methodologies and consideration of mitigation and monitoring. Limitations to the environmental assessment are described in Section 3.4, 4 and 5.

To set the context of the studies, it should be noted that EAR considers the environmental impacts of implementing a drought permit during the worst environmental conditions (natural drought) that the permit could be implemented in.

In accordance with the DPG and the Habitats Regulations, the assessment considers how the proposed drought permit may affect the environment in combination with the effects of other existing abstraction licences, environment permits and other plans. This includes assessment of the potential cumulative effects of the following:

- Welsh Water's existing abstraction licences that operate within the hydrological zone of influence of the drought option, as well as other abstraction and discharge consents
- Assessment of cumulative impacts of the drought permit with other Welsh Water supply side and drought permit options within the hydrological zone of influence (including both intra- and inter- zone options)
- Other plans and projects of relevance, including:
 - Welsh Water's WRMP schemes which are scheduled to be implemented and become operational within the time period of the revised Drought Plan (i.e. before 2025)

- Drought options from other neighbouring water company Drought Plans, NRW Drought Plans.
- National Policy Statements for Wastewater and Renewable Energy Infrastructure.

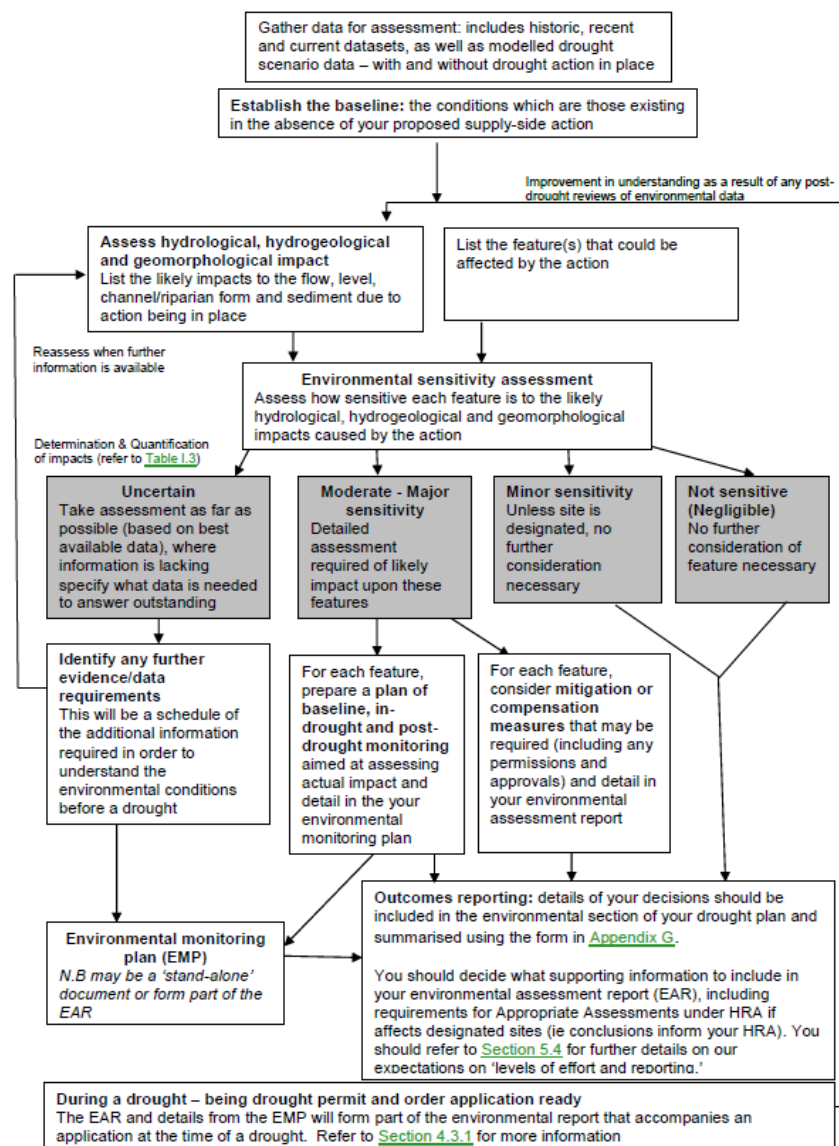
This is discussed further in Section 7.

3.2 APPROACH TO SCREENING AND SCOPING

3.2.1 Screening

Screening was undertaken using the DPG; specifically Section 5 and Appendix I. Figure 2 of the DPG (replicated in **Figure 3.1** below) identifies the environmental impact activities required.

Figure 3.1 Environmental Impact Activities Identified in the Drought Plan Guideline



The screening fulfils the requirement to “Assess how sensitive each feature is to the likely hydrological, hydrogeological and geomorphological impacts caused by the action”. Stage 1 (hydrological impact) fulfils the requirement to “List the likely impacts to the flow, level, channel/riparian form and sediment due to action being in place”. Stage 2 (environmental sensitivity) fulfils the requirement to “list the feature(s) that could be affected by the action” and to “Assess how sensitive each feature is to the likely hydrological, hydrogeological and geomorphological impacts caused by the action”

It is important to acknowledge the basis of the assessment; i.e. impacts of drought permit implementation should be considered in the context of what would occur without drought permit implementation (see Sections 2.2, 2.7 and 2.9).

The approach to undertaking Stages 1 and 2 is described below.

Stage 1 – Hydrological and Hydrogeological Impact

Consideration is required (by the DPG) of the likely impacts on the hydrology, hydrogeology and geomorphology of every river reach, wetland or lake area influenced by the proposed drought management action, specifically:

- identify the drought conditions which trigger the proposed action;
- identify any changes that the action is likely to bring about, specifying their length, severity and location in relation to existing natural and artificial features;
- describe the likely conditions in the absence of the proposed action;
- describe how the likely conditions would differ with the action in place compared to the same (or analogous) watercourse under natural conditions; and
- identify the extent of the area affected by the planned actions.

The hydrogeological and hydrological information is used together with information on the other environmental features in the study area from Stage 2 - Environmental Sensitivity (see below) to identify the environmental risk of implementing the drought permit.

Although the DPG informs the hydrometric data to be used as part of environmental features for consideration within the environmental assessment (see Box 1 Appendix I of the DPG), it does not provide a methodology for identifying the hydrological impact. A bespoke assessment has therefore been undertaken.

The full hydrological assessment approach is set out in **Appendix A**.

The output from these studies provides an understanding of the scale of change in the

hydrological characteristics as a result of implementing the drought permit. Where changes have been identified, the potential significance of adverse or beneficial impacts has been assessed.

Quantitative and qualitative measures have been used to grade the impacts on surface waters. The assessment has identified the potential severity of impact based on the following criteria:

- **Positive or Negative Impact** – all impacts are considered to be negative unless otherwise stated in the feature assessment.
- **Extent** – the extent of the impact is covered as part of the magnitude consideration.
- **Magnitude** – the magnitude of the impact is identified as:
 - *High*: There is a long-term large-scale (i.e. catchment) change in the physical environment.
 - *Medium*: There is a short-term large-scale change or long-term short-scale (i.e. reach) change in the physical environment, however, no changes in the overall integrity of the physical environment.
 - *Low*: There is a short-term small-scale change in the physical environment, but its overall integrity is not impacted.
 - *Negligible*: No perceptible change in the physical environment.
- **Duration** – the duration of impact is considered to be for 6 months, which is the duration for which a drought option is implemented, unless otherwise stated.
- **Reversibility** – all hydrological impacts are considered to be reversible.
- **Timing and Frequency** – the drought option could be implemented at any point in the year, unless otherwise stated. The assessment is based upon the operation of a single drought permit, with subsequent applications for a drought permit required to consider cumulative effects of multiple drought permits.
- **Probability** – all impacts are considered to be probable, unless otherwise stated.

The hydrological impact assessment is described fully in **Appendix B**.

Section 4 provides a summary of the hydrology and physical environment assessment as a result of implementing a drought permit at the Afon Lwyd.

Stage 2 - Environmental Sensitivity

With the extent and level of flow impact mapped, using GIS and other data sources, potentially sensitive receptors (sites / features) located within the extents of impact have been identified. Potentially sensitive features investigated in the screening have

been drawn from Box 1 in Appendix I of the DPG. These include:

- designated biodiversity sites (Local Nature Reserve (LNR), National Nature Reserve (NNR), Marine Protected Areas, National Parks, Areas of Outstanding Natural Beauty (AONB), SSSI, Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar) and Environment (Wales) Act Section 7 species / habitats which are located on or within 500m of the impacted reaches;
- protected species;
- ecological communities (fish, bryophyte & lichen, macro-invertebrates, macrophytes, algae) and, where identified, Water Framework Directive (WFD) status of designated waterbodies which contain the impacted reaches;
- invasive non-native species;
- sensitive ecological features as advised by NRW;
- wider features which should be taken into account in determining the potential impacts of drought option implementation – specifically socio-economic & health, amenity & aesthetics, recreation, navigation, architectural & archaeological heritage.

Each of the identified sensitive receptors within the extent of impact have been listed, alongside a brief summary of their potential susceptibility to flow impacts. For designated sites, this has included an indication as to whether the sites have water dependent qualifying interests.

The environmental sensitivity of each site has been identified according to the ecological and nature conservation interests of the area and, in particular, the proximity of and / or connectivity with the designated protected area. Each site has been assessed according to whether the extent of hydrological influence includes or is considered to affect a designated or protected site. Designated or protected sites outside the extent of hydrological influence are considered not to be influenced by the drought permit.

The outcome of Stage 1 and Stage 2 of the screening exercise are presented in Sections 4 and 5 respectively.

3.2.2 Scope

The screening exercise establishes the study area for the Afon Lwyd drought permit together with identification of relevant, sensitive environmental features within those study areas (based on the risk of them being impacted by the drought permit during the period of its operation).

As set out in **Figure 3.1**, the environmental sensitivity screening identifies the

outcome for each listed feature. Four outcomes are possible from the screening: uncertain; moderate-major sensitivity; minor sensitivity; not sensitive (negligible); and identifies appropriate next steps. Sections 4.2 and 5.2 present the findings which show that a number of features were identified as either: 1) uncertain; 2) moderate-major sensitivity; or 3) minor sensitivity in a designated site and in accordance with the DPG are features for which further assessment work will be required. These features alone form the scope of monitoring, environmental assessment, and consideration of mitigation actions.

The DPG states that environmental assessment, mitigation and / or monitoring is not required for features where screening has identified a minor (unless a site is designated) or negligible impact. However, the requirement for assessment, monitoring and / or mitigation has been reviewed on a case-by-case basis. In some cases, mitigation and / or monitoring has been recommended where minor impacts are identified, where considered appropriate on a precautionary basis.

3.3 APPROACH TO ASSESSING IMPACTS, MITIGATION AND MONITORING

3.3.1 General Approach

The assessment approach is in accordance with legislation, national regulations and guidance, including:

- NRW (2017) Water Company Drought Plan Technical Guideline (DPG)
- Welsh Ministers (2017) The Drought Plan (Wales) Direction
- Institute of Environmental Management and Assessment (2004) Guidelines for Environmental Assessment
- Chartered Institute of Ecology and Environmental Management (CIEEM) (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland²
- UKWIR (2007, updated 2012) Strategic Environmental Assessment – Guidance for Water Resources Management Plans and Drought Plans. Prepared by Cascade Consulting
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)
- Council Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat , December 1975

² CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal. September 2018.

- Conservation of Habitats and Species Regulations 2017
- The Countryside and Rights of Way Act 2000.

All aspects of the drought permit of potential environmental significance are considered in the environmental assessment.

The DPG states that a water company should clearly show what evidence and data have been used in decision making, that uncertainties should be identified, and which additional data requirements are provided for through the environmental monitoring plan.

In accordance with the DPG the approach to the assessment addresses the following: i) potential effects on each sensitive receptor; ii) definitions for impacts (adverse / beneficial); iii) the data requirements; iv) assessment methodology (including the treatment of uncertainty where the complete data requirements are not available).

This EAR presents the environmental baseline, i.e. habitats and environmental pressures (including flow and water quality) in the study identified zone of hydrological influence without the drought permit in place, utilising a description of the catchment, geomorphology, anthropogenic features and water quality. Key changes to the physical environment as a result of implementing the drought permit have been identified and described and, where appropriate, this information is used to frame and support the assessments of features which have been scoped in further to the screening and scoping exercise (see Section 3.2).

3.3.2 Assessment Methodologies

The aim of the Environmental Assessment is to provide:

- A clear summary of the outcome of each assessment (per feature) from which NRW can readily identify the significance of the impact when determining the drought permit application.
- Identification of those predicted impacts which are to be taken forward to consider additional monitoring and mitigation actions.

The assessment considers the environmental impacts of implementing the drought permit against baseline operating conditions of Welsh Water's abstraction licence in advance of drought permit implementation. Environmental sensitivity has been assessed considering the context of the timing of drought permit implementation. **It is important to acknowledge the basis of the assessment; i.e. impacts of drought permit implementation are assessed against what would occur without drought permit implementation.**

The impact assessment for sensitive features is feature specific and is dependent on

the availability and resolution of available data. Where possible, quantitative assessments have been undertaken. However, for many features, it is acknowledged that the assessments are qualitative and based on professional judgement, and using, where relevant, experience of local knowledge and reference to literature. This introduces uncertainty into the impact assessment. A precautionary approach has been used to assigning impact significance where data are absent or found not to be robust.

The assessment of impacts on designated sites has been undertaken using professional judgement with reference to conservation objectives and condition status of habitats and species, for which a site has been designated. The ecological assessment has been undertaken recognising the IEMA^{3,4} and the CIEEM study guidelines⁵. The assessment of impacts on other environmental receptors e.g. recreation and landscape has been carried out largely by qualitative expert judgement.

Assessment of impacts on specific features has then been undertaken. Specific assessment methodologies have been developed for key environmental features. These are set out in **Appendix C** (assessment methodologies for the ecological assessment of Environment (Wales) Act Section 7 species, designated sites and other flora and fauna).

Other abstractors, including other water company abstractions, are features that have been reviewed within the assessment. This has been undertaken to determine whether other abstractors could potentially be affected by changes to surface water flows and levels as a result of implementation of the drought permit.

3.3.3 Mitigation and Monitoring

Section 5.3 of the DPG identifies the specific requirements for mitigation of serious impacts on the environment as a result of implementing a drought management measure. The assessments undertaken in this EAR confirm the features requiring consideration of mitigation and appropriate monitoring triggering mitigation. Appropriate mitigation actions identified are both available and practicable.

The DPG also identifies the specific requirements for monitoring. The assessments undertaken in this EAR inform the features requiring consideration for monitoring prior to, during, or after implementation of the drought permit.

The mitigation and monitoring proposals (see Sections 6 and 10) will act as a safeguard that responds and is responsive to both predicted and unpredicted drought impacts. Future data collection and monitoring can then be focused to identify the aquatic

³ IEMA (2004) Guidelines for Environmental Impact Assessment.

⁴ IEMA (2011) Special Report – The State of Environmental Impact Assessment Practice in the UK

⁵ CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland.

ecosystem interaction to better quantify the potential impacts where gaps in the evidence base are identified and ensure the appropriate targeting of monitoring and mitigation response. The EMP will need to be finalised in agreement with NRW.

3.4 LIMITATIONS OF THE ASSESSMENT AND UNCERTAINTIES

The DPG states that a water company should clearly show what evidence and data have been used in decision making, that uncertainties should be identified, and which additional data requirements are provided for through the environmental monitoring plan.

The assessment presented in this document draws on available information from surveys and investigations undertaken by Welsh Water, NRW, as well as other bodies over a number of years. Reference has also been made to wider studies from published and grey literature, i.e. academic literature that is not formally published, where appropriate.

Specific details are provided on the quality of the data collected and used in the assessment. Where uncertainties remain with respect to the quantification and prediction of impacts, the limitations and any assumptions made are included in the relevant technical sections (Sections 4 and 5).

Overall, it is considered that the conclusions are based on information that is robust and valid at the time of writing. However, it should be noted that this EAR would be updated to support any future actual application, including a review of data.

4 AFON LWYD DROUGHT PERMIT - HYDROLOGY AND THE PHYSICAL ENVIRONMENT

4.1 INTRODUCTION

Consideration of hydrology and the water physical environment sets the context for the potential range of environmental effects of the drought permit. **Appendix B** sets out an assessment of the potential impacts on the physical environment of the Afon Lwyd during the period of implementation of the drought permit. The “without drought permit” baseline is set out in Section 2.9.

The water physical environment assessment includes consideration of hydrology and hydrodynamics; geomorphology; and water quality. The assessment has three key objectives:

1. It is used to “list likely changes in flow, level, channel/riparian form and sediment due to implementing the action’ as required by the DPG and set out in Figure 2 of the DPG
2. It is used to support the screening and assessment of sensitive features (including ecological features and designated sites) as required by the DPG and set out in Section 5 of this report
3. Where sensitive features are the physical environment itself, it provides supporting technical information for their screening and assessment.

Each of these are summarised below.

4.2 SUMMARY OF STAGE 1 SCREENING

This fulfils the DPG requirements of Stage 1 of the screening of potential drought permit impacts, identifying the likely changes in flow/ level regime due to implementing the drought permit. The specific requirements of the DPG are summarised as:

- identify any changes that the drought permit is likely to bring about, specifying their length, severity and location in relation to existing natural and artificial features (e.g. flow, water level, channel dynamics and sediment changes);
- describe the likely conditions in the absence of the drought permit;
- describe how the likely conditions would differ with the drought permit in place compared to the same (or analogous) watercourse under natural conditions; and
- identify the extent of the area affected by your planned actions.

These requirements are addressed in the following sections.

1. The perceived extent of potential impact:
2. The study area (see **Figure 2.3**) includes all of the Afon Lwyd from the source down to the tidal limit, comprising two distinct hydrological reaches.
3. The nature and duration of the potential impact:

A description of the likely conditions with the drought permit in place, in comparison to the baseline conditions (absence of the proposed action) is provided in **Appendix B**. Given the conditions of the proposed drought permit, the key areas for the assessment of the physical environment have been identified as:

- Changes in river flows of the Afon Lwyd.

The **Appendix B** assessment has been summarised in **Table 4.1** in terms of the magnitude and duration of each of these potential physical environment impacts.

4. The length of the potential impact:

The **Appendix B** assessment has been summarised in **Table 4.1** in terms of the timing of each of the potential physical environment impacts. The drought permit is most likely to occur during the summer and autumn period, considered to not extend outside the period September to November.

4.3 SUMMARY OF POTENTIAL EFFECTS ON THE PHYSICAL ENVIRONMENT

The potential changes to the physical environment (water quality and geomorphology) due to implementation of the drought permit are summarised in **Table 4.1**. These impacts are presented in detail in **Appendix B**.

Table 4.1 Summary of Potential Hydrodynamic and Water Quality Impacts of the Drought Permit

Llandegfedd Reservoir	
Water levels in Llandegfedd Reservoir <i>Minor beneficial impacts in summer/autumn period</i>	<ul style="list-style-type: none"> The hydrological impact of this option is assessed as being minor (beneficial).
Afon Lwyd (Reach 1)	
Flows in the Afon Lwyd <i>Minor impacts during the period of implementation from September to November inclusive</i>	<ul style="list-style-type: none"> No reduction in flows is anticipated, but the hydrological impact has been assessed as minor due to localised ponding effects from the temporary weir which would be located at the proposed abstraction point.
Geomorphology <i>Negligible impacts in summer/autumn period</i>	<ul style="list-style-type: none"> Impacts on geomorphology in Reach 1 related to the ponding effects of the temporary weir are assessed as negligible.
Water quality <i>Low to medium risk in summer/autumn period</i>	<ul style="list-style-type: none"> Low risk linked to total ammonia and dissolved oxygen. Medium risk linked to soluble reactive phosphorus due to history of standard failure
Consented Discharges <i>Negligible impacts in summer/autumn period</i>	<ul style="list-style-type: none"> Negligible risk
CSOs <i>Negligible risk in summer/autumn period</i>	<ul style="list-style-type: none"> Negligible risk
Afon Lwyd (Reach 2)	
Flows in the Afon Lwyd <i>Major impacts in summer period (September); moderate impacts in winter period (October to November inclusive)</i>	<ul style="list-style-type: none"> The impact on hydrological reach 2 has been assessed as major in summer, with a 36% reduction in the summer Q₉₅ flow and a 59% reduction in the summer Q₉₉ flow. In winter months there is a 9.7% reduction in the year round median flow (Q₅₀) and a 30.9% reduction in year round low flow (Q₉₅); this is assessed as a moderate impact.
Geomorphology <i>Negligible impacts in summer/autumn period</i>	<ul style="list-style-type: none"> Impacts on geomorphology due to a reduction in the wetted depth during the operation of a drought permit have been assessed as negligible.
Water quality <i>Low to high risk during summer/autumn period</i>	<ul style="list-style-type: none"> Medium risk linked to total ammonia and low risk from dissolved oxygen. High risk linked to soluble reactive phosphorus due to standard failure and major hydrological impacts
Consented Discharges <i>Negligible impacts in summer/autumn period</i>	<ul style="list-style-type: none"> Negligible risk
CSOs <i>Negligible risk in summer/autumn period</i>	<ul style="list-style-type: none"> Negligible risk

4.3.1 Support to the Screening and Assessment of Sensitive Features

The assessment included in **Appendix B** has provided information to support the screening and assessment of sensitive features in Section 5. This includes information on short and long term (acute and chronic) direct and indirect, cumulative, and permanent and temporary effects. The assessment is also specific on the difference between the drought permit impacts and the baseline condition without a drought permit in place.

4.3.2 Supporting Technical Information for Assessment of any Physical Environment Sensitive Features

As described in Section 5, several sensitive features relate to the physical environment, rather than ecology or human interaction (e.g. landscape, recreation). The assessment included in **Appendix B** has provided supporting technical information for their screening and assessment in Section 5.

5 AFON LWYD DROUGHT PERMIT ENVIRONMENTAL FEATURES ASSESSMENT

5.1 INTRODUCTION

As set out in **Box 1** above, environmental sensitivity screening of the drought permit was undertaken in line with the approach recommended by the DPG, and scoping undertaken in line with the methodology described in Section 3.2. The screening and scoping has subsequently been reviewed and refined further to discussions and consultation with NRW (see Sections 1.2 and 1.3). The outcome of this process is described in Section 5.2 which shows that a number of features were identified as either: 1) uncertain; 2) moderate-major sensitivity; or 3) minor sensitivity in a designated site. These features form the scope of environmental assessment, which is further described in Section 5.3.

The features assessment is informed by the assessment of the physical environment presented in Section 4 (which includes hydrology, geomorphology and water quality) and identifies the significance of any potential impacts. Consideration of mitigation actions and monitoring is described in Sections 6 and 10 respectively.

Points of interest referred to throughout the text in Section 5 are indicated on **Figure 2.3**.

5.2 SUMMARY OF STAGE 2 SCREENING AND SCOPING

5.2.1 Designated Sites and Other Sensitive Fauna and Flora

In accordance with the DPG, **Table 5.1** identifies designated biodiversity sites (including LNR, NNR, SSSI, SAC, SPA), Environment (Wales) Act Section 7 species / habitats and other sensitive receptors that could be affected by the drought permit. Susceptibility to the flow / level impacts resulting from the drought permit (see Section 4) is identified according to whether interest features of the site or the species are water dependent. Sensitivity is then determined according to professional judgment based on susceptibility and the level of hydrological impact at the location.

Table 5.1 Designated Sites and Other Sensitive Receptors Within the Zone of Influence of the Afon Lwyd Drought Permit

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, Moderate/Major, Minor, Negligible)	Further Consideration Required (Yes/No)
Afon Lwyd and Llandegfedd Reservoir				
River Usk SAC/SSSI	Major (Reach 2)	The Afon Lwyd is a tributary of the River Usk, which is recognised as an important conservation area both nationally and internationally and is designated as both a SAC and SSSI. Mobile features of the designated site may utilise Afon Lwyd, therefore the impact of this drought permit may influence these features.	Uncertain	Yes
Llandegfedd Reservoir SSSI	Minor beneficial	Implementation of the drought permit requires temporary pipelines to pump the abstracted water from the Afon Lwyd to either Llandegfedd Reservoir or direct to the nearby Sluvald WTW. The site is particularly important for the overall numbers and variety of wintering wildfowl. The area around the reservoir includes grassland, important for feeding and roosting wildfowl, woodland and scrub. The drought permit would serve to reduce the rate of reservoir drawdown, resulting in potentially shorter duration or a less extensive drawdown. This may reduce the extent of exposed shoreline that would have been available to birds during environmental drought were the drought permit not implemented although this impact would be negligible.	Negligible	No
Cycle path from Blaenavon to the viaduct LNR	Minor (Reach 1) Major (Reach 2)	There are no water dependant features in this designated site therefore the drought permit is not expected to have any impact.	Negligible	No
Blorenges SSSI	Minor (Reach 1) Major (Reach 2)	The southern part of this extensive upland site is comprised of submontane heath. In the north there are exposures of Carboniferous Limestone bearing a grassland rich in calcicole species. The features of this designated site are not water dependant and are therefore not expected to be impacted by the implementation of this drought permit.	Negligible	No
Garn lakes LNR	Minor (Reach 1) Major (Reach 2)	Garn lakes is not hydrologically connected to the Afon Lwyd and is not expected to be impacted by the implementation of this drought permit.	Negligible	No
Notable Species – Mammals Otter <i>Lutra lutra</i> Water voles <i>Arvicola terrestris</i>	Minor (Reach 1) Major (Reach 2)	Otter are known to be present along the Afon Lwyd. Otter are water-dependent, foraging in, over or adjacent to water for fish and aquatic invertebrates. However, this species is not expected to be significantly impacted by the drought permit implementation, as habitat availability and quality for otter is not anticipated to be significantly altered. Water voles are not known to be present along the impacted reaches of the Afon Lwyd and would not be expected to be impacted by the implementation of this drought permit.	Negligible	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, Moderate/ Major, Minor, Negligible)	Further Consideration Required (Yes/No)
Notable Species – Fish Atlantic salmon Brown/sea trout <i>Salmo trutta</i> European eel <i>Anguilla Anguilla</i> Bullhead	Minor (Reach 1) Major (Reach 2)	A number of fish species are known to be present within the Afon Lwyd, which would likely be impacted by the implementation of this drought permit. Changes to velocity, depth, wetted width may restrict the access of migratory fish to spawning tributaries or to dry spawning gravels. Reductions in flow may alter habitat and availability for the resident fish community.	Major	Yes
Notable Species – Invertebrates White clawed crayfish <i>Austropotamobius pallipes</i>	Minor (Reach 1) Major (Reach 2)	There are records of the white-clawed crayfish within the extent of hydrological influence of the drought permit, however, no quantitative data records have been made available for the Afon Lwyd population. The NERC Act Section 42 states that the species is sensitive to habitat modification from the management of water bodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows.	Moderate / Major	Yes
Macroinvertebrate community	Minor (Reach 1) Major (Reach 2)	The hydrological impacts associated with the implementation of this drought permit may adversely affect the ecological integrity of the macroinvertebrate community present in the Afon Lwyd. Changes to wetted width and velocity could potentially reduce habitat availability and community composition.	Moderate	Yes
Macrophyte community	Minor (Reach 1) Major (Reach 2)	The hydrological impacts associated with the implementation of this drought permit may adversely affect the ecological integrity of the macrophyte community present in the Afon Lwyd. Changes to wetted width and velocity could potentially reduce habitat availability and community composition.	Moderate	Yes
Phytobenthos community	Minor (Reach 1) Major (Reach 2)	The hydrological impacts associated with the implementation of this drought permit may adversely affect the ecological integrity of the phytobenthos community present in the Afon Lwyd. Changes to wetted width and velocity could potentially reduce habitat availability and community composition.	Moderate	Yes
Invasive fauna Himalayan balsam <i>Impatiens glandulifera</i> Japanese knotweed <i>Fallopia japonica</i>	Minor (Reach 1) Major (Reach 2)	These two invasive terrestrial plant species have been recorded along the banks of the Afon Lwyd. Implementation of this drought permit is not expected to increase the distribution of these species.	Negligible	No
Landscape and visual amenity	Minor (Reach 1) Major (Reach 2)	There are no Areas of Outstanding Natural Beauty (AONBs) or National Parks within the immediate vicinity of the Afon Lwyd and the zone of hydrological influence of the drought permit. The impact on wetted width and wetted depth in the Afon Lwyd will only be temporary and will be ameliorated once the drought has passed.	Uncertain	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, Moderate/ Major, Minor, Negligible)	Further Consideration Required (Yes/No)
Recreation	Minor (Reach 1) Major (Reach 2)	Recreation activities in the study area include cross country running, golf, and horse riding, walking, angling and canoeing. Llandegfedd Reservoir to the east of the study reach is popular for bird watching, sailing, sub aqua activities and windsurfing. Any reduction in wetted width and depth may influence the angling resource on the Afon Lwyd flows in the study area.	Uncertain	Yes
Archaeology	Minor (Reach 1) Major (Reach 2)	There are two scheduled ancient monuments within the zone of influence of this drought permit. Both of which are post medieval and are not expected to be impacted by the implementation of this drought permit.	Negligible	No

5.2.2 WFD Waterbody Status

Table 5.2 identifies the WFD status classification of the WFD waterbodies that may be impacted by implementation of the drought permit. Waterbodies classified as overall high / good status / potential, and / or high / good ecological status for fish or macroinvertebrates are likely to be more sensitive to flow impacts. **Table 5.2** summarises the risk to WFD status and indicates where further assessment has been carried out as reported in Section 5.3 below.

Table 5.2 WFD Status Classifications

Waterbody Name	Afon Lwyd- below Mon and Brecon Canal (GB109056032911)		Afon Lwyd - source to Mon and Brecon Canal (GB109056032912)	
Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Major		Minor	
Heavily Modified Waterbody (Y/N)	No		No	
RBMP Cycle	RBMP2 (2015) ⁶	2018 C2 Interim ⁷	RBMP2 (2015)	2018 C2 Interim
Ecological	Good	Moderate	Poor	Poor
Fish	Good	Good	Poor	Poor
Macrophytes	Good	High	Not assessed	Not assessed
Phytobenthos	High	High	Not assessed	Not assessed
Macro-invertebrates	Good	Good	High	High
Total P/ Phosphate	High	Moderate	Good	Moderate
Ammonia	High	High	High	High
Dissolved Oxygen	High	High	High	High
pH	High	High	High	High
Sensitivity (Uncertain, Moderate/ Major, Minor, Not sensitive)	Major		Minor	
Further Consideration Required (Y/N)	Yes		No	

5.3 FEATURES ASSESSMENT

5.3.1 Basis of Features Assessment

This section describes and assesses the potential impacts on the sensitive features during the period of implementation of the drought permit.

Based on the sensitive features identified in Section 5.2.2, the degree of impact has been assessed and analysed in Section 5.3. Desk-based assessments have been completed for each of the sensitive receptors, where applicable, in order to determine

⁶ NRW (2017) <https://drive.google.com/file/d/0B2hsDbdxztZHItRU9lNkg1YWw/view>.

⁷ NRW (2018) https://drive.google.com/file/d/14w17jLo5sNuToVELqMCK_yc6DdHU7STb/view.

the magnitude of impact in the Afon Lwyd drought permit hydrological zone of impact. Each feature assessment describes the analyses carried out and a statement of the assessed impact. All impacts are considered to be negative / adverse unless otherwise stated in the feature assessment. The approach is described in Section 3.3.

The hydrological assessment is summarised in Section 4 and is presented in full in **Appendix B**.

5.3.2 Summary of Features Assessment

Table 5.3 presents the overall summary of the significance of potential impacts of the drought permit identified from the assessment of designated sites, and other ecologically significant receptors and their relevant reaches. Full details of the features assessment are provided in **Appendix D**. A brief summary of the features assessment is also provided below in Sections 5.3.3 – 5.3.8.

Table 5.3 Summary of Impacts of Drought Permit Implementation Pre-Mitigation

Month		J	F	M	A	M	J	J	A	S	O	N	D
River Usk SAC / Lower Usk SSSI		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Reach 1: Source to temporary abstraction point (New Inn)													
Macrophytes		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Macroinvertebrates		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Atlantic salmon	Spawning, egg survival, and juveniles	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
	Adult upstream migration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
	Water quality	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Brown / sea trout	Adult migration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
	Juveniles (habitat loss)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
	Water quality	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Bullhead		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
European eel Migration		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Other fish species - Minnow, stone loach and three-spined stickleback		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Risk to WFD waterbody fish status		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Phy to benthos		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Crustacea: White-clawed Crayfish		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Invasive Species		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Landscape		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Recreation		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Reach 2 – Temporary abstraction point (New Inn) to the tidal limit													
Macrophytes		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Macroinvertebrates		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Notable macroinvertebrate species – <i>Omphiscola glabra</i>		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Risk to WFD waterbody macroinvertebrate status		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Atlantic salmon	Spawning, egg survival, and juveniles	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
	Adult upstream migration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
	Water quality	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Brown / sea trout	Adult migration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
	Juveniles (habitat loss)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
	Water quality	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Bullhead		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
European eel Migration		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Other fish species - Minnow, stone loach and three-spined stickleback		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Risk to WFD waterbody fish status		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Phy to benthos		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Crustacea: White-clawed Crayfish		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Invasive Species		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Landscape		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Recreation		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A

Key to Environmental Effects:

N/A	Outside implementation period
N	Negligible impacts are considered likely
	Minor adverse impacts are considered likely
	Moderate adverse impacts are considered likely
	Major adverse impacts are considered likely
	Potential minor beneficial impacts are considered likely
	Potential moderate beneficial impacts are considered likely

5.3.3 Designated Sites

Table 5.4 presents a summary of the potential impacts of the drought permit identified from the assessment of designated sites. The location of each of the designated sites discussed below is set out in **Figure 2.3**.

Table 5.4 Summary of Impacts of Drought Permit Implementation on Designated Sites

Feature	Impact	Significance of Impact
Reach 1 and 2		
River Usk SAC / Lower Usk SSSI	<ul style="list-style-type: none"> Impacts on Atlantic salmon, brown/sea trout and European eel within the zone influence to impact upon the fish population of the designated site. 	Minor

5.3.4 WFD and Community Assessment

This section considers the potential impact on the feature community within each reach as well as identifying the risk of deterioration in status / potential under the WFD.

WFD Definitions

The following definitions are provided for the determination of status under the WFD.

High ecological status - the values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions and show no, or only very minor, evidence of distortion.

Good ecological status - the values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.

Moderate ecological status - the values of the biological quality elements for the surface water body type deviate moderately from those normally associated with the surface water body type under undisturbed conditions. The values show moderate signs of distortion resulting from human activity and are significantly more disturbed than under conditions of good status.

Poor ecological status - waters showing evidence of major alterations to the values of the biological quality elements for the surface water body type and in which the relevant biological communities deviate substantially from those normally associated with the surface water body type under undisturbed conditions, shall be classified as poor.

Bad ecological status - waters showing evidence of severe alterations to the values

of the biological quality elements for the surface water body type and in which large portions of the relevant biological communities normally associated with the surface water body type are absent, shall be classified as bad.

Good ecological potential - there are slight changes in the values of the relevant biological quality elements as compared to the values found at high ecological potential.

Moderate ecological potential - there are moderate changes in the values of the relevant biological quality elements as compared to the values found at maximum ecological potential.

The Environment Agency⁸ identify that a number of different factors need be considered when making an assessment of the ecological potential of HMWBs. Of primary importance is the need to put a specified range of mitigation measures in place to address the effects of the anthropogenic impact. Selected ecological quality elements may also be required to be at good ecological status for the waterbody to be classified as good ecological potential. Where the designated use includes for impacts on flow and flow-related mitigation measures the measured status of the fish and macroinvertebrate communities do not affect the classification of GEP.

Assessment

A summary of the potential impacts of the drought permit on macrophyte, macroinvertebrate, phytobenthos and fish communities and WFD status is presented below. Full details, including detailed baseline information, can be found in **Appendix D**.

⁸ Environment Agency (2011) Method statement for the classification of surface water bodies v2.0 (external release) Monitoring Strategy v2.0 July 2011

Macrophytes

Table 5.5 presents a summary of the potential impacts of the drought permit identified from the assessment of macrophytes.

Table 5.5 Summary of Impacts of Drought Permit Implementation on Macrophytes

WFD Status/ Community	Impact	Significance of Impact
Afon Lwyd -below Mon and Brecon Canal (GB109056032911) Current status: High (2018 interim status)	<ul style="list-style-type: none"> There is a minor risk of short-term deterioration in status of the macrophyte component of the waterbody due to the moderate adverse, short-term, temporary and reversible impacts associated with the drought permit 	Minor
Feature	Impact	Significance of Impact
Reach 1 - Source to the temporary abstraction point		
Macrophytes	<ul style="list-style-type: none"> Increased water depth, siltation and growth of marginal plants Decrease in species diversity and smothering of macrophytes by filamentous algae due to increase in soluble reactive phosphorous 	Negligible
Reach 2 – Temporary abstraction point and the tidal limit		
Macrophytes	<ul style="list-style-type: none"> Reduction in wetted area and velocities. Desiccation of some species such as bryophytes Increase in marginal species Decrease in species diversity and smothering of macrophytes by filamentous algae due to increase in soluble reactive phosphorous 	Moderate

Macroinvertebrates

Table 5.6 presents a summary of the potential impacts of the drought permit identified from the assessment of macroinvertebrates.

Table 5.6 Summary of Impacts of Drought Permit Implementation on Macroinvertebrates

WFD Status/ Community	Impact	Significance of Impact
Afon Lwyd - below Mon and Brecon Canal (GB109056032911) Current status: Good	<ul style="list-style-type: none"> There is a minor risk of short-term deterioration in status of the macroinvertebrate component of the waterbody due to the moderate adverse, short-term, temporary and reversible impacts associated with the drought permit 	Minor
Feature	Impact	Significance of Impact
Reach 1 - Source to the temporary abstraction point		
Macroinvertebrates	<ul style="list-style-type: none"> Increased depth directly upstream of the temporary weir, potentially leading to increased siltation 	Negligible
Reach 2 – Temporary abstraction point and the tidal limit		
Macroinvertebrates	<ul style="list-style-type: none"> Reduction in wetted area and velocities Water quality deterioration 	Moderate
<i>Omphiscola glabra</i>	<ul style="list-style-type: none"> Water quality deterioration 	Minor

Fish

Table 5.7 presents a summary of the potential impacts of the drought permit identified from the assessment of fish.

Table 5.7 Summary of Impacts of Drought Permit Implementation on Fish

WFD Status/ Community	Impact	Significance of Impact
Afon Lwyd - below Mon and Brecon Canal (GB109056032911) Current status: Good	<ul style="list-style-type: none"> There is a major risk of short-term deterioration in status of the macroinvertebrate component of the waterbody due to the moderate adverse, short-term, temporary and reversible impacts associated with the drought permit 	Major
Feature	Impact	Significance of Impact
Reach 1 - Afon Lwyd from headwater to temporary abstraction point at New Inn		
Atlantic salmon	<ul style="list-style-type: none"> Delays and potential cessation of adult and smolt migrations due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point 	Major
	<ul style="list-style-type: none"> Reduced water quality 	Negligible
	<ul style="list-style-type: none"> Reduction in spawning and juvenile survival due to habitat loss 	Minor
Brown/sea trout	<ul style="list-style-type: none"> Delays and potential cessation of adult and smolt migrations due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point 	Major
	<ul style="list-style-type: none"> Reduced water quality 	Negligible
	<ul style="list-style-type: none"> Reduction in spawning and juvenile survival due to habitat loss. 	Negligible
Bullhead	<ul style="list-style-type: none"> Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow. 	Minor
European eel	<ul style="list-style-type: none"> Delays and potential cessation of silver eel migration due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point 	Moderate
	<ul style="list-style-type: none"> Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow. 	Negligible
Other fish species	<ul style="list-style-type: none"> Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow. 	Negligible
Reach 2 - Afon Lwyd at New Inn to the tidal limit		
Atlantic salmon	<ul style="list-style-type: none"> Delays and potential cessation of adult and smolt migrations due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point 	Major
	<ul style="list-style-type: none"> Reduced water quality 	Minor
	<ul style="list-style-type: none"> Reduction in spawning and juvenile survival due to habitat loss. 	Major
Brown/sea trout	<ul style="list-style-type: none"> Delays and potential cessation of adult and smolt migrations due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point 	Major

	<ul style="list-style-type: none"> Reduced water quality 	Minor
	<ul style="list-style-type: none"> Reduction in spawning and juvenile survival due to habitat loss. 	Major
Bullhead	<ul style="list-style-type: none"> Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow. 	Major
European eel	<ul style="list-style-type: none"> Delays and potential cessation of silver eel migration due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point 	Moderate
	<ul style="list-style-type: none"> Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow 	Negligible
Other fish species	<ul style="list-style-type: none"> Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow 	Major

Phytobenthos

Table 5.8 presents a summary of the potential impacts of the drought permit identified from the assessment of phytobenthos.

Table 5.8 Summary of Impacts of Drought Permit Implementation on Phytobenthos

WFD Status/ Community	Impact	Significance of Impact
Afon Lwyd - below Mon and Brecon Canal (GB1 09056032911) Current status: High	<ul style="list-style-type: none"> There is a minor risk of short-term deterioration in status of the macroinvertebrate component of the waterbody due to the moderate adverse, short-term, temporary and reversible impacts associated with the drought permit 	Minor
Feature	Impact	Significance of Impact
Reach 1 - Source to the temporary abstraction point		
Phytobenthos	<ul style="list-style-type: none"> Deterioration related to soluble reactive phosphorous 	Minor
Reach 2 – Temporary abstraction point and the tidal limit		
Phytobenthos	<ul style="list-style-type: none"> Reduction in wetted area Deterioration related to soluble reactive phosphorous 	Moderate

Crustacea: White-clawed Crayfish

Table 5.9 presents a summary of the potential impacts of the drought permit identified from the assessment of notable crustacea species.

Table 5.9 Summary of Impacts of Drought Permit Implementation on White-clawed Crayfish

Species	Impact	Significance of Impact
Reach 1 - Source to the temporary abstraction point		
White-clawed crayfish	<ul style="list-style-type: none"> Increased mortality as a result of deterioration to water quality. 	Minor
Reach 2 - Temporary abstraction point and the tidal limit		
White-clawed crayfish	<ul style="list-style-type: none"> Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. Reduction in availability of refuges Increased mortality (density dependant) as a result of increased predation and competition Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats Increased mortality as a result of deterioration to water quality. 	Moderate

5.3.5 Invasive Flora and Fauna

Table 5.10 presents a summary of the potential impacts of the drought permit identified from the assessment of invasive flora and fauna.

Table 5.10 Summary of Impacts of Drought Permit Implementation on Invasive Flora and Fauna

Species	Impact	Significance of Impact
Afon Lwyd / Llandegfedd Reservoir		
Non-native species	<ul style="list-style-type: none"> Pumping of water from the Afon Lwyd into Llandegfedd Reservoir may introduce non-native flora and fauna into the reservoir 	Minor

5.3.6 Landscape and Recreation

Table 5.11 presents a summary of the potential impacts of the drought permit identified from the assessment of landscape and recreation.

Table 5.11 Summary of Impacts of Drought Permit Implementation on Landscape and Recreation

Feature	Impact	Significance of Impact
Reach 1 & 2		
Landscape	<ul style="list-style-type: none"> Flows during a drought will be low such that further reduction in flows due to the drought permit would not result in a further loss of aesthetic value 	Negligible
Recreation	<ul style="list-style-type: none"> Impacts on recreation activities (e.g. angling, cycling, walking) are not anticipated over those from the natural drought conditions 	Negligible

6 AFON LWYD DROUGHT PERMIT – MITIGATION

The environmental assessment has identified some significant impacts, including major hydrological impacts, minor impacts on designated sites, major aquatic ecology impacts including major impacts on fish and moderate impacts on macrophytes and macroinvertebrates.

For those receptors with a potential impact or risk identified as being significant as a result of implementation of the drought permit, precautionary monitoring and mitigation measures have been identified, and will be further developed in consultation with NRW.

Mitigation measures are feature, location, species and community specific, and are targeted only to those impacts that arise specifically as a result of drought permit implementation (as opposed to those arising due to environmental drought pressures). Similarly, monitoring and the targeting of mitigation measures to impacts that arise specifically as a result of drought permit implementation will help identify the responsible party for the specific actions relating to the associated measure. Information attained through monitoring undertaken during future droughts and potential drought permit implementation events will provide a tool for discussions regarding best working practices between Welsh Water, NRW and any other interested parties.

The range of mitigation measures that are possible for the features identified fall into three general activity types:

- 1) measures to reduce impacts at source
- 2) measures to modify environmental conditions in the river/lake
- 3) management of sensitive ecological species and communities.

The first activity type looks at mitigation measures that will reduce the pressure at source by reducing the hydrological impact. In the circumstances, the options are limited because the drought permit is required to safeguard public water supply. The second activity focuses on mitigation measures that involve undertaking actions within the waterbodies to reduce the pressure at sensitive locations. The third activity type involves direct action to manage impact by movement or management of the receptor / feature itself.

The mitigation measures that could be considered at the on-set of drought, during implementation of the drought permit and post-drought permit implementation include:

Table 6.1 Potential Generic Mitigation Measures Considered to Address Adverse Effects of the Drought Permit

Type of Mitigation	Typical Application
Temporary reduction or cessation of the terms of the Drought permit	Where continuous water quality monitoring (typically dissolved oxygen) and/or fish distress monitoring indicate a sharp deterioration in aquatic conditions, modifications to abstraction licence conditions under the terms of the permit may need to be reduced or cease altogether until conditions have improved. The precise trigger levels for considering such action would be set out in discussion with NRW at the time of application taking account of the time of year and prevailing environmental conditions. Temporary cessation of the implementation of the permit may be required as a means of mitigating ecological effect, balanced against the need to safeguard public water supplies.
Fish distress monitoring with triggers and response plan	Regular visual observations carried out on key stretches of rivers or lakes to detect signs of large scale fish distress and agree appropriate mitigation with NRW specific to the conditions identified. This might include temporary oxygenation measures.
Protection of 'spate flows'	Temporary increases in river flows following periods of rain can be important to flush sediment/pollutants from the system or promote fish passage. Where possible, the terms of the drought permit could be temporarily reduced/suspended so that these spate flows are preferentially allowed to pass through the system. This decision would need to be taken in dialogue with NRW to take account of the prevailing conditions and considering the merits of encouraging fish migration during a drought.
Reduce fish predation	Consider (where feasible) a limited and targeted reduction of predation risk on fish through either the provision of refugia, in the form of artificial or natural habitat provision or improvement, or the placement of piscivorous bird scarers (in areas remote from residential locations). The merits of each option and subsequent deployment would be subject to review on a case-by-case basis in consultation with NRW.
Physical works	In some cases, temporary physical in-river works such as channel narrowing or provision of refugia could be carried out to mitigate environmental risks. If any physical works are likely to impact fish passage, appropriate mitigation measures will need to be considered as part of the design of the works.
Compensation flows	In some cases, it may be possible to use other sources of water to provide compensation flows within surface water courses to temporarily mitigate the impact of the drought permit
Provision of alternative water supplies	If there is a risk of derogation of other abstractors from the drought permit, it may be possible for Welsh Water to provide alternative water supplies or lower pumps in boreholes. Provision is otherwise provided in legislation ⁹ for compensation to be agreed with the abstractor.

A suggested suite of mitigation measures for environmental features with potentially significant impacts relating to implementation of the Afon Lwyd drought permit are given in **Table 10.1**. For these features, a range of precautionary monitoring and triggers leading to enabling of appropriate mitigation measures are also described.

⁹ Schedule 9 of the Water Resources Act (WRA) 1991

7 CUMULATIVE IMPACTS

In accordance with the DPG and the Habitats Regulations, consideration has been given to how the proposed drought permit may affect the environment in combination with the effects of existing abstraction licences, environmental permits and other plans. This includes assessment of the potential cumulative effects of the following:

- Welsh Water's existing abstraction licences that operate within the hydrological zone of influence of the drought option, as well as other abstraction licences and discharge permits, as identified in NRW Review of Consents reports;
- Assessment of cumulative impacts of the drought permit with other Welsh Water supply-side and drought permit options within the hydrological zone of influence (including both intra- and inter- zone options);
- Other plans and projects of relevance, including;
 - Any Welsh Water WRMP schemes which are scheduled to be implemented and become operational within the time period of the Drought Plan (i.e. before 2025).
 - Drought supply-side and drought permit options from NRW Drought Plans.
 - National Policy Statements for Wastewater and Renewable Energy Infrastructure.
- Environmental monitoring before, during and after drought permit implementation (see Section 10).

If a drought permit application is progressed in the future, the potential for cumulative effects will be reviewed and revised to reflect any changes which are relevant to the timing of the drought permit specified in the application.

Welsh Water's existing abstraction licences and other abstraction licences and discharge permits

The assessment of hydrological impacts presented in **Appendix B**, and summarised in Section 4, has considered how the proposed drought permit may affect the environment in combination with the effects of existing licences and consents. Therefore no relevant licences or consents have been identified as relevant for assessment of cumulative effects.

Other relevant Welsh Water drought permit

Consideration has been given to the potential for cumulative impacts of drought options implemented by neighbouring water companies (see **Table B5.1**). The assessment of the potential for cumulative impacts of Welsh Water's supply side and

drought order / permit options with drought options listed in neighbouring water companies' drought plans has also been undertaken as part of the Strategic Environmental Assessment (SEA) of Welsh Water's Draft Statutory Drought Plan. The SEA was informed by the most recent information available on the neighbouring water companies' drought plans.

No cumulative effects of implementing the Afon Lwyd drought permit with other drought permit schemes have been identified. However, this should be reviewed at the time of any future application for a drought permit at the Afon Lwyd.

Welsh Water WRMP schemes

No WRMP schemes identified with cumulative impacts.

NRW Drought Plans

No cumulative impacts of options in NRW Drought Plan with a drought permit at the Afon Lwyd are anticipated. However, this should be reviewed at time of future application for a drought permit.

National Policy Statements for Wastewater and Renewable Energy Infrastructure

No cumulative schemes have been identified for assessment.

Environmental Monitoring

Recommendations for environmental monitoring before, during and after drought permit implementation have been made in the EMP which is presented in Section 10 of this EAR. The EMP has been developed in consultation with NRW.

It is assumed that all monitoring activities will be undertaken with the best interests of the site in mind, and in discussion and agreement with NRW. Where activities which require in-river working are proposed, a method statement for the survey will be prepared and agreed with NRW in advance of the survey.

Assuming rigorous implementation of the method statements, there will be no adverse impacts of the monitoring on hydrology, water quality or ecology, and no adverse impacts of environmental monitoring on the site are anticipated.

8 AFON LWYD DROUGHT PERMIT - SUMMARY OF RESIDUAL IMPACTS

The residual impact on environmental features is dependent on the effects observed during environmental monitoring, and the mitigation measures that are taken forward and their timely and effective application once the trigger for their need has been identified. Consequently, at this stage it is not possible to provide an accurate indication as to the residual impacts on environmental features due to implementation of mitigation measures. However, should the mitigation measures be effectively applied in all situations in a timely manner, it is anticipated that the magnitude of impacts, and in some cases the significance of impacts, will be reduced from those summarised in **Table 5.3**.

Should the application of mitigation measures applicable during the drought permit implementation period not reduce the impact magnitude or significance, compensatory measures such as restocking will be considered to help ensure pre-drought conditions return and reduce the significance of any post-drought permit impacts.

9 HABITATS REGULATIONS ASSESSMENT: STAGE 1 SCREENING

9.1 INTRODUCTION

Under Regulation 63 of the Habitats Regulations, the competent authority (in the case of a drought permit in Wales this would be Welsh Ministers, advised by NRW) is required to undertake an Appropriate Assessment of any plan / project which is likely to have a significant effect on a European site, to determine the implications for the site in view of the site's conservation objectives. The Regulations state that a person applying for any such consent (in this case Welsh Water), must provide such information as the competent authority (Welsh Ministers, advised by NRW) may reasonably require for the purposes of the assessment or to enable them to determine whether an appropriate assessment is required.

9.1.1 HRA Stages

Stage 1 – Screening

The first stage in the Habitats Regulations Assessment (HRA) is screening to determine the likelihood of the drought order to have a significant effect (LSE) on any European site (either alone or in-combination with other plans and projects) and thus if a full 'Appropriate Assessment' of any of the drought order would be required.

An in-combination assessment is carried out to establish the possibility of cumulative or synergistic impacts.

The screening stage identifies if the drought permit is likely to have significant effects on European designated site, and requires Appropriate Assessment.

Stage 2 – Appropriate Assessment

Drought options that are identified during HRA Screening (Stage 1) as being likely to have a significant effect (either alone or in combination) will be taken forward to Appropriate Assessment. The Appropriate Assessment will consider the impacts of the drought permit, against the conservation objectives of a European Site, in order to identify whether there are likely to be any adverse effects on site integrity and site features. The assessment will conclude whether or not the drought permit, either alone or in combination with other plans and projects, would adversely affect the integrity of the European site in question. This is judged in terms of the implications of the plan for a site's conservation objectives, which relate to its 'qualifying features' (i.e. those Annex I habitats, Annex II species, and Annex I bird populations for which it has been designated). The responsibility for undertaking the Appropriate Assessment lies with the (Welsh Ministers, advised by NRW).

Stage 3 – Alternative Options Stage

Where significant adverse effects are identified at the Appropriate Assessment stage, alternative options would be examined to avoid any potential damaging effects to the integrity of the European site.

Stage 4 – Assessment where adverse impacts remain

Stage 4 comprises an assessment of compensatory measures where, in the light of an assessment of Imperative Reasons of Overriding Public Interest, it is deemed that the project or plan should proceed. Imperative Reasons of Overriding Public Interest will only be progressed if no alternatives are identified as part of Stage 3.

9.2 STAGE 1 SCREENING OF AFON LWYD DROUGHT PERMIT

The objective of this section is to bring together all relevant information to enable a HRA to be undertaken of the impacts of the Afon Lwyd drought permit on relevant European designated sites.

These assessments have been completed in accordance with the DPG (see Section 3.3).

This section considers each of the River Usk SAC designated features and discusses the potential for the drought permit at Afon Lwyd to influence their status. For species, impacts on populations, range and supporting habitats and species have been considered.

9.2.1 Potential Impacts on River Usk SAC Qualifying Features

In carrying out the screening process, the assessment has considered the main possible sources of effects on the sites arising from the potential drought order, possible pathways to the designated sites and the effects on possible sensitive receptors in the sites. Only if there is an identifiable pathway between the impacted reaches and the designated sites, or individual receptors, is there likely to be an impact and where this is absent those sites have been screened out. The screening assessment has also considered the River Usk SAC conservation objectives. The development of conservation objectives is required by the 1992 'Habitats' Directive (92/43/EEC). In accordance with the Habitats Directive, the objectives aim to achieve the 'favourable conservation status' of habitats and species features for which SAC is designated (see **Figure 9.1**).

Site-specific conservation objectives provide a description of what is considered to be the favourable conservation status of the feature within the whole plan area. Conservation objectives for the site have been prepared by NRW.

Figure 9.1 Favourable conservation status as defined in Articles 1(e) and 1(i) of the Habitats Directive

“The conservation status of a natural habitat is the sum of the influences acting on it and its typical species that may affect its long-term natural distribution, structure and functions as well as the long term survival of its typical species. The conservation status of a natural habitat will be taken as favourable when:

- *Its natural range and areas it covers within that range are stable or increasing, and*
- *The specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and*
- *The conservation status of its typical species is favourable.*

The conservation status of a species is the sum of the influences acting on the species that may affect the long-term distribution and abundance of its populations. The conservation status will be taken as ‘favourable’ when:

- *Population dynamics data on the species indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and*
- *The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and*
- *There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.”*

In addition to the conservation objectives, the Core Management Plan has been used to determine LSEs against each of the specific attributes and targets for each of the qualifying features. A summary of the overall screening conclusion for each feature is provided below, with **Table 9.1** providing the assessment against each attribute and target.

Allis and Twaite Shad

There are no records of Allis *Alosa alosa* or Twaite *Alosa fallax* Shad within or near to the hydrological zone of impact on the Afon Lwyd. Therefore it can be concluded that the drought permit will have no likely significant effects on the feature.

Brook, River and Sea Lamprey

There are no records of sea lamprey within or near to the hydrological zone of impact on the Afon Lwyd. Therefore it can be concluded that the drought permit will have no likely significant effects on the feature.

Bullhead

The mouth of the River Usk to the confluence with the Afon Lwyd is located within

management unit 1 of the SAC¹⁰. The core management plan states that bullhead are not present in management unit 1. Therefore it can be concluded that the drought permit will have no likely significant effects on the feature.

Atlantic Salmon

Reach 2 of the Afon Lwyd, located approximately 4km upstream of the confluence with the River Usk, is an important migratory pathway for Atlantic salmon (both upstream-migrating adults and out-migrating smolt). The majority of Atlantic salmon migration into the Afon Lwyd is likely to occur from October to December; coinciding with the implementation of the drought permit. The majority of out-migrating smolt would be likely to migrate between mid-March and mid-May depending on water temperature; outside of the drought permit implementation period. Delays and possible cessation of adult migration due to reduced flows and obstruction caused by the sandbag weir would be expected to impair migration of adults out of the lower reaches of the Afon Lwyd in the upstream direction, although it would not impact migration through the River Usk itself. Water quality deterioration is associated with implementation of this drought permit, and would be expected to have impacts in tandem.

As a result, it can be concluded that implementation of a drought order has the potential to result in likely significant effects on the populations of Atlantic salmon within the River Usk SAC.

Otter

The screening assessment identified the potential for impacts on otter as a result of a reduction in the flow velocity, wetted width and depth of the river.

However, there are not anticipated to be any changes to habitat or prey availability for otter as a result of drought permit implementation. Therefore it can be concluded that the drought order will have no likely significant effects on the feature

Water Courses of Plain to Montane Levels with the Ranunculus fluitantis and Callitriche-Batrachion Vegetation

The impacted reaches associated with drought permit implementation are not located within the River Usk SAC.

As a result, it can be concluded that implementation of a drought permit will have no likely significant effects on the water courses of plain to montane levels with the *Ranunculus fluitantis* and *Callitriche-Batrachion* vegetation feature in the River Usk SAC.

¹⁰ Countryside Council for Wales (2008) *Core Management Plan Including Conservation Objectives, River Usk SAC*. 7 March 2008.

Table 9.1 Summary of Likely Significant Effects of Afon Lwyd Drought Permit Implementation Against Conservation Objectives for the River Usk SAC

Feature	Attribute (taken directly from NRW Conservation Objectives document)	Site Specific Target range and Measures	Impact of Drought Order and level of certainty	LSE?
Brook and River Lamprey	Age/size structure of ammocoete population	Samples < 50 ammocoetes ~ 2 size classes Samples > 50 ammocoetes ~ at least 3 size classes	No risk to achievement of conservation objective;	No
	Distribution of ammocoetes within catchment	Present at not less than 2/3 of sites surveyed within natural range No reduction in distribution of ammocoetes	No risk to achievement of conservation objective;	No
	Ammocoete density	Optimal habitat: >10m ⁻² Overall catchment mean: >5m ⁻²	No risk to achievement of conservation objective;	No
Atlantic Salmon	Adult run size	Conservation Limit complied with at least four years in five	Potential adverse impacts of drought permit implementation on Atlantic salmon adult run size	Yes
	Juvenile densities	Density thresholds from electrofishing results.	Potential adverse impacts of drought permit implementation on juvenile Atlantic salmon densities	Yes
	Water quality – biological	Biological GQA class A	No risk to achievement of conservation objective;	No
	Water quality – chemical	RE1	No risk to achievement of conservation objective;	No
	Hydromorphology – flow	Targets are set in relation to river/reach type(s).	No risk to achievement of conservation objective;	No
Bullhead	Adult densities	No less than 0.2 m ⁻² in sampled reaches	No risk to achievement of conservation objective;	No
	Distribution	Bullheads should be present in all suitable reaches. As a minimum, no decline in distribution from current.	No risk to achievement of conservation objective;	No
	Reproduction/age structure	Young of year fish should occur at densities at least equal to adults	No risk to achievement of conservation objective;	No
	Alien/ introduced species	No impact on native biota from alien or introduced species	No risk to achievement of conservation objective;	No

9.2.2 Summary

In summary, likely significant effects have been identified for Atlantic salmon populations within the River Usk SAC as a result of the implementation of the drought permit.

A Stage 2 Appropriate Assessment has therefore been carried out to identify whether the implementation of the drought permit will result in adverse effects on the site's conservation objectives and therefore whether the overall site integrity would be compromised. This is reported separately.

9.2.3 Cumulative and In-combination Impacts

The Habitats Directive requires a consideration in the assessment of '*any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plan or projects*'.

Consideration of potential plans or projects with cumulative effects is presented in Section 7.

10 ENVIRONMENTAL MONITORING PLAN (EMP)

10.1 INTRODUCTION

The overall scope of the EMP for the Afon Lwyd drought permit meets the requirements of Section 5.2 (Monitoring) and informs the requirements of Section 5.3 (Mitigation) of the DPG. As required by the DPG, the level of monitoring identified in the EMP is risk-based. The EMP is tailored to the characteristics of the study area and is informed by the knowledge and assessment of environmental sensitivity (presented in Sections 4 and 5 of this EAR). The EMP fulfils several requirements, including:

- Establishing required baseline environmental monitoring and data acquisition to maintain and update the understanding of the environmental baseline conditions and to reduce uncertainties in the assessment.
- Pre-drought permit monitoring describes the prevailing environmental conditions prior to drought permit implementation. This will inform the implementation and management of any mitigation actions during the drought.
- During-drought permit monitoring describes the environmental conditions during the implementation of the drought permit. Surveillance monitoring of sensitive locations, informed by, for example, walkover surveys and pre-drought monitoring, will provide early warnings of any unpredicted environmental impacts and ensure that mitigation actions are operating as designed.
- Post-drought permit monitoring describes the recovery of environmental conditions following the cessation of a drought permit, and establishes whether the affected ecosystems have recovered to conditions prevailing in the pre-drought permit period.

The basis of the development of the EMP is provided in Section 10.2.1. Monitoring recommendations are set out in Section 10.2.2.

10.2 BASIS OF THE EMP

Guidance on the objectives and content of the EMP is given in Section 5.2 and Appendix J of the DPG.

The guidance states that:

- Water companies are responsible for understanding the effects of a drought and its drought management actions on the environment and that companies can demonstrate this by assessing the impacts of drought management actions during and after a drought and completing the environment assessment.
- Companies should ensure that adequate arrangements for environmental monitoring are detailed in an EMP within its drought plan.

- The level of monitoring needed should be risk-based. Not all sites will require in-drought and post-drought monitoring.
- Surveys may be needed to support/inform the decisions on environmental sensitivity and likely impact or to ascertain baseline conditions.
- In-drought permit monitoring is required to assess the impacts from the implementation of the drought management action and for the management of mitigation actions during a drought.
- Post-drought permit monitoring aims to assess a site's recovery.
- Sites with moderate to major environmental risk should focus monitoring on those feature(s) sensitive to the likely impacts from implementing drought management actions. For Habitats Directive sites, data collected will be sufficient to demonstrate there is no adverse effect on the interest features. For SSSIs, data collected will need to be sensitive enough to pick up the likelihood of damage at the site. For WFD sites data collected will be to assess any potential 'deterioration' to status and allow you to comply with the requirements of Articles 4.6 to 4.9.
- Control sites are important to provide a comparison between the 'natural' impacts of the drought and the impacts of the drought management action.
- The EMP should include details of any surveys to support the environmental assessment, in-drought and post-drought data needs, including:
 - the feature/s to be monitored and the methods used
 - the location of survey sites
 - the timing and frequency of monitoring
 - who will undertake the monitoring.
- Separating the 'natural' impacts of a drought from those resulting from the implementation of drought management actions can be complex and made more difficult where data problems and/or a lack of hydro-ecological understanding exists. Water companies must ensure that their EMP is adequate to assess the most significant environmental impacts of its proposed drought actions and associated mitigation measures.
- The EMP needs to be agreed with NRW. Consultation with NRW should be undertaken to ensure that the monitoring proposed within the EMP to assess the potential impacts at these sites is adequate.
- A water company must provide details in the Drought Plan of likely mitigation or compensation needed against serious impacts on the environment or other water users of any proposed drought action. The EMP should assist in identifying sites that may require mitigation. In some cases, mitigation actions may be necessary to prevent derogation of other abstractions (for example, by providing alternative supplies or releasing compensation water into watercourses to limit the impact of

reduced flows).

10.3 MONITORING RECOMMENDATIONS

The EMP describes the nature and extent of the baseline and drought year data that would be required in order to differentiate the impacts resulting solely from the implementation of a drought permit with those resulting naturally as a result of the drought itself. The EMP is site specific and the scope is based on the current assessment of the drought permit.

Recommendations for pre-drought, in drought and post-drought monitoring, based on the outcome of the current environmental assessment, are provided in **Table 10.1** and are illustrated on **Figure 10.1**.

Monitoring outside of drought conditions is also recommended to address the baseline data limitations to the environmental assessment identified in this report and ensure a robust baseline exists for all sensitive features.

Data and results from baseline monitoring will increase the robustness of the assessment, and will be incorporated at the time of EAR preparation to support any future application for drought powers. The impact assessment has adopted a precautionary approach where baseline data limitations have been identified.

Control sites are crucial in assessing the ecological impact of flow pressure resulting from water resource activities. They can help determine whether any ecological impact being observed is a result of the water resource activity being investigated, rather than wider environmental influences. Good control sites for hydroecological assessment should be chosen where there are no significant water quality problems or pressures which could undermine relationships between ecology and flow. They must not be affected by the water resource activity being investigated nor have additional water resource activity upstream that could affect the flow regime. It is imperative that they are as similar in nature to the baseline conditions of the impact sites as possible, most importantly stream size and channel gradient. Possible options could include reaches upstream of those impacted, or other watercourses where the watercourses are comparable and not subject to a drought permit application. Control sites will need to be identified at the time of application following a review of where drought permits are required to be implemented. Consultation with NRW to determine suitable control sites will be undertaken at the time of application of this drought permit.

The following monitoring programme is an initial draft and will be iterated and agreed with NRW prior to EMP implementation. Any updates to the EMP will consider:

- Any potential changes in the assessment of the hydrological, water quality and geomorphological impacts based on baseline conditions at the onset of drought;

- Any potential changes in the assessment of impacts on environmental features based on baseline conditions at the onset of drought; and
- Any changes in assessment and/or monitoring methodologies and biological indices.

Table 10.1 Recommended EMP - On-set of Natural Drought, During Drought and Post Drought Monitoring and Mitigation

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
N/A		Walkover survey during low flow conditions - Mapping of sensitive habitats, communities, species and any monitoring sites that are required in order to improve understanding of the baseline communities.	N/A				Welsh Water
		Spot flow gauging surveys	One site per hydrological reach. Three occasions.	One site per hydrological reach. Three occasions.	N/A	One site per hydrological reach. Three occasions.	Welsh Water
		Biochemical water quality sampling.	One site per hydrological reach. Monthly. Consider continuous monitoring.	One site per hydrological reach. Weekly. Consider continuous monitoring.	N/A	One site per hydrological reach. Monthly, until recovery to pre-drought levels. Consider continuous monitoring.	Welsh Water
Macrophytes Reach 2	<ul style="list-style-type: none"> Reduction in abundance and distribution of taxa sensitive to nutrient enrichment (SRP) Reduction in growth or condition as a result of impacts on water levels and flows Changes to community composition due to changes to flow velocities and 	<p>The macrophyte community in the impacted reach is reasonably well understood as a result of a monitoring carried out by Welsh Water and NRW, however, recent data (post 2013) is absent, meaning an up to date status of the community is lacking. Surveys to ideally be carried out to provide a three-year baseline dataset, then repeated every three years. Monitoring sites are located at:</p> <ul style="list-style-type: none"> Control Site in Reach 1: M32 NRW Site: AT PONTRHYDYRUN (Reach 2) 	<p>Survey to be undertaken and macrophytes identified (if drought permit likely to be implemented in the plant growing season June-September). Follow LEAFACS2 standard methodology¹¹.</p> <p>Walkover survey to identify any key sources of nutrient loading.</p> <p>Carry out water quality sampling at the baseline sites including samples for soluble reactive phosphorus.</p>	<p>Walkover of key sections known to be susceptible to lower flows, informed by pre-drought survey.</p> <p>If drought permit implementation occurs in the plant growing season, carry out macrophyte surveys at baseline sites. Follow LEAFACS2 standard methodology for assessing macrophyte communities.</p> <p>Carry out water quality sampling at the baseline sites including samples</p>	<p>Mitigating impacts to the macrophyte community as a result of lowered flow and water level is not feasible during drought permit implementation.</p> <p>Mitigating this impact should be triggered by post drought macrophyte community assessments to implement post drought mitigation measures.</p> <p>Consider measures to address identified point sources of nutrient loading.</p>	<p>In the two years following drought permit implementation and in June to September monitoring period carry out LEAFACS2 macrophyte surveys at the baseline monitoring sites. To be extended if recovery has not occurred in two years.</p> <p>Significant alteration to macrophyte community composition (as informed by expert judgement, based on baseline data and multivariate statistical analyses) triggers post drought mitigation</p>	Welsh Water

¹¹ Environment Agency (2011). Surveying freshwater macrophytes in rivers. Operational instruction 131_07. (Unpublished procedures manual)

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
	<p>habitat loss due to reduction in wetted width and depth.</p> <ul style="list-style-type: none"> Increase in detrimental smothering by filamentous algae levels increasing due to an increase in nutrients, increases in water temperature and decreased velocity 	<ul style="list-style-type: none"> NRW Site: AT PONTNHIR (Reach 2) 		for soluble reactive phosphorus.	Consider scope for addressing any identified sources of nutrient loading from walkover survey, if this would help address water quality risks.	<p>actions:</p> <p>If existing macrophyte community has significantly deteriorated, consider reseeded/replanting where possible to promote recovery. Replanting of macrophyte community composition to be informed by pre-drought community.</p>	
<p>Macroinvertebrates</p> <p>Reach 2</p>	<ul style="list-style-type: none"> Reduction in species diversity as a result of the loss of flow-sensitive taxa Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats Alteration to community composition as a result of water quality deterioration. 	<p>The macroinvertebrate community in the impacted reach is well understood as a result of monitoring carried out by Welsh Water and NRW. Surveys to ideally be carried out to provide a three-year baseline dataset, then repeated every three years. Monitoring sites are located at the following NRW sites:</p> <ul style="list-style-type: none"> Control Site in Reach 1: M32 NRW Site: AT PONTRHYDYRUN (Reach 2) NRW Site: AT PONTNHIR (Reach 2) 	<p>Seasonal monitoring of macroinvertebrates at the baseline survey sites (spring and autumn). Samples to be collected and identified to species level.</p> <p>Carry out water quality surveys at same time.</p> <p>In severe drought conditions, no in stream monitoring is advised during environmental drought to prevent further harm to the invertebrate community through kick/ sweep sampling.</p>	<p>Seasonal monitoring of macroinvertebrates at the baseline survey sites (spring and autumn). Samples to be collected and identified to species level.</p> <p>Carry out water quality surveys at same time.</p> <p>In severe drought conditions, no in stream monitoring is advised during environmental drought to prevent further harm to the invertebrate community through kick/ sweep sampling.</p>	<p>Mitigating impacts to the macroinvertebrate community as a result of lowered flow and water level is not feasible during drought permit implementation.</p> <p>Mitigating this impact should be triggered by post drought macroinvertebrate community assessments to implement post drought mitigation measures.</p> <p>Consider possible in-stream measures or adjustments to improve habitat conditions, including:</p> <ul style="list-style-type: none"> Targeted installation of woody debris features to 	<p>In the two years following drought permit implementation, 3-minute kick sampling and mixed taxon level analysis at the three routine monitoring sites. To be extended if recovery has not occurred in two years.</p> <p>Significant alteration to macroinvertebrate community composition (as informed by expert judgement and based on baseline data) triggers post drought mitigation actions:</p> <p>Targeted habitat alteration/improvements can enhance natural recovery. Habitat restoration techniques can be utilised to improve</p>	Welsh Water

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
					increase localised flow velocity/scour at the most flow impacted areas of the channel in order to sustain habitat requirements for flow sensitive taxa.	habitat quality, and flush sediment from benthic substrate. If sedimentation is deemed to be a risk to the community, consider the removal of fine silt by manual raking of any accessible shallow marginal areas.	
<p>Fish (including brown / sea trout, Atlantic salmon, bullhead, European eel and other fish species)</p> <p>Reach 2</p>	<ul style="list-style-type: none"> Loss of juvenile fish habitat as a result of reduced flow related impacts Increased mortality (density dependant) as a result of increased predation and competition Delays and potential cessation of adult salmonid migration due to reduced flows Changes in flows and water levels 	<p>The fish community in the impacted reach is reasonably well understood as a result of monitoring carried out by Welsh Water and NRW, however, recent data (post 2013) is absent, meaning an up to date status of the community is lacking. Surveys to ideally be carried out to provide a three-year baseline dataset, then repeated every three years. Monitoring sites are located at:</p> <ul style="list-style-type: none"> Control site in Reach 1: L005 L006 (Reach 2) L014 (Reach 2) 	<p>Electric-fishing surveys to monitor fish populations at three sites in the impacted reach.</p> <p>In severe drought conditions, no fish population surveys are advised during drought as this may cause further stress.</p> <p>Walkover of impacted section of Reach 1 (immediately u/s of the temporary weir) and Reach 2:</p> <ul style="list-style-type: none"> Identification of key structures which may provide a barrier at lower flows. Identification of key habitats which are at risk of low flow impacts. <p>Measure dissolved oxygen, conductivity and temperature in the field using calibrated handheld equipment.</p> <p>Appropriate trigger values</p>	<p>No fish population surveys are advised during drought as this may cause further stress.</p> <p>Additional walkovers, if situation is expected to deteriorate in stream sections known to contain high fish densities, nursery and cover habitats. Record extent of exposed marginal habitats, bed substrates and estimates of overlying silt cover.</p> <p>Frequency of walkovers to be determined based on the on-set of environmental drought walkover and expert judgement of the resolution required to monitor the impacts of the drought.</p>	<p>Targeted installation of woody debris features to provide fish with the habitat required to support feeding and development (growth).</p> <p>If the results of the walkovers deem spawning gravels to be at risk to siltation, the following mitigation action/s may be undertaken:</p> <ul style="list-style-type: none"> Gravel washing of key spawning areas to be undertaken prior to salmonid spawning period (winter)¹² Targeted installation of woody debris features to increase localised flow velocity/scour at 	<p>Two years of annual post-drought fish population surveys at baseline monitoring sites (corresponding with a control and impact site/s) to determine any changes in population dynamics both temporally and spatially.</p> <p>The results of the fish population surveys should help inform mitigation, targeting habitat restoration where deemed to be appropriate to support and enhance affected populations.</p> <p>Walkover of key fish habitat locations recording the number of juvenile lamprey habitat potentially affected. Record extent of exposed marginal habitats, and</p>	Welsh Water

¹² Wild Trout Trust Habitat Management Sheet – Gravel Cleaning http://www.wildtrout.org/sites/default/files/library/Gravel_Cleaning_Apr2012_WEB.pdf

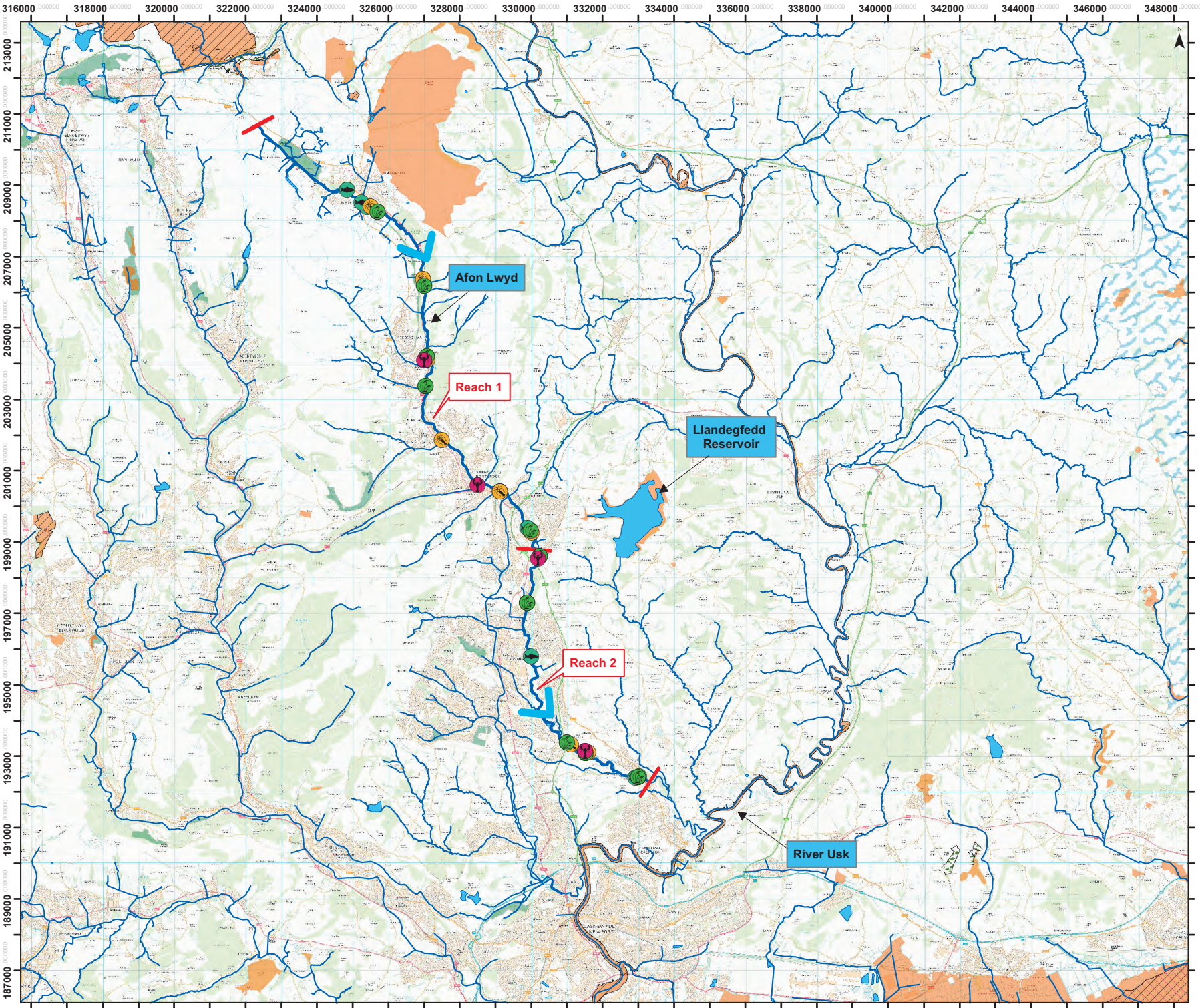
Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
	<p>may delay or prevent passage over barriers to migration</p> <ul style="list-style-type: none"> • Alteration to species distribution and abundance as a result of water quality deterioration. • Mortality as a result of water quality deterioration (e.g. oxygen stress) 		would be set for level and flow for spawning habitats based on local circumstances, timing, seasonality and expert opinion.	<p>Targeted fish passage assessment of barriers/obstructions to fish passage and any associated fish passes should be undertaken to ascertain if they pose an increased risk to the free movement of fish during key migration periods, i.e. during adult salmonid and juvenile lamprey migration (late summer/autumn).</p> <p>Frequency of fish passage assessments to be determined based on the on-set of environmental drought walkover and expert judgement of the resolution required to monitor the impacts of the drought.</p> <p>Measure dissolved oxygen, conductivity and temperature in the field using calibrated handheld equipment.</p> <p>Deployment of automated water quality equipment that continuously monitors for dissolved oxygen.</p>	<p>im pacted spawning gravels (to aid sediment transport and increase water depth for spawning depth)</p> <p>If the results of the walkovers deem important habitats to be at risk to exposure/reduction (in extent), the following mitigation action/s may be undertaken:</p> <ul style="list-style-type: none"> • Deployment of aeration equipment in key reaches that have standing or slow flowing water with low oxygen levels. • Targeted installation of woody debris features to provide submerged and overhead cover from predation where significant abundances of fish have been identified by walkover surveys. <p>Consider provision of physical deterrents to deter piscivorous birds at significant locations (e.g. scare crows) in consultation with NRW.</p>	<p>composition of the bed substrate and estimates of overlying silt cover.</p> <p>If the results of the walkovers deem important habitats to be at risk to exposure/reduction (in extent), the following mitigation action/s may be undertaken:</p> <ul style="list-style-type: none"> • Targeted fish passage assessment of barriers/obstructions to fish passage and any associated fish passes should be undertaken to ascertain if they pose an increased risk to the free movement of fish during key migration periods, i.e. during adult salmonid and juvenile lamprey migration (late summer/autumn). • Modify any im pacted fish passes (where possible) to ensure passage is achievable during key migration periods (e.g. agree to provide an appropriate proportion of flow into the pass to enable passage). Where fish passage is not currently provided at a 	

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
					<p>In extreme cases (where environmental parameters such as dissolved oxygen and temperature allow), consider removal of concentrated abundances of fish deemed to be stranded/at risk, relocating fish to suitable locations outside of the impacted reach within more suitable catchment, but would need to be discussed with NRW to ensure compliance with the Keeping and Introduction of Fish Regulations 2014.</p> <p>Modify any impacted fish passes (where possible) to ensure passage is maintained during key migration periods (e.g. agree to provide an appropriate proportion of flow into the pass to enable passage).</p> <p>Consider 'Trap & Transport' of concentrated abundances of migrating fish accumulated below impassable barrier/s to spawning grounds</p>	barrier, investigate appropriate methods of improving passage (e.g. fish passage design and installation).	

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
					upstream of the impacted reach (where environmental parameters such as dissolved oxygen and temperature allow).		
Phytobenthos	<ul style="list-style-type: none"> Decrease in flow affecting phytobenthos community composition. Low risk of deterioration to SRP affecting phytobenthos community composition and TDI score. Increases in filamentous algae smothering the substrate. 	<p>Data is absent for the impacted reach. Sampling according to DARLEQ2 protocol is recommended at one site in Reach 1 (control) and one site in Reach 2. Sampling to be undertaken in at least 1 year, ideally 2-year baseline, ideally encompassing 1 x “normal” flow year and 1 x “dry” flow year, 2 x sampling per year, in spring and autumn.</p> <p>Identify survey sites during walkover as outlined above.</p>	Sampling according to DARLEQ2 protocol, at baseline survey sites, in spring and autumn.	Sampling according to DARLEQ2 protocol, at baseline survey sites, in spring and autumn.	No additional measures specified.	Sampling according to DARLEQ2 protocol, at baseline survey sites, in spring and autumn.	Welsh Water
White clawed cray fish Reach 1 & 2	<ul style="list-style-type: none"> Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. 	<p>White-clawed crayfish monitoring will be undertaken between July and September, in accordance with the methods described in the Conserving Natura 2000 Rivers Monitoring Series document¹³.</p> <p>One survey to be undertaken</p>	To be confirmed following baseline survey	To be confirmed following baseline survey	No additional measures specified.	To be confirmed following baseline survey	Welsh Water

¹³ Peay S (2003). Monitoring the White-clawed Crayfish *Austropotamobius pallipes*. Conserving Natura 2000 Rivers Monitoring Series No. 1, English Nature, Peterborough

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
	<ul style="list-style-type: none"> • Reduction in availability of refuges • Increased mortality (density dependant) as a result of increased predation and competition • Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats • Increased mortality as a result of deterioration to water quality. 	per 500m survey stretch (survey stretches to be established during the initial baseline walkover).					



- Legend**
- Hydrological Reach
 - Water Courses
 - Flow Direction
 - Reservoir
 - RAMSAR Site
 - Site of Special Scientific Interest
 - Special Area of Conservation
 - Local Nature Reserve
 - National Nature Reserve
 - Area of Natural Beauty
 - Fish Survey
 - Macrophyte Survey
 - White-clawed Crayfish Survey Site
 - Macroinvertebrate Survey Site



1:100,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey Information
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Project Title: Welsh Water Drought Plan
Environmental Assessment

Figure Title: Environmental Monitoring: 8109-4
Afon Lwyd
Increase in the aggregate abstraction

Figure Number: Figure 10.1
Date: February 2019

11 CONCLUSIONS

This EAR provides an assessment of the potential environmental impacts relating to the implementation of the Afon Lwyd drought permit. If granted and implemented, the drought permit would enable Welsh Water abstract up to 12Ml/d from a temporary intake at New Inn on the Afon Lwyd, for transfer either to Llandegfedd Reservoir or direct to Sluvad WTW.

The scope of the assessment has been defined by an impact screening and scoping exercise. In accordance with the DPG, the screening exercise involved two stages, a hydrological impact assessment (Stage 1) and the identification of the environmental features that could be affected by the drought permit (Stage 2).

The assessment has concluded that there is a **minor** impact on flows in headwater streams and a **major** impact on flows in the Afon Lwyd as a result of implementing the drought permit. These hydrological impacts are assessed as leading to **negligible** impacts on the physical environment of the river, including water quality.

An environmental assessment was therefore required and included for features where screening has identified a major or moderate impact. Screening identified River Usk SAC/SSSI, notable fish species, WFD status and Community Assessment / Environment (Wales) Act Section 7 Species, landscape and visual amenity and recreation as environmental features for which an environmental assessment was required.

The assessment has concluded that there are **major** impacts on fish, **moderate** impacts on macrophytes, white-clawed crayfish, macroinvertebrates and phytobenthos and **minor** impacts on the Lower Usk SSSI.

The HRA Screening could not conclude that implementation of a drought permit would not result in likely significant effects on Atlantic populations within the River Usk SAC.

No cumulative effects of implementing the drought permit with other existing licences, consents and plans are currently anticipated. However, this should be reviewed at the time of any future application for a drought permit at the Afon Lwyd.

The environmental assessment has identified significant impacts of implementation of a drought permit at the Afon Lwyd. Consequently, in line with the DPG, mitigation measures have been proposed and further discussion with NRW is required in permit to develop suitable mitigation measures.

In summary, it has been concluded that the environmental effects on river flows and ecology of implementing a drought permit at the Afon Lwyd, over and above those conditions that already exist under "normal", i.e. licensed, baseline conditions, with the onset of a natural drought, would be **moderate** to **major**.

APPENDIX A HYDROLOGY AND HYDROGEOLOGY METHODOLOGY

A.1 HYDROLOGICAL AND HYDROGEOLOGY IMPACT METHODOLOGY (STAGE 1 SCREENING)

Consideration is required (by the DPG¹) of the likely changes in flow / level regime due to implementing the drought management action, specifically:

- the perceived extent of potential impact
- the nature and duration of the potential impact
- the timing of the potential impact.

The hydrogeological and hydrological information is used together with information on the other environmental features in the study area from Stage 2 - Environmental Sensitivity (see Section 3.2.1 in main report) to identify the environmental risk of the drought order / permit.

Although the DPG informs the hydrometric data to be used as part of environmental features for consideration within the environmental assessment (see Box 1 Appendix H of the DPG), it does not provide a methodology for identifying the hydrological impact.

Cascade has developed a flexible approach² to identifying the spatial extent of the study area from hydrological information and characterising the hydrological impact within the study area, in terms of the scale, nature, duration and timing of impacts, although this is only appropriate to apply to reaches that do not dry naturally. A hydrological methodology for watercourses that naturally dry for part of the year is also presented that characterises the hydrological impact within the study area, in terms of the scale, nature, duration and timing of impacts. These are presented below.

Perennially flowing watercourse hydrological methodology

This methodology is applied to watercourses that flow throughout the year and that are potentially impacted on by the drought order / permit.

Core to this approach is the use of relevant long term flow statistics to inform the scale of hydrological impact and thereby delimit the zone of influence in the downstream river system. To determine these, potential reductions in flow resulting from implementation of the drought order / permit are compared with flows without the drought order / permit in place (i.e. the additional abstraction advocated by the drought order / permit over and above the existing abstraction). This helps to determine the scale of potential impact at any particular site/feature using the matrix in **Figure A.1** or **Figure A.2** depending on the altitude of the waterbody and whether it is classified as lowland or upland³. Where possible, the hydrological assessments presented in previous EMPs and EARs of the drought options have been used to

¹ Welsh Government / Defra / NRW / Environment Agency (2011). Water Company Drought Plan Guideline. June 2011.

² Hydrological impact approach used in previous drought plan environmental assessments for water companies including Thames Water, Yorkshire Water and United Utilities

³ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

The Directions set out the principles of classification of surface water and groundwater bodies, including the use of 80m above Ordnance Datum as the altitude that differentiates water quality requirements for upland and lowland biology. Where there are ambiguities, or thresholds are crossed, upland is assumed to apply to ensure a precautionary assessment.

help identify the spatial extent of the study area from hydrological information and characterising the hydrological impact within the study area.

Figure A.1 Hydrological Assessment Matrix (Upland)

% reduction in flow		Summer Q99		
		<10%	10-25%	>25%
Summer Q95	<10%	Negligible	Minor	Moderate
	10-25%	Minor	Moderate	Major
	>25%	Moderate	Major	Major

Figure A.2 Hydrological Assessment Matrix (Lowland)

% reduction in flow		Summer Q99		
		<10%	10-25%	>25%
Summer Q95	<20%	Negligible	Minor	Moderate
	20-50%	Minor	Moderate	Major
	>50%	Moderate	Major	Major

Figure A.1 illustrates that at the time of implementation of a drought order / permit, upland river systems of relevance to each of these proposed options will exhibit high sensitivity to changes in low flow (represented by Q₉₅, summer⁴) and very high sensitivity to changes in extreme low flow (represented by Q₉₉, summer). As illustrated by **Figure A.2**, lowland rivers of relevance to each of these proposed options are considered to be less sensitive to reductions in summer low flows (summer Q₉₅), but similarly sensitive to reductions in extreme summer low flows (summer Q₉₉).

Figures A.1 and **A.2** are appropriate for the assessment of hydrological impacts on low flow regimes in watercourses during the spring, summer and autumn. However, in some cases there is a need to assess the impacts of drought order schemes on watercourses during the winter. For example, a reduction in compensation release may remain in force during the winter high flow period, to increase the probability of reservoir refill prior to the following year's spring/summer drawdown period. During the winter season, watercourses have relatively lower sensitivity to changes in low flow, and moderate sensitivity to changes in moderate flow. This can be reflected by the use of the matrices in **Figures A.3** and **A.4** for the assessment of drought order / permit schemes which are only likely to impact on a watercourse during the winter. The categorisation of impacts as negligible, minor, moderate or major is based on the percentage reduction in year round low flow (Q₉₅) and year round median flow (Q₅₀).

Figure A.3 Hydrological Assessment Matrix (Upland / Winter)

% reduction in flow		Year round Q95		
		<10%	10-25%	>25%
Year round Q50	<10%	Negligible	Minor	Moderate
	10-25%	Minor	Moderate	Major
	>25%	Moderate	Major	Major

⁴ Flow statistics indicate the proportion of days a flow is equalled or exceeded. Therefore Q₉₅ indicates flow equalled or exceeded on 95% of days in the measured record (equivalent to an average of 347 days per year)

Figure A.4 Hydrological Assessment Matrix (Lowland / Winter)

		Year round Q95		
% reduction in flow		<10%	10-25%	>25%
Year round Q50	<20%	Negligible	Minor	Moderate
	20-50%	Minor	Moderate	Major
	>50%	Moderate	Major	Major

The matrices are used to identify 1) the overall study area – which extends downstream of the abstraction until the hydrological impact has reduced to negligible; 2) reaches with similar scales of impact within the overall study area; and 3) the scale of hydrological impact within each reach. Typically reaches have been delimited by the addition of flow from a significant tributary or discharge; although the similarity of geomorphological characteristics of the reach may also be important in reach specification. The matrices can be applied to a variety of upland or lowland catchments respectively including those dominated by groundwater, and can be applied until the tidal limit.

In addition to the information provided by summary flow statistics in the matrix, information on the timing, duration and relevant seasons of the drought order / permit impacts have been informed by licence details and river gauging data have also been used to characterise the likely nature of the drought order / permit impacts.

If the drought order / permit does not impact on the magnitude of low flows in a watercourse, but does cause changes in the duration of low flow periods (which can be quantified), then the matrix in **Figure A.5** may be appropriate. The assessment is based on the percentage increase in the number of days for which flow is at or below the low flow (Q95) value. Typically this would be the case when the low flow regime in a watercourse downstream of a reservoir is protected by a statutory compensation release from the reservoir, but the reservoir may be drawn down below top water level for longer periods due to increased direct abstraction under the drought order / permit conditions.

If low flows in a watercourse are adversely affected in both magnitude and duration, then the impacts on magnitude are always used to determine the significance of hydrological impacts, using the appropriate matrix from **Figures A.1 to A.4** inclusive. **Figure A.5** is only used when the impacts on low flows are on duration only.

Figure A.5 Hydrological Assessment Matrix (Low Flow Duration)

Percentage increase in low flow duration	Significance
<5%	Negligible
5-10%	Minor
10-25%	Moderate
>25%	Major

Intermittently flowing watercourse hydrological methodology

This methodology is applied to watercourses, potentially impacted on by the drought order / permit, that flow for most of the time but seasonally or occasionally ceasing to flow in response to decreased water availability e.g. due to increased evapotranspiration or bed seepage. . Such watercourses are identified from previous investigations and available data. Examples of watercourses where this methodology would be applied include winter bournes or watercourses that dry along their route due to losses to underlying aquifers. The impact classification of this methodology is as follows:

- Major - If the drought order / permit resulted in sections drying that did not dry up anyway
- Moderate - If the drought order / permit resulted in sections drying earlier (by more than a week) and / or recovering later (by more than a week) and hence flow reduction occurring in the channel for more than a week
- Minor - If the drought order / permit resulted in sections drying earlier (up to a week) and/or recovering later (by up to a week) and hence flow reduction occurring in the channel for up to a week OR if the drought order / permit were a secondary flow driver (e.g. flow through gravels being primary cause of flow losses rather than the drought order / permit)
- Negligible - No significant impact

In addition to the derived classifications, information on the timing, duration and relevant seasons of the drought order / permit impacts have been informed by licence details, available data and findings of previous investigations. These have been used to characterise the likely nature of the drought order / permit impacts.

Reservoir hydrological methodology

More recently Cascade has developed a similar approach to categorise the significance of hydrological impacts of drought order / permit operations on reservoirs. The assessment requires an estimate of the relative change in duration of reservoir drawdown (i.e. the period for which water in the reservoir is below top water level), and the percentage decrease in the minimum reservoir level reached during the drawdown period. These two parameters are then compared against the reservoir impacts hydrological assessment matrix in **Figure A.6**.

This approach would be a suitable method to assess the impacts of a drought order / permit which involves significant changes to the reservoir water level regime (that would not normally be experienced during a drought without any additional measures implemented). For example, a drought order / permit may involve increasing daily or annual licensed abstraction limits to allow an increased rate of direct abstraction from the reservoir. This may enable some or all of a reservoir's emergency storage volume to be utilised, but is likely to lead to both lower water levels and increased periods of time below top water level.

Figure A.6 Hydrological Assessment Matrix (Reservoir Impacts)

	% Increase in duration of reservoir drawdown			
% Decrease in minimum reservoir level	<5%	5-10%	10-25%	>25%
<5%	Negligible	Negligible	Minor	Moderate
5-10%	Negligible	Minor	Moderate	Major
10-25%	Minor	Moderate	Major	Major
>25%	Moderate	Major	Major	Major

Additional Considerations

For groundwater schemes, hydrogeological data, where available, has been reviewed to inform the study area and duration of any impacts (noting impacts on groundwater may extend beyond the six month period of drought order / permit implementation - see below). An increase in groundwater abstractions would lead to an increased cone of depression in groundwater levels for groundwater abstraction. This impact can affect other non-surface water receptors such as other wells, springs or groundwater dependent ecosystems. It could also mean that surface water impacts would extend upstream of the abstraction point or, in significant instances, to other watercourses some distance from the abstraction.

For groundwater abstractions, the impact of a drought order / permit could extend beyond the six month period (time limited) of abstraction depending on the local hydrogeology of the area. During drought situations, where there is limited recharge to the aquifer system, the abstraction can be mainly at the expense of groundwater stored in the aquifer. This can, in the long run, delay groundwater level recovery and have a knock on effect on baseflow contributions to watercourses. Flows could, therefore, be reduced for longer than the six month period during which the drought order / permit could be implemented and, as such, has been considered as part of the assessment described in this report.

APPENDIX B

HYDROLOGY AND

PHYSICAL ENVIRONMENT ASSESSMENT

B1 INTRODUCTION

This appendix assesses the potential impacts on the physical environment of the Afon Lwyd river catchment during the period of implementation of the drought permit.

For the purposes of this assessment, the “without drought permit” baseline excludes any abstraction from the Afon Lwyd, as there is currently no licence in place. The assessed drought permit involves an abstraction of up to 12Ml/d from a temporary intake at New Inn on the Afon Lwyd for up to three months, for transfer either to Llandegfedd Reservoir or direct to Sluvad WTW.

B.1.1 Welsh Water Existing Operations

Welsh Water have six licences in the Afon Lwyd catchment to abstract water under the Water Resources Act 1991, some of which have not been used for a number of years:

- Blaenavon (No.2) spring (licence no. 20/56/12/0031)
- Cwmavon Reservoir, springs and artesian well (licence no. 20/56/12/0046)
- Cwmyravon filter station, Nant-y-Mailor Reservoir and spring (licence no. 20/56/12/0047)
- Abersychan spring (licence no. 20/56/12/0048)
- Cwmsychan Reservoir spring (licence no. 20/56/12/0050)
- Penyrheol Reservoir intake chamber (licence no. 20/56/12/0051).

The total daily abstraction licensed from all of these sources is in the order of 12Ml/d. No direct abstraction is currently made by Welsh Water from the Afon Lwyd.

The Llandegfedd raw water storage reservoir is within a few kilometres of the Lwyd. This is a pumped storage reservoir which takes water from the River Usk through the Welsh Water abstraction at Prioress Mill (Abstraction Licence No. 20/56/22/0027) and can also take water from an abstraction at Llantrisant (Abstraction Licence No. 20/56/21/0034) with water treated at the adjacent Sluvad Water Treatment Works (WTW) (see **Figure B1.1**). This treated water is supplied to the South East Wales Conjunctive Use System (SEWCUS) Resource Zone.

B.1.2 Welsh Water’s Proposed Drought Permit Operations

The drought permit involves a new, unsupported emergency river abstraction of 12Ml/d from the Afon Lwyd, which is proposed to be located at New Inn, between Pontypool and Cwmbran (see **Figure B1.1**). The drought permit abstraction would not be for additional water, but would transfer the sum of the existing abstraction licences (see Section B.1.1 above) to the proposed location. The exact location of the unsupported emergency river abstraction would

need to be determined through further investigations by Welsh Water. The abstraction is required to support raw water supply to either Llandegfedd Reservoir or direct to the nearby Sluvad WTW. To enable abstraction a low, temporary weir, probably constructed of sandbags, would be required across the Afon Lwyd. At this stage, it is not envisaged that the temporary weir will incorporate a fish pass.

A modest volume of water would be available from this drought permit scheme during a drought and there is benefit to supply through provision of an immediate additional water resource to an existing WTW.

The timing of the drought permit is most likely to occur during the period from September to November inclusive. This is based on water resources modelling undertaken by Welsh Water. The drought permit scheme will influence the Afon Lwyd downstream of the abstraction to its tidal limit during ongoing low flow conditions. It will also act as an impassable physical barrier upstream of the temporary weir.

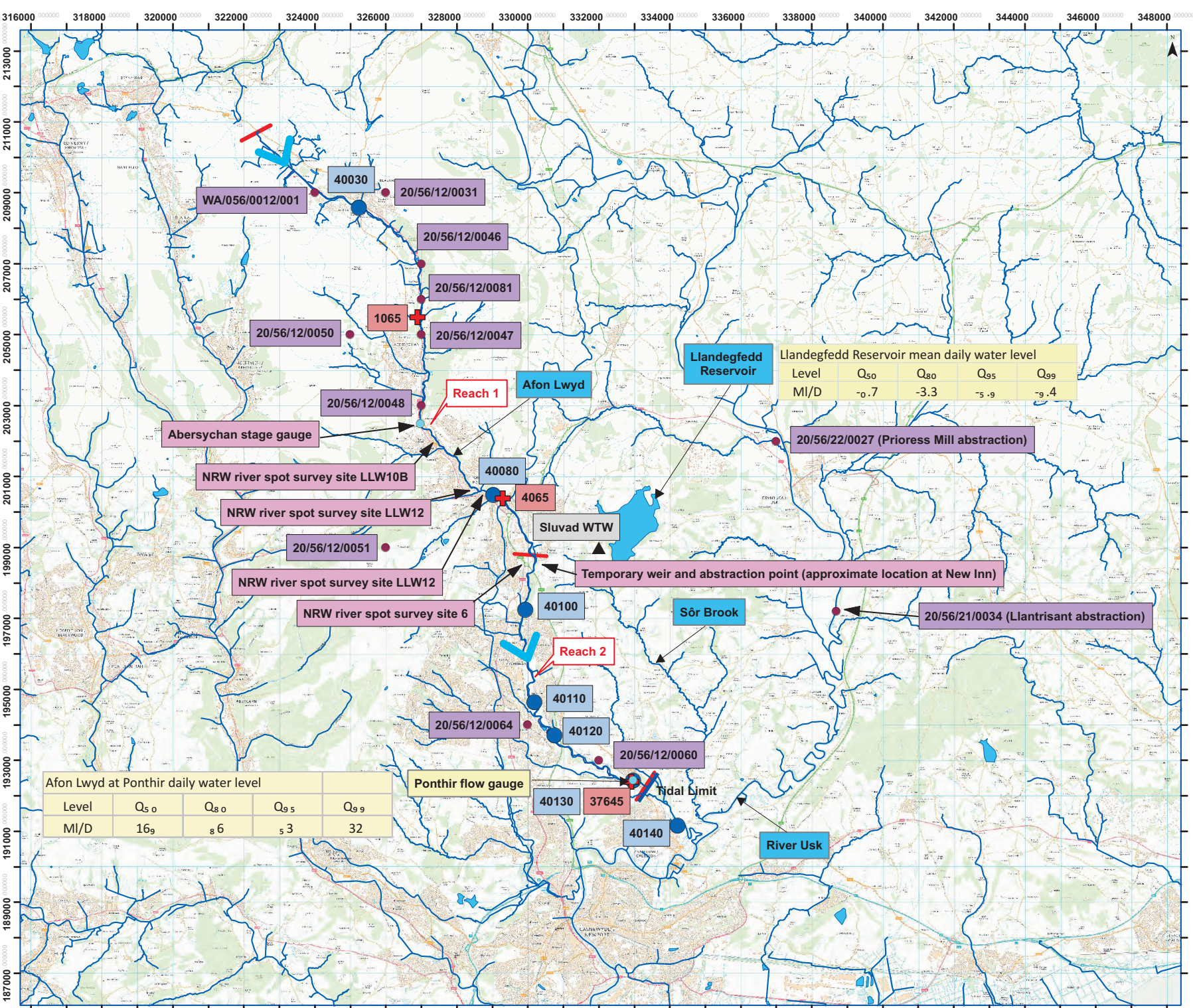
This environmental assessment report includes Llandegfedd Reservoir and the Afon Lwyd (see **Figure B1.1**). The physical environment includes consideration of hydrology and hydrodynamics, geomorphology, and water quality. The assessment has three key objectives:

1. To “list the likely impacts to the flow, level, channel/riparian form and sediment due to action being in place” as required by the DPG¹ and set out in Figure 2 of the DPG..
2. To support the screening and assessment of sensitive features (including ecological features and designated sites) as required by the DPG and set out in Section 5 of this report.
3. To provide supporting technical information for their screening and assessment where sensitive features are the physical environment itself.

This appendix is set out in the following sections:

- Section B.2 Hydrological Impact
- Section B.3 Physical Environment Assessment
- Section B.4 Physical Environment Impact Summary
- Section B.5 Cumulative Impacts

¹ Natural Resources Wales (2017) *Water Company Drought Plan Technical Guideline*. Available at <https://cdn.naturalresources.wales/media/684414/final-wc-drought-plan-guidance-2017.pdf?mode=pad&rnd=131656713580000000>, Accessed 04 February 2019.



- Legend**
- Hydrological Reach
 - Water Courses
 - Flow Direction
 - Abstraction
 - Flow Gauge
 - Water Quality Monitoring Site
 - River Habitat Survey Site
 - Water Treatment Works

1:100,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey Information
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Project Title: Welsh Water Drought Plan
Environmental Assessment

Figure Title: Hydrological Overview: 8109-4
Afon Lwyd
Increase in the aggregate abstraction

Figure Number:
Figure B1.1

Date:
February 2019

B2 HYDROLOGICAL IMPACT

B.2.1 Reference Conditions

B.2.1.1 Catchment Overview

The Afon Lwyd is a typical steep sided river valley. The river is of a medium to large size with total catchment size of around 110km² at the tidal limit approximately 1km before it joins the estuarine River Usk. The Afon Lwyd has a flashy flow regime, with flow responding quickly to heavy rainfall. The underlying geology does not retain large quantities of water in storage, and baseflow contribution from groundwater to the Afon Lwyd is limited. At the point of the proposed abstraction, the Afon Lwyd drains a catchment area of 71.6km² with an average annual rainfall of 1,444mm.

The study area is underlain by a series of lithologies which form south-west to north-east trending bands. The abstraction site and the entire remainder of the Afon Lwyd downstream, until the Lwyd at Ponthir gauge, flows over rocks of Silurian (Pridoli) age (419-416Ma) which consist of mudstone, siltstone and sandstone lithologies. Lower and Upper Devonian lithologies (416-397Ma and 385-359Ma respectively) underlie the Afon Lwyd immediately upstream of the abstraction site. Further upstream of the abstraction site the Lwyd rises in, and runs through, rocks of Carboniferous age sandstones, mudstones and limestones. The limestone and coal measures provide some baseflow to the river. Superficial deposits in the catchment are limited with the Afon Lwyd situated in alluvium. Above the abstraction site, the Afon Lwyd runs through several soil types with freely draining slightly acid base-rich soils and slowly permeable wet acid upland soils being prevalent, with some restored soils (from mining spoil) occurring. Below the abstraction site, the Afon Lwyd runs through, and is surrounded by, freely draining floodplain soils.

B.2.1.2 Baseline Data Availability

Continuous monitoring is undertaken by Welsh Water of its operations at Llandegfedd Reservoir, including:

- Llandegfedd Reservoir, weekly storage volume, 1976, 1984 and 1989 to 2006, and daily mean water level, 2010 to 2017

Continuous monitoring of river level in the Afon Lwyd is undertaken by Natural Resources Wales (NRW) at Abersychan, Pontnewynydd (NGR: SO26980265), 6.2km upstream of the proposed abstraction, and NRW also measured river flow at Ponthir Gauging Station (NGR: ST329924) on the Afon Lwyd up until 2015, when the gauge was closed due to concerns over data quality.

Available data include:

- Ponthir flow gauge, Afon Lwyd; daily river flow 1966 to 2015

NRW have undertaken several spot flow gauging surveys at a network of sites on the Afon Lwyd. Data are available for three locations between Abersychan stage level gauge and the

location of the proposed abstraction, at flows ranging from extreme low flow (Q_{99}) to moderate flow (Q_{60}):

- NRW river spot flow survey site LLW10B, NGR SO27530185
- NRW river spot flow survey site LLW12, NGR SO28590063
- NRW river spot flow survey site LLW14, NGR SO29360028.

Additionally, Welsh Water have undertaken further spot flow gauging at six sites on the Afon Lwyd in the summer of 2011.

A summary of spot flow gauging results at the nearest locations to the proposed temporary abstraction point is provided in Section B.2.2.

B.2.1.3 Hydrology

Llandegfedd Reservoir

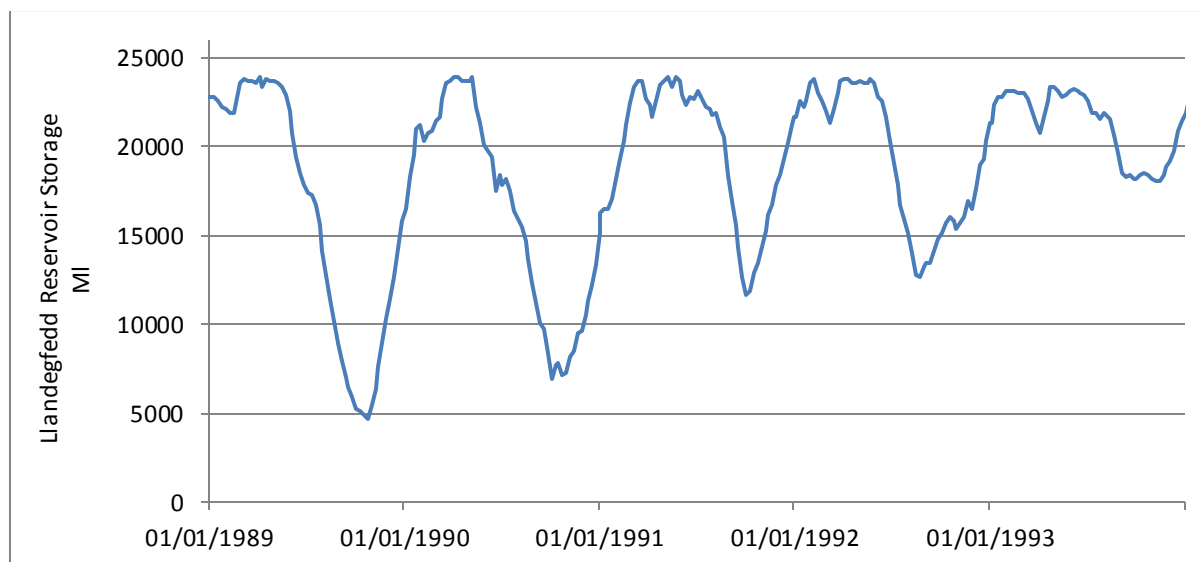
Water levels in Llandegfedd Reservoir range from 10.5m below weir crest to 0m below weir crest over the period 2010 – 2016. A summary of monthly water levels over this period is given in **Table B2.1** below.

Storage in Llandegfedd Reservoir ranges from 4,669Ml (19% of total storage capacity) to 23,948Ml (100% of total storage capacity) over the periods of available data. Storage drops to around 50% of full capacity or less in almost half of the years for which storage or level data is available. **Figure B2.1** illustrates a typical pattern of reservoir storage over a 5-year period from 1989 onwards.

Table B2.1 Summary of Recorded Mean Daily Water Level in Llandegfedd Reservoir (2010 – 2016)

Percentage of time water level equalled or exceeded	Mean daily level, m above weir crest, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum level	0.0	-0.2	-0.2	-0.1	0.0	-0.2	0.0	-0.2	0.0	0.0	0.0	0.0	0.0
10% (high level)	-0.4	-0.4	-0.2	-0.2	-0.2	-0.3	-0.3	-0.4	0.0	-0.4	-0.3	-0.2	-0.3
50%	-1.1	-0.8	-0.4	-0.3	-0.4	-0.4	-0.9	-2.9	-3.2	-2.5	-1.3	-1.2	-0.7
80%	-3.8	-3.0	-1.0	-0.5	-0.5	-1.3	-2.8	-4.4	-4.3	-5.3	-6.2	-5.4	-3.3
90%	-6.5	-3.7	-1.4	-0.6	-1.5	-2.1	-3.2	-4.8	-4.6	-5.9	-6.8	-9.9	-4.6
95% (low level)	-7.6	-4.0	-1.9	-0.6	-1.7	-2.5	-3.4	-5.0	-4.8	-6.6	-7.5	-10.2	-5.9
99% (extreme low level)	-8.7	-4.9	-2.2	-0.8	-2.3	-2.7	-3.6	-5.1	-5.2	-6.8	-8.5	-10.5	-9.4
Minimum level	-9.1	-5.1	-2.3	-1.0	-2.4	-2.9	-3.7	-5.1	-5.3	-6.9	-8.8	-10.5	-10.5

Figure B2.1 Llandegfedd Reservoir Storage, 1989-1993



Afon Lwyd at Ponthir

Flow is measured in the Afon Lwyd at Ponthir (NGR: ST329924). A summary of the available daily flow data from 1966 to 2015 is given in **Table B2.2** below.

Table B2.2 Summary of Recorded Mean Daily Flow in Afon Lwyd at Ponthir (1966 – 2015)

Percentage of time river flow equalled or exceeded	Mean daily flow Ml/d, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum flow	2,359	6,532	3,620	1,244	1,339	1,555	1,814	4,113	2,843	3,663	2,454	5,832	6,532
10% (high flow)	938	825	604	435	357	254	199	228	348	647	717	844	566
50%	326	254	221	181	148	116	86	83	92	168	251	278	169
80%	186	167	143	111	100	77	63	58	59	75	143	156	86
90%	143	141	118	91	79	62	55	49	44	54	104	124	65
95% (low flow)	120	124	102	79	66	53	50	40	34	43	80	105	53
99% (extreme low flow)	101	82	79	34	37	32	37	30	16	23	30	72	32
Minimum flow	91	59	53	19	23	23	24	26	1	13	8	53	1

The low flow statistics for the summer period (1 April to 30 September inclusive) are: Summer Q_{95} = 46Ml/d; Summer Q_{99} = 28Ml/d.

Figure B2.2 shows the typical pattern of flows at Ponthir from 2005 to 2006, and the flow duration curve is shown in **Figure B2.3**.

Figure B2.2 Afon Lwyd at Ponthir Flows (2005 – 2006)

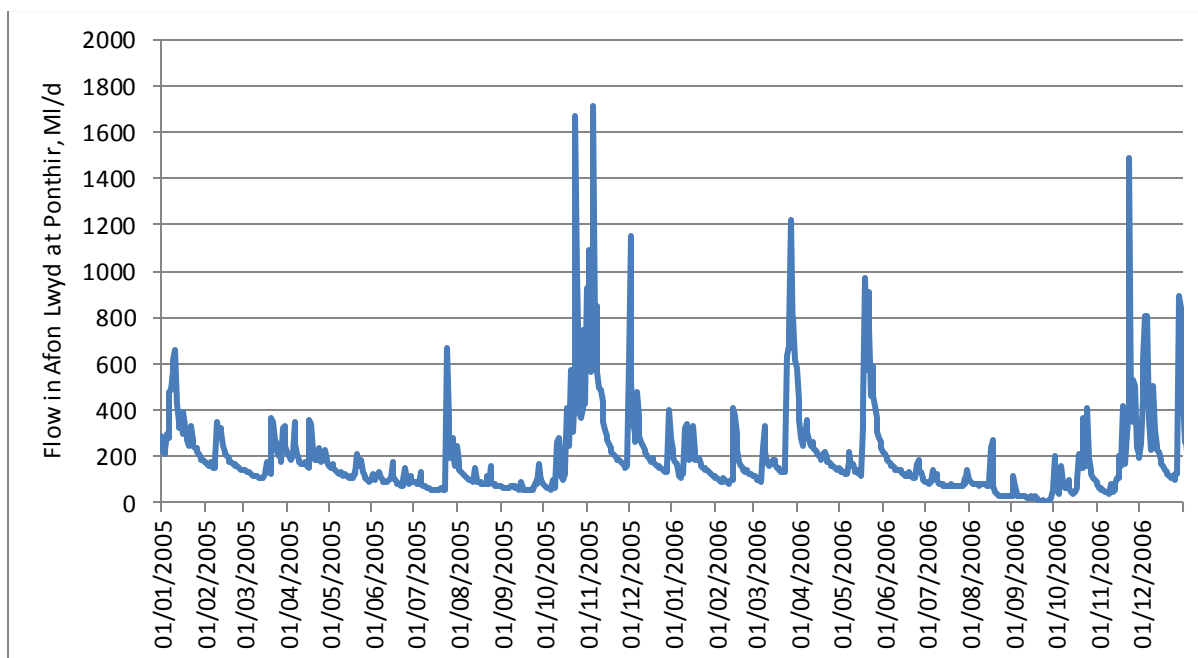
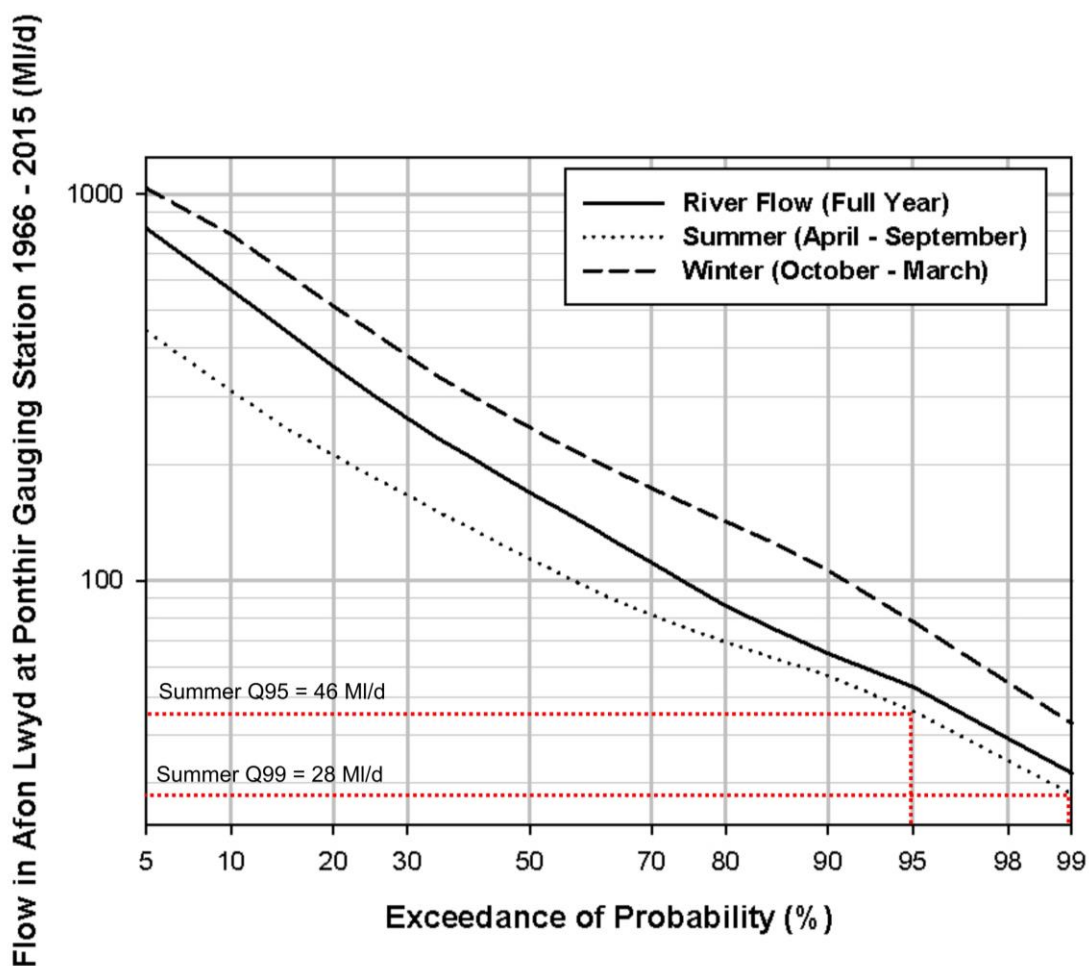


Figure B2.3 Afon Lwyd at Ponthir Flow Summary (1966 – 2015)



B.2.2 Hydrological Impact

B.2.2.1 Hydrological Zone of Influence

The study area includes all of the Afon Lwyd from the source down to the tidal limit, comprising two distinct hydrological reaches as shown in **Figure B1.1**:

- Reach 1 is the Afon Lwyd from the source to the proposed temporary abstraction point at New Inn.
- Reach 2 is the Afon Lwyd, from the temporary abstraction point to the tidal limit.

The potential hydrological impacts of the drought permit option have been assessed for Llandegfedd Reservoir and for the two separately identified river reaches, as summarised in **Table B2.6** and **Table B2.7** at the end of this section. The flow to the estuary at the tidal limit approximately 1km before the Afon Lwyd joins the estuarine River Usk with the drought permit is a negligible reduction in freshwater contribution to the estuary and the zone of hydrological influence ends at the tidal limit.

The details of the assessment for each reach are presented below.

B.2.2.2 Hydrological Impact Assessment

Llandegfedd Reservoir

Pumping of water abstracted from the Afon Lwyd to the reservoir would serve to reduce the rate of reservoir drawdown, resulting in potentially shorter duration of drawdown, or a less extensive drawdown than might have occurred without the drought permit.

The hydrological impact of the drought option on Llandegfedd Reservoir is therefore considered as **minor beneficial** and has not been assessed in further detail.

Assessment of River Reach Impacts

In order to assess the impact of the proposed temporary abstraction on the flow regime of the Afon Lwyd, estimates of key flow statistics in the vicinity of the abstraction location are required. Continuous monitoring of flow in the Afon Lwyd is carried out by NRW at Ponthir Gauging Station, several kilometres downstream, and by comparison of relative catchment areas it is possible to estimate flow statistics by area-flow apportionment as shown in **Table B2.3**.

Table B2.3 Summary of Catchment Areas and Key Flow Statistics: Afon Lwyd at Temporary Abstraction Location and Ponthir Gauging Station

Location	Grid Reference	Catchment area km ²	Ratio of catchment areas to Ponthir	Summer (April to September inclusive) Low Flow Statistics (Ml/d)			Year round Flow Statistics (Ml/d)		Source
				Q ₉₉	Q ₉₅	Q ₉₀	Q ₉₅	Q ₅₀	
Temporary Abstraction at New Inn	ST302986	71.6	73 %	20.47	33.61	41.43	38.85	123.60	Area-flow apportionment
Ponthir Gauging Station	ST329924	98.1	-	28.04	46.05	56.76	53.22	169.34	Data record

Spot flow gauging results were available from a number of different sites, obtained by both Environment Agency Wales (now NRW) during the period 2002-2008 and by Welsh Water in the summer of 2011. A summary of the flow results from the locations closest to the proposed temporary abstraction point, and a comparison with the gauged flow record at Ponthir Gauging Station, is given in **Table B2.4**.

Table B2.4 Summary of Spot Flow Gauging Results, 2003 - 2011

	Location and Grid Reference – Mean Daily Flows in Ml/d			Approximate percentile of Ponthir flow distribution (Apr-Sept)
	Spot Flow Location		Comparable Flow Record	
	Afon Lwyd downstream of Afon Dar confluence (NRW site LLW14)	Afon Lwyd downstream of temporary abstraction site (Welsh Water site 6)	Ponthir Gauging Station	
Date	SO29360028	Unknown	ST329924	-
11/04/2003	78.09		93.312	Q77
11/07/2003	51.50		58.579	Q93
21/09/2003	41.34		43.805	Q97
07/09/2004	55.71		64.8	Q90
19/07/2006	45.99		73.699	Q86
25/07/2006	45.59		71.712	Q87
07/08/2006	2.35		80.698	Q83
20/04/2007	100.58		29.722	Q99
08/05/2008	122.54		62.122	Q91
21/07/2011		59.8	Unavailable	-
05/08/2011		55.3	Unavailable	-
22/09/2011		11.2	111.456	Q70

There is some inconsistency in the above spot flow gauging results, particularly when compared to the daily flow record at the Ponthir Gauging Station. For example, a Q₉₉ flow value at Ponthir corresponds to a relatively high spot flow upstream of the abstraction intake (20 April 2007). The spot flow value of 2.35Ml/d on 7 August 2006 appears particularly low in the context of a Q₈₃ flow value at Ponthir on that date. The values from summer 2003 do suggest a Q₉₅ flow value at New Inn of between about 40Ml/d and 50Ml/d, somewhat higher than the figure of 33.6Ml/d based on catchment area apportionment. As a precautionary

approach, therefore, we have used the lower summer flow statistics based on catchment area apportionment (**Table B2.3**) as the basis of the hydrological impact assessment.

Hydrological Reach 1 – Afon Lwyd from the source to the temporary abstraction at New Inn

Reach 1 is the 19.0km stretch of the Afon Lwyd from the source to the temporary abstraction point. The drought permit would not amend the flow regime of the river in Reach 1. However, the temporary weir will have a local ponding effect, increasing wetted width and wetted depth while reducing velocities and potentially increasing fine sediment deposition in a short stretch of river, perhaps up to 50m, behind the sandbags. The extent of this ponding will be dependent on the height and siting of the sandbags, which themselves will form a physical barrier in the river. The potential hydrological impact of the drought permit in Reach 1 is therefore considered **minor** during the period of implementation of the drought permit from September to November inclusive.

Hydrological Reach 2 – Afon Lwyd, from the temporary abstraction at New Inn to the tidal limit

Reach 2 is the 12.25km stretch of the Afon Lwyd from the temporary abstraction point down to the tidal limit. During a drought, river flows in Reach 2 would be low. Estimates of summer low flow conditions (April - September Q_{95}) in upper hydrological reach 2 are approximately 33.6Ml/d, with extreme low summer flows estimated at around 20.5Ml/d (April - September Q_{99}). A 12Ml/d drought permit abstraction would have a significant impact on the hydrology of this reach, reducing the summer Q_{95} and Q_{99} flow values by around 36% and 59% respectively. This would lead to significant reductions in wetted width and wetted depth below those observed in the Afon Lwyd without a drought permit. In the lower Reach 2, low and extreme low summer flows measured at the Ponthir flow gauge are around 46Ml/d (summer Q_{95}) and 28Ml/d (summer Q_{99}); the drought permit abstraction would represent reductions of 26% and 43% in the flows at this location respectively. The potential hydrological impact of the drought permit in hydrological reach 2 is therefore considered to be **major** during the summer month of September.

During the winter months, estimates of year round flow statistics in upper hydrological reach 2 are 38.85Ml/d (Q_{95}) and 123.6Ml/d (Q_{50}). The reduction in flow of 12Ml/d due to the drought permit abstraction would represent a percentage reduction of around 30.9% and 9.7% respectively. This would be assessed as a **moderate** hydrological impact during the winter months of October to November inclusive. At Ponthir gauging station, the key year round flow statistics are 53.22Ml/d (Q_{95}) and 169.34Ml/d (Q_{50}), with the 12Ml/d flow reduction representing percentage flow reductions of around 22.5% and 7.1% respectively. The hydrological impact is therefore assessed as **minor** at the lower end of reach 2, during October to November inclusive.

Detailed hydrometric data from Welsh Water's 2011 monitoring for Site 6, the site closest to the temporary abstraction, on each sampling day, is presented in **Table B2.5** below. Changes

in flow were associated with a reduction in wetted depth and not a reduction in velocities.

Table B2.5 2011 Hydrometric parameters obtained from sampling in Lwyd catchment at Site 6

Hydrometric Parameter	Date		
	21.7.2011	5.8.2011	22.9.2011
Flow (Ml/d)	59.8	55.3	11.2
Wetted Width (m)	9.8	9.7	9.7
Wetted width with depth greater than 0.1m (m)	8.0	9.0	0
Maximum Depth (m)	0.33	0.36	0.042
Mean Velocity (m/s)	0.32	0.23	0.34
Maximum Velocity (m/s)	0.75	0.67	0.75

B.2.2.3 Hydrological Impact Summary

Two river reaches on the Afon Lwyd have been considered for which the assessed hydrological impacts range from **minor** to **major** during the summer month of September, and from **minor** to **moderate** during the winter months of October to November. The impacted reaches are shown in **Table B2.6** and **Table B2.7** and establish the full in-channel zone of influence of the drought permit for environmental sensitivity screening (see **Figure B1.1**).

The hydrological impact on Llandegfedd Reservoir itself has been assessed as **minor beneficial**, due to an increase in water levels from the transfer from the Afon Lwyd.

Table B2.6 Hydrological Reaches and Impacts identified in the Study Area - Summer Impact (September)

Hydrological Reach		Reach boundary		Reach length	% flow reduction		Hydrological Impact (summer)
		Upstream	Downstream		Summer Q ₉₅	Summer Q ₉₉	
Llandegfedd reservoir		n/a	n/a	n/a	n/a	n/a	Minor beneficial
1	Afon Lwyd Reach 1	Source	Temporary abstraction point at New Inn	19.0km	0%	0%	Minor (associated with ponding)
2	Afon Lwyd Reach 2	Temporary abstraction point at New Inn	Tidal Limit	12.25km	36%	59%	Major

Table B2.7 Hydrological Reaches and Impacts identified in the Study Area - Winter Impact (October to November)

Hydrological Reach	Reach boundary		Reach length	% flow reduction		Hydrological Impact (winter)
	Upstream	Downstream		Year round Q ₅₀	Year round Q ₉₅	
Llandegfedd reservoir	n/a	n/a	n/a	n/a	n/a	Minor beneficial
1 Afon Lwyd Reach 1	Source	Temporary abstraction point at New Inn	19.0km	0%	0%	Minor (associated with ponding)
2 Afon Lwyd Reach 2	Temporary abstraction point at New Inn	Tidal Limit	12.25km	9.7%	30.9%	Moderate

B3 PHYSICAL ENVIRONMENT ASSESSMENT

B.3.1 Geomorphology

Geomorphology information for the Afon Lwyd catchment is obtained from the results of walkover surveys undertaken for Welsh Water during summer 2011, existing NRW River Habitat Survey (RHS) hydromorphology data and, where required, interpretation of existing aerial imagery. For the purposes of the assessment, the Afon Lwyd (from its source to the tidal limit) has been divided into two hydrological reaches. Hydrological Reach 1 stretches for 19.0km between the source and the temporary abstraction point. Hydrological Reach 2 stretches for 12.2km between the temporary abstraction point and the tidal limit.

Data are available for three Environment Agency Wales RHS sites: site 1065 which is located ~9.2km upstream from the proposed abstraction point in Reach 1, site 4065 which is located ~2.3km upstream of the proposed abstraction point in Reach 1 and site 37645 which is located ~9.2km downstream of the proposed abstraction point in Reach 2 (see **Figure B1.1**).

B.3.1.1 Impacts on sediment erosion, transport and deposition

Hydrological Reach 1, Afon Lwyd from headwater to temporary abstraction point at New Inn

Flowing over 19 km, in the upper reaches, from the source to Abersychan, the channel is sinuous with occasional straight reaches. Sinuosity increases downstream of Abersychan. Riparian tree cover increases from absent to isolated in the upper reaches near the source and is continuous at the downstream end of the reach. Land-use in the upper areas of the reach are characterised by upland scrub and rough pasture trending towards a mixture of grassland and shrubs in a downstream direction. The channel passes adjacent to derelict industrial land and spoil tips, especially close to the source. Urban areas adjacent to the channel become increasingly frequent moving downstream, being almost continuous downstream of Abersychan, with areas of improved grassland and parkland scattered along the banks.

Left bank heights recorded in RHS data vary from 2.25-2.5m, right bank heights from 2.25-4m. Average channel width ranges from <1-10 m and depth varied from 0.1-0.2 m in the RHS data. Channel banks at the upper RHS site (1065) are composed of a mixture of concrete, brick/laid stone and some bedrock, while earth and brick/laid stone are the predominant constituents at the lower RHS site (4065). Given the modified nature of the channel in the first 3km, it is likely that banks are commonly composed of concrete or brick/laid stone here. At the upper RHS site (1065), a range of bank profiles were noted, mainly steep ($>45^{\circ}$), gentle and composite with some reinforced whole banks. At the lower RHS site (4065), banks were predominantly steep ($>45^{\circ}$). Bank faces were mostly composed of simple vegetation at both RHS sites in the reach. The walkover identified no significant areas of bank erosion, while the RHS data indicated no erosional features. These data highlight that the reach is depositional and geomorphologically stable with respect to the current flow and sediment regime.

Bed substrate is varied, due to modification; concrete dominates the upper part of the reach (first 3.1km), however, some gravel/pebble was observed. Downstream, bedrock dominates, however cobble and boulders were also observed; and the presence of cobble increases downstream. Riffles and pools were recorded in RHS data and point bar deposits are also visible from aerial imagery. Flow is predominantly rippled and unbroken standing waves. However, smooth flow was also noted in the upstream reach, and broken standing waves in the downstream portion of the reach. In-channel depositional features were observed within the reach, such as unvegetated and vegetated side bars at RHS site 1065.

The channel is also heavily modified, with habitat modification scores of 720, and 925 at RHS sites 1065 and 4065 respectively. The level of modification increases downstream and modifications include bed and bank reinforcements, flow dissipation structures, re-sectioning, bridges and culverts. The RHS surveys identified the presence of 11 weirs within the reach.

Impacts in Hydrological Reach 1 relate to ponding effects associated with the temporary weir required to undertake the emergency abstraction. The drought permit would not amend the flow regime of the river in Hydrological Reach 1, however, the temporary weir would have a local ponding affect upstream of the weir and could lead to a decrease in flow velocities. As the current morphology of the weir is not known, particularly with regard to its height (which would determine the depth of ponding) and permeability (which could lead to variability in discharge through the structure as well as small local increases in flow velocity), the spatial impacts of the weir upstream are unknown. The ponding and reduction in flow velocity could impact on fine sediment dynamics and promote increased particle sedimentation. However, given the very low suspended sediment concentrations measured in the river when flow levels are low and the presumed absence of any significant geomorphological work (i.e. erosion or transport or depositional processes) in the catchment due to the presence of drought conditions, the impact of the temporary weir on sediment dynamics in Reach 1 is considered to be temporary and **negligible**.

Hydrological Reach 2, Afon Lwyd at New Inn to the tidal limit

Hydrological Reach 2 is 12.25km in length and is initially sinuous with some straight sections, before beginning to meander in the downstream sections of the reach towards the tidal limit. Floodplains are extensive on both banks along this reach and the single RHS site (37645) indicates the presence of two river terraces. Average channel width is ~11m. Riparian tree cover is largely continuous, though there are isolated areas where improved grassland/parkland abuts the banks. Land-use is mainly urban, interspersed with areas of rough pasture and improved grassland and some areas of scrub, parkland and adjacent woodland are present, usually on one side of the river only. The middle section of this reach flows through areas of rough pasture and improved grassland on both banks, with the final section flowing through urban areas close to the tidal limit.

Average channel width is ~11m. Channel banks are predominantly composed of earth or brick/laid stone. At RHS site 37645, a mixture of bank materials were noted. The left bank was composed predominantly of rip-rap, earth and gravel/sand, with brick/laid stone, concrete and wood piling also noted. The right banks were composed predominantly of earth and brick/laid stone, with concrete, cobble and gravel/sand also noted. At this site bank profiles were noted as being a mixture of steep ($>45^{\circ}$), resectioned and reinforced banks. Bank faces were generally bare to uniform and simple vegetation.

In Hydrological Reach 2, the channel bank is commonly reinforced with brick/laid stone and rip-rap. The single RHS site (37645) records a very high HMS of 3790 due to extensive resectioned and reinforced banks and bridges. The walkover survey recorded four weirs or other anthropogenic structures within the river, which could potentially modify flow and impact geomorphological processes. Numerous bridges also cross the channel.

The flow types recorded in Reach 2 are predominantly rippled and unbroken standing wave. Some areas of smooth flow, particularly before the end of the reach, and an area of upwelling, were noted. Broken standing waves were noted throughout the reach, particularly in the final ~5km of the reach. The RHS survey indicates channel bed substrate is predominantly cobble in the initial 3km of the reach, fining to gravel/pebble thereafter until the end of the reach. A small area of concrete was noted as composing the channel substrate at the start of the reach.

Additionally, total suspended solids (TSS) data exist for the Afon Lwyd at five sites: Blaenavon (4.2km downstream from the start of the reach) Pontymoile (15.0km downstream), Pontrhydyrun (16.5km downstream), Llanyravon (19.6km downstream) and Llantarnam Bridge (21.1km downstream). With the exception of Llanyravon, data was collected monthly from January 2000 to December 2002. At Llanyravon data was collected from January 2000 to July 2011.

The correlation between level, measured at the Abersychan stage gauge, and suspended solids measured at Llanyravon, is shown in **Figure B3.1**. As is common with TSS – discharge correlations, the correlation between the paired data is poor and this is related to variability in sediment dynamics throughout the catchment under varying conditions. Despite this, it is

apparent that TSS are generally very low, even for the higher flow levels recorded towards 0.6m with TSS generally being less than 5mg/l. This data indicates that at most flows, there is very little to no sediment transport occurring, with peaks in TSS related to the impact of storm events. If any particles are in suspension, they are likely to be clay sized.

Figure B3.1 Suspended Solids at Llanyravon and Flow Level Measured at the Abersychan Stage Gauge Between 2000 and 2011

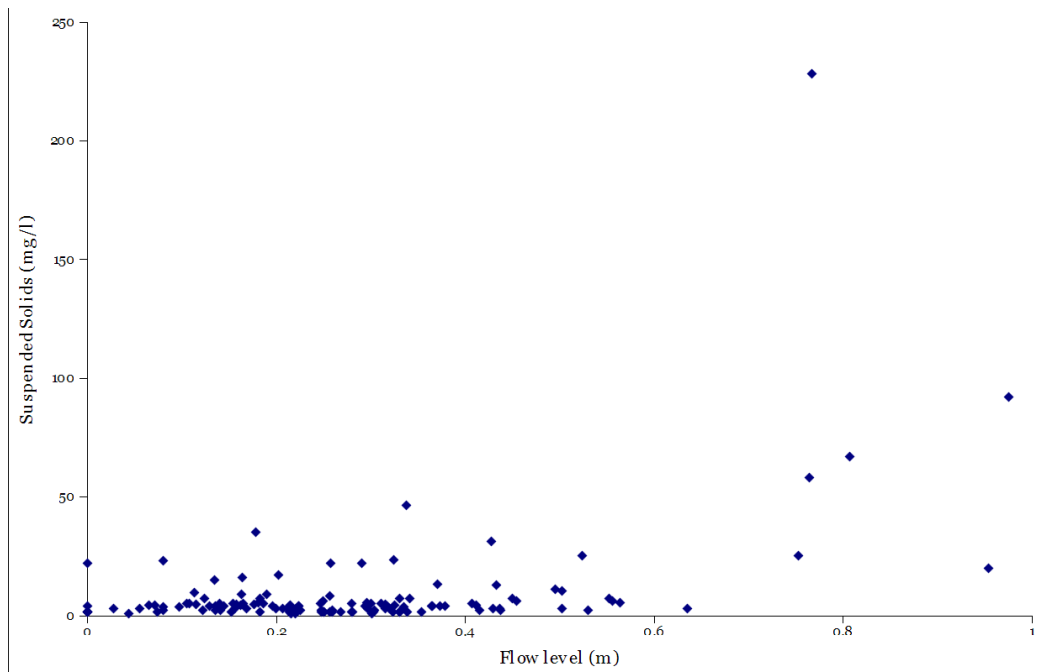
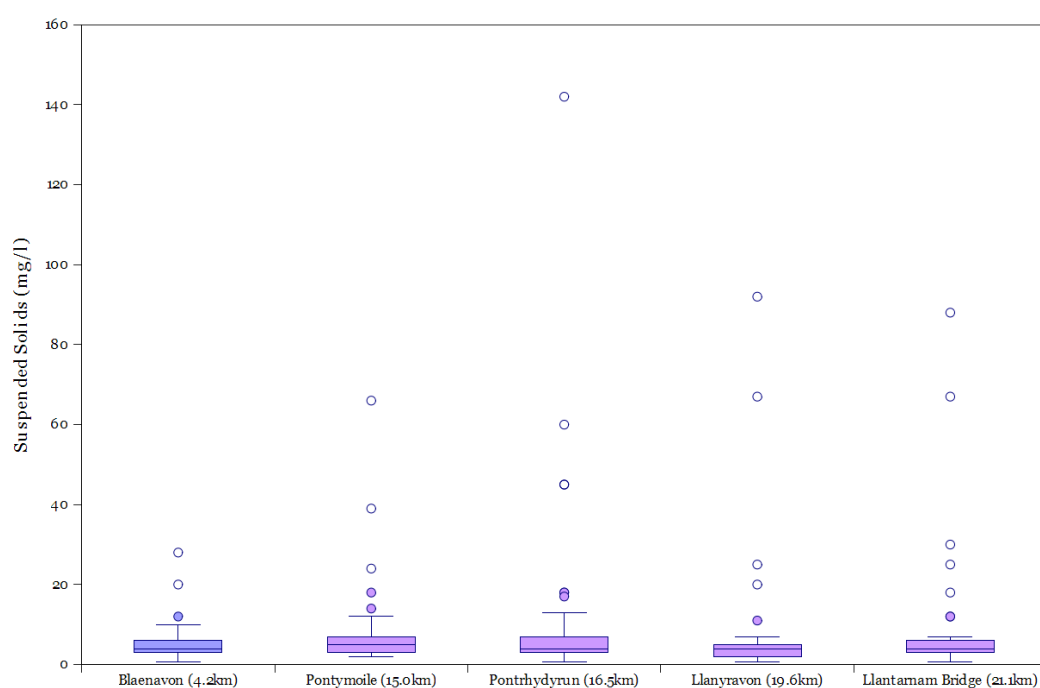


Figure B3.2 displays the TSS data measured at five locations in the Afon Lwyd between January 2000 and December 2002. With the exception of the outliers, which have been attributed to the impact of storm events within the Lwyd catchment, TSS concentrations are very similar and low throughout the measurement period. Median TSS varies little, being 4mg/l at all sites, with the exception of Pontymoile where the median increases slightly to 5mg/l. The data therefore show that TSS will be very low during the operation of the drought permit, with the potential for elevated levels related to storm events.

Figure B3.2 Suspended Sediment Measured at Five Sites in the Afon Lwyd Between January 2000 and December 2002 (Distance Downstream from Source of Afon Lwyd Noted in Parentheses)



Velocity data are available for six cross-sections on the Afon Lwyd. These data were collected by Welsh Water in summer 2011 on 21 July, 5 August and 22 September 2011 for the purposes of estimating river depth and discharge at these cross-sections. Site 6 was the closest to the proposed abstraction, being ~5.7km downstream of the proposed weir at Llanyravon. The lowest river depths measured at the cross-section occurred on 22 September 2011 (see **Table B2.5**), with average river depths of 0.04m and a calculated discharge of 0.130m³/s (11.2Ml/d). Flow velocity measured at the cross section (at ~60% of the depth of the flow) ranged between 0.04 – 0.75m/s and an average velocity of 0.42m/s. The very low TSS concentrations (5mg/l and below) indicated in **Figure B3.1**, for low flow velocities measured at the site, suggest that there will be little potential for transport of sediment at the low and extreme low flows. Furthermore, due to the presence of environmental drought conditions during implementation of a drought permit, it is assumed that no significant geomorphological work (i.e. erosion or transport or depositional processes) will be occurring within the catchment or river, and sediment supply to the river is likely to be **negligible**.

Considering the existing data and conditions in the river during an environmental drought, the impact of the drought permit on sediment dynamics is considered to be **negligible**.

B.3.1.2 Impacts to river channel, bed and bank morphology and stability

Hydrological Reach 1, Afon Lwyd from headwater to temporary abstraction point at New Inn

Flow ponding upstream of the temporary weir is taken to exert a **negligible** impact on river

channel, bed and bank morphology and stability due to the very low flow velocities expected in the ponded section and given the heavily reinforced nature of many of the banks around and upstream of the temporary weir.

Hydrological Reach 2, Afon Lwyd at New Inn to the tidal limit

During the operation of a drought permit, flows would be reduced. These decreases in flow may result in small changes in river depth, resulting in increased exposure of channel banks and changes in wetted width. This could potentially lead to desiccation of earth banks during drought conditions, increasing the risk of bank collapse due to gravity and also increasing potential for erosion of dry earth banks as normal flows resume. However, the hydrometric data collected at Site 6 in 2011 indicates wetted width remains stable during depth changes, although this is reduced for wetted width >10cm. In addition, given that level data measured at Abersychan indicate that river depths commonly drop below 0.2m, the fact that the walkover survey identified that the reach was dominantly depositional and that many banks were reinforced, exposure of channel banks is unlikely to significantly change with the expected reductions in flow during the implementation of the drought permit. Therefore, the impact of reducing flows on the channel banks is concluded to be **negligible**.

The change in river depth may expose sections of the channel bed, which could lead to exposure of in-channel features such as riffles (no side, point or mid channel bars were noted by the walkover survey). In addition, the reduction in river depth may reduce flow velocity due to increasing friction between the bed surface and flow, possibly leading to protrusion of the coarser bed particles through the flow surface. The reduction in velocities could impact on particle dynamics. However, given the already very low flow velocities measured during the summer 2011 cross-sectional surveys, very low TSS concentrations and, where visible, the general gravel/pebble nature of the channel bed, the impacts of reductions in flow are concluded to be **negligible**.

A reduction in the wetted depth during the operation of a drought permit may also impact on the stability of bankside vegetation along the hydrological monitoring reach. Implementation of the drought permit could lead to the loss of vegetation from the banks, leaving them susceptible to erosion by higher flows when drought conditions cease. However, it is unlikely that a marked decrease in vegetation will occur due to the limited change in flow. As such, the influence of the drought permit on bankside vegetation and erosion is considered to be **negligible**.

B.3.2 Water Quality

This section sets out the baseline water quality and examines changes over time and with respect to river flows. Environmental pressures on river water quality (such as discharges from STWs), which may cause deterioration in water quality with the drought permit in place, are discussed separately in Section B.3.3.

To support the assessment of potentially sensitive environmental features (see Section 5 of the main report), an understanding of the water quality of the rivers within the zone of influence of the drought permit has been developed, including trends over time and with respect to river flow. For Water Framework Directive (WFD) classification, the Environment Agency has set out the following WFD-UK technical advisory group (UKTAG) evidence regarding what pressures, including water quality pressures, each biological quality element is capable of responding to. For the purposes of assessment, supporting water quality parameters are set out for fish and macroinvertebrates (where identified as sensitive features) as dissolved oxygen saturation and total ammonia concentration; and for macrophytes and algae (phytobenthos / diatoms) (where identified as sensitive features) as soluble reactive phosphorus (SRP). Specifically, for macrophytes, if the hydrological impacts of drought permit implementation have been identified within the main macrophyte growing season (April to September), an assessment of SRP has been undertaken.

Potential impacts on other water quality parameters, such as temperature, have been considered where appropriate (e.g. temperature influences dissolved oxygen and if sufficient information is available on dissolved oxygen and is being reviewed it may not be necessary to undertake a separate temperature assessment). Where data are lacking, the assessment has been undertaken using professional judgement.

NRW routine monitoring data were reviewed to provide an overview of water quality in the zone of impact. In the Afon Lwyd catchment, within the extent of influence of the drought permit there are seven NRW water quality sampling sites, as detailed in **Table B3.1** and **Figure B1.1**. Where data is lacking, the assessment has been undertaken using professional judgement. Values at the limit of detection were halved in line with standard NRW practice.

Table B3.1 Details of NRW Water Quality Sampling Points on the Afon Lwyd

Reach	Site Name	NRW Site Code	Grid reference
1	Afon Road, Blaenavon	40030	SO2524908583
	Afon Lwyd, Pontymoile	40080	SO2903500485
2	Afon Lwyd, Pontrhydyrun	40100	ST2993297244
	Afon Lwyd, Llanyravon	40110	ST3018494644
	Afon Lwyd, Llantarnam Bridge	40120	ST3076093695
	Afon Lwyd at Ponthir G.S.	40130	ST3297892433
	Afon Lwyd, Pont Sadwrn	40140	ST3423391158

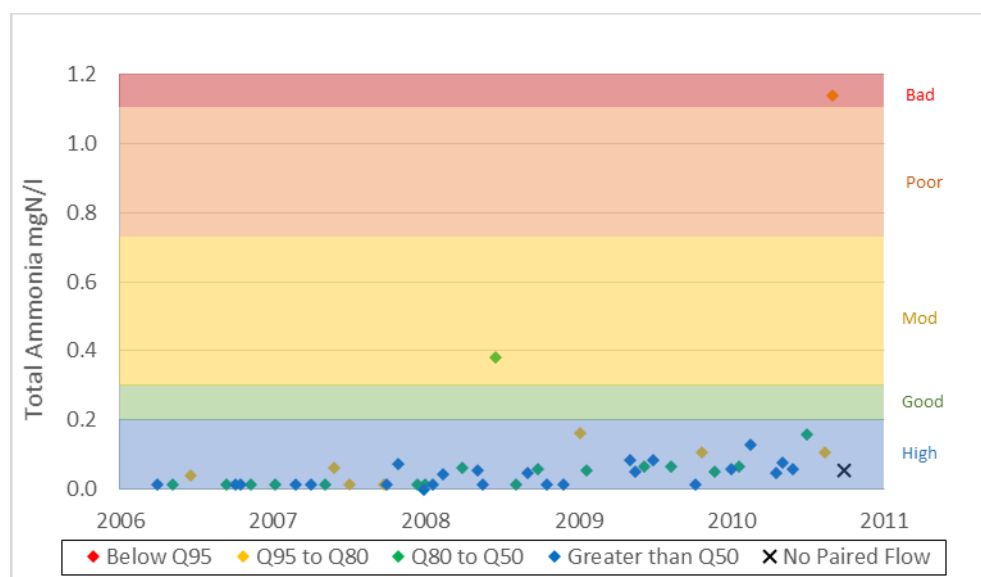
B.3.2.1 Reach 1 - Afon Lwyd, from the Source to Temporary abstraction point at New Inn:

Water quality analysis has been undertaken based on the data available at the two NRW monitoring points in this reach (characterised by a minor hydrological impact): Afon Road, Blaevavon (site 40030) and Afon Lwyd, Pontymoile (site 40080). The monitoring site Afon Road, Blaenavon (40030) had an average pH reading of 7.9 over the sampling period, and had a maximum water temperature of 20.2°C. The monitoring site Afon Lwyd, Pontymoile (40080) had the same average pH of 7.9, and a maximum water temperature of 17°C.

Total Ammonia Concentration

Total ammonia concentration data from Afon Road, Blaenavon were reviewed and presented in Figure B3.1 against the relevant WFD standards for an upland low alkalinity river².

Figure B3.1: Total Ammonia at Afon Road, Blaenavon, Incorporating Appropriate WFD Status Bands

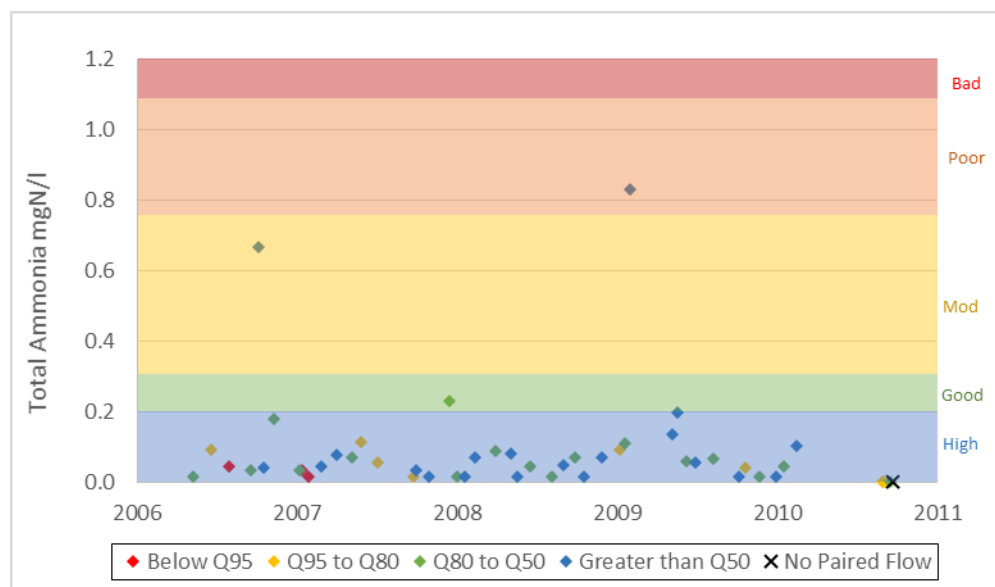


Total ammonia concentrations at Afon Road, Blaenavon were predominantly consistent with the WFD standard to support good status for fish and invertebrates (0.3 mg/l), being thoroughly indicative of general high water quality standard. Two isolated events where total ammonia concentrations fell below this standard (into the moderate and poor standard bands) took place in 2008 and 2011 respectively. The highest ammonia concentration is related to flows below Q₉₅. An increasing trend in total ammonia concentrations is evident in from 2008 onwards.

² The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Total ammonia concentrations on the Afon Lwyd Pontymoile were reviewed and data presented in **Figure B3.2** against the relevant WFD standards for an upland low alkalinity river³.

Figure B3.2: Total Ammonia on the Afon Lwyd Pontymoile, Incorporating Appropriate WFD Status Bands



Total ammonia concentrations on the Afon Lwyd, Pontymoile were also predominantly consistent with the WFD standard to support good status for fish and invertebrates (0.3 mg/l), being mostly indicative of general high water quality. However, two instances in which the good standard was not met and total ammonia concentrations were indicative of moderate and poor water quality conditions happened in 2006 and 2009 respectively. No association between low flows and high ammonia concentrations are noted at this site.

Dissolved Oxygen Saturation

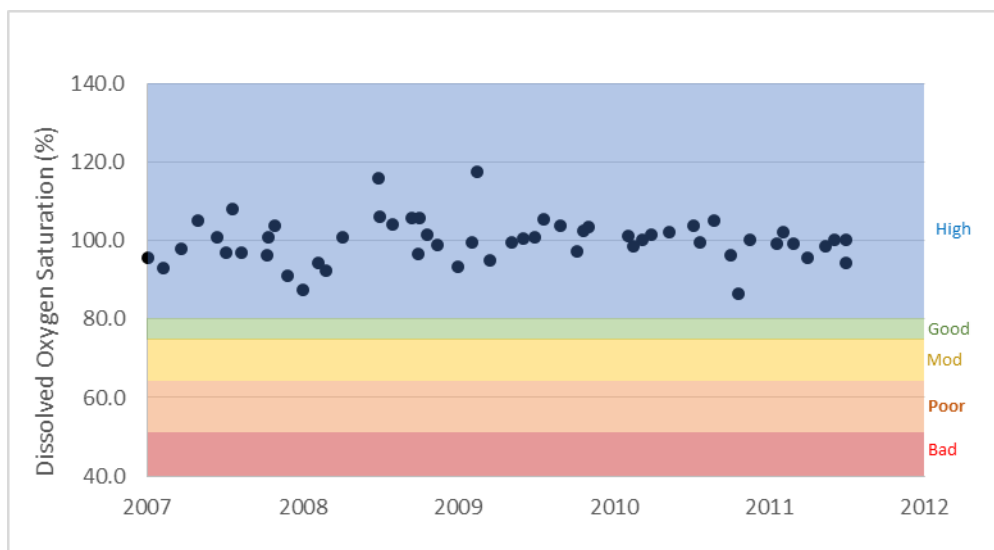
Dissolved oxygen saturation at Afon Road, Blaenavon was reviewed and data are presented in **Figure B3.3** against the relevant WFD standards for an upland low alkalinity river⁴.

Dissolved oxygen saturation measurements at Afon Road, Blaenavon were all consistent with the WFD standard to support good status for fish and invertebrates (75% saturation), indicative of general high water quality. Some degree of seasonality is evident, with higher dissolved oxygen concentrations during winter and spring.

³ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

⁴ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

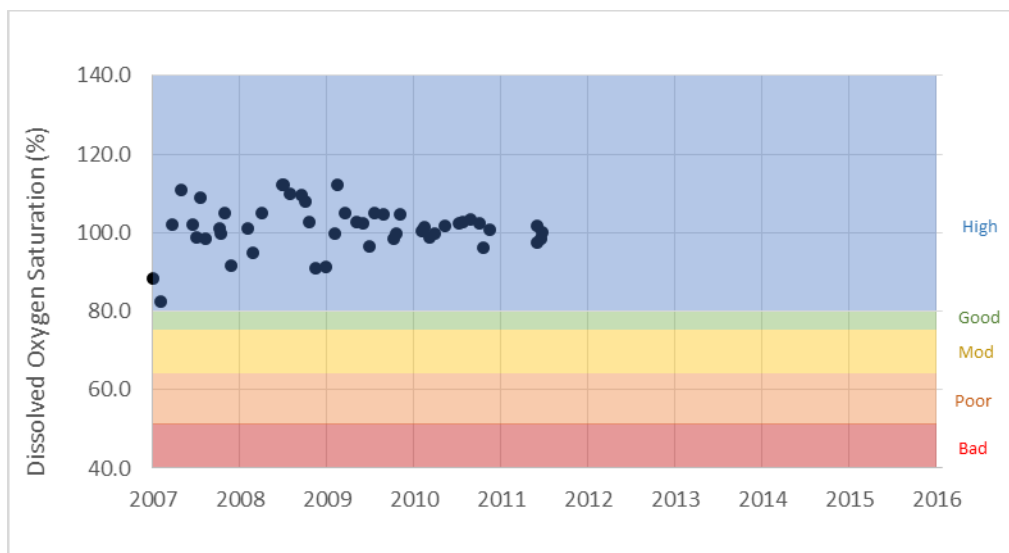
Figure B3.3: Dissolved Oxygen concentrations at Afon Road Blaenavon, Incorporating Appropriate WFD Status Bands



Dissolved oxygen saturation on the Afon Lwyd Pontymoile was reviewed and data are presented in **Figure B3.4** against the relevant WFD standards for an upland low alkalinity river⁵.

Dissolved oxygen saturation measurements on the Afon Lwyd, Pontymoile were again all consistent with the WFD standard to support good status for fish and invertebrates (75% saturation), indicative of general high water quality. Some degree of seasonality is evident, with higher dissolved oxygen concentrations during winter and spring

Figure B3.4: Dissolved Oxygen Concentrations on the Afon Lwyd Pontymoile, Incorporating Appropriate WFD Status Bands



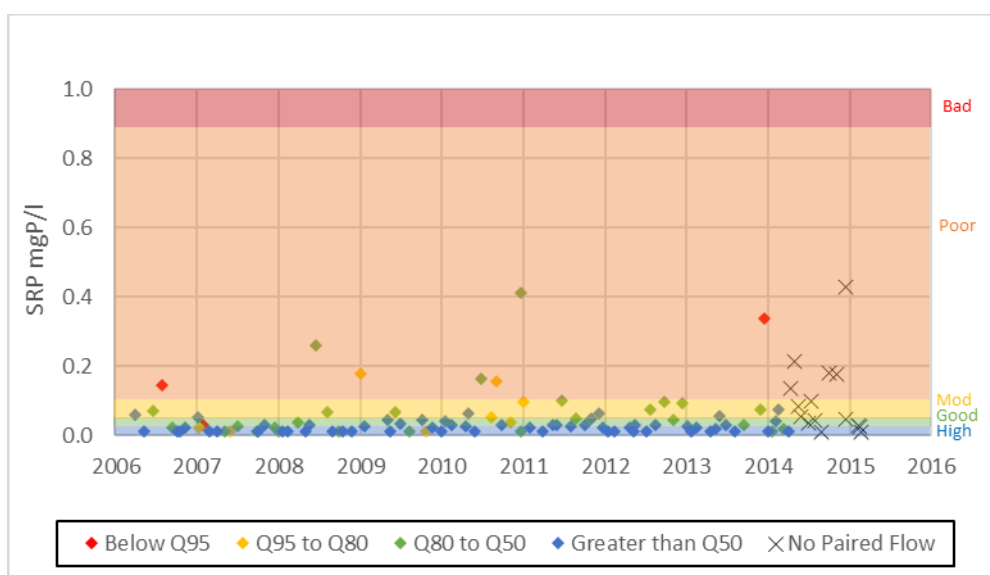
⁵ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Soluble Reactive Phosphorus

SRP concentrations on the Afon Road, Blaenavon were reviewed and data are presented in **Figure B3.5** against the relevant WFD site specific standards provided by NRW⁶.

SRP concentrations on the Afon Road, Blaenavon were largely consistent with the WFD standard to support good status for fish and invertebrates (0.03 mgP/l), although several instances where this standard was not met are present throughout the record. There is no particular association between low flows and high SRP concentrations at this location.

Figure B3.5 SRP Concentrations on the Afon Road, Blaenavon, Incorporating Appropriate WFD Status Bands



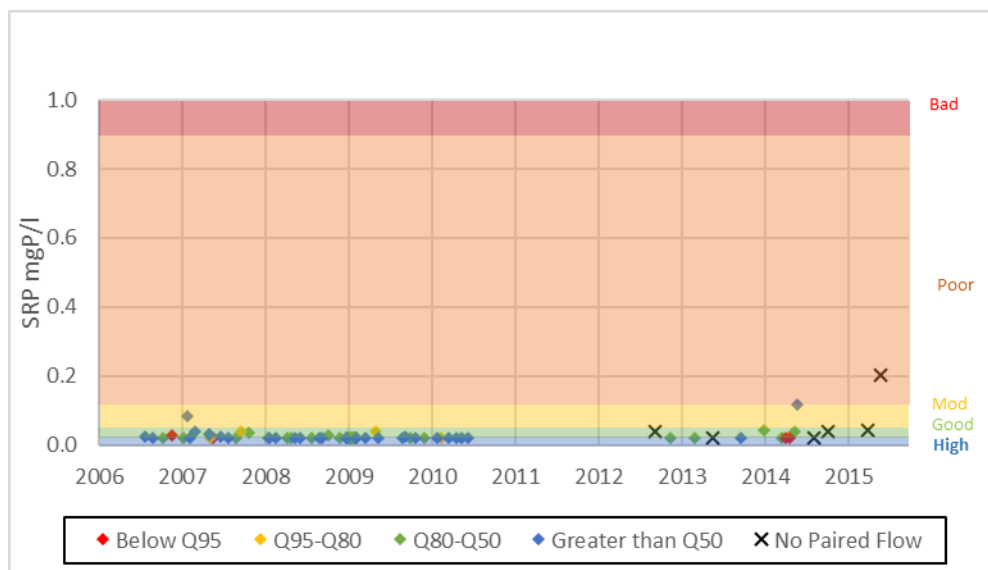
SRP concentrations at the Afon Lwyd Pontymoile were reviewed and data are presented in **Figure B3.6** against the relevant WFD site specific standards provided by NRW⁷.

SRP concentrations at the Afon Lwyd Pontymoile were almost entirely consistent with the WFD standard to support good status for fish and invertebrates (0.06 mgP/l), with only one instance where the standard was not met recorded in 2006. No association with river flows is apparent at this location.

⁶ The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

⁷ The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Figure B3.6 SRP Concentrations at the Afon Lwyd Pontymoile, Incorporating Appropriate WFD Status Bands



B.3.2.2 Reach 2 - Afon Lwyd, from the Temporary abstraction point at New Inn to the Tidal Limit:

Water quality analysis was undertaken based on data available at the five NRW monitoring points in this reach (characterised by a major hydrological impact): Afon Lwyd, Pontrhydyrun Site 40100), Afon Lwyd, Llanyravon (Site 40110), Afon Lwyd, Llantarnam Bridge (Site 40120), Afon Lwyd at Ponthir G.S. (Site 40130) and Afon Lwyd, Pont Sadwrn (Site 40140).

Average pH and maximum water temperature data for all sites in this reach are summarised in **Table B3.2** below.

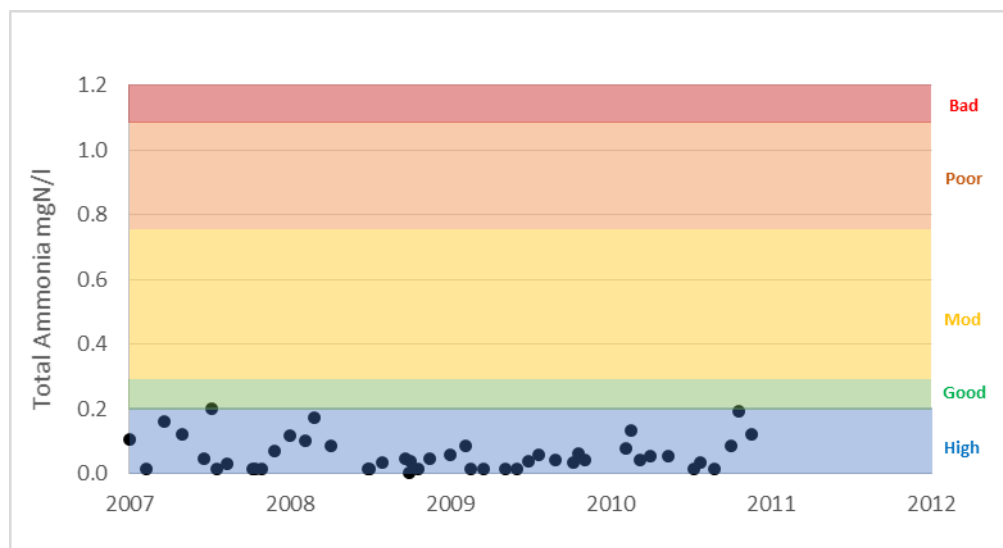
Table B3.2 Average pH and Water Temperature Throughout Reach 2

Monitoring Site	Average pH (pH Units)	Maximum Water Temperature (°C)
Afon Lwyd, Pontrhydyrun (Site 40100)	8.0	16.8
Afon Lwyd, Llanyravon (Site 40110)	8.0	19
Afon Lwyd, Llantarnam Bridge (Site 40120)	8.0	18.7
Afon Lwyd at Ponthir G.S. (Site 40130)	8.0	18.4
Afon Lwyd, Pont Sadwrn (Site 40140)	7.7	17.8

Total Ammonia Concentration

Total ammonia concentrations at Afon Lwyd, Pontrhydyrun were reviewed and data presented in **Figure B3.7** against the relevant WFD standards for an upland low alkalinity river⁸.

Figure B3.7: Total Ammonia Concentrations at Afon Lwyd, Pontrhydyrun, Incorporating Appropriate WFD Status Bands



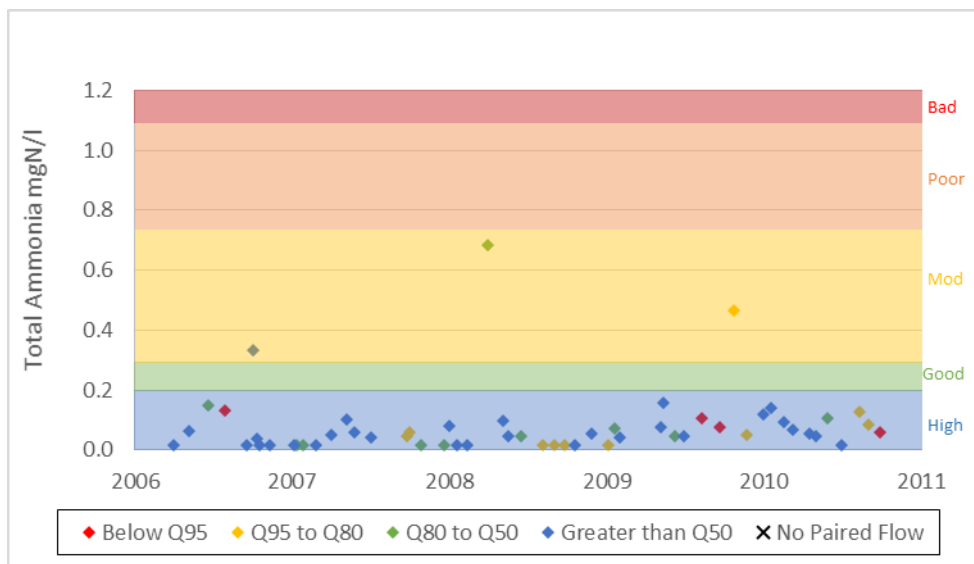
Total ammonia concentrations at Afon Lwyd, Pontrhydyrun were all consistent with the WFD standard to support good status for fish and invertebrates (0.3mg/l), being thoroughly indicative of general high water quality. A seasonal pattern can be detected throughout the record, with higher total ammonia concentrations being observed during winter and spring.

Total ammonia concentrations on the Afon Lwyd, Llanyrayon were reviewed and data presented in **Figure B3.8** against the relevant WFD standards for an upland low alkalinity river⁹.

⁸ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

⁹ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

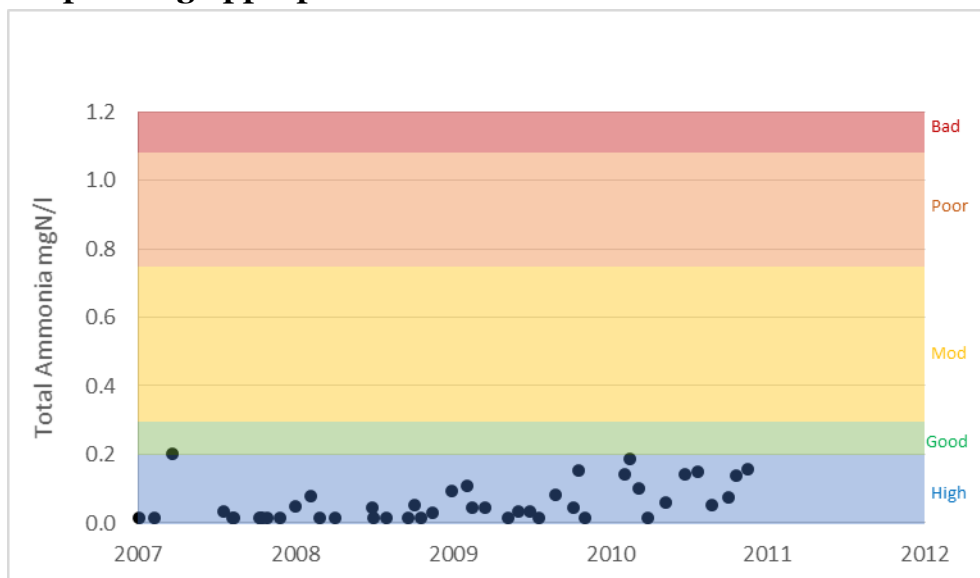
Figure B3.8: Total Ammonia Concentrations on the Afon Lwyd, Llanyrayon, Incorporating Appropriate WFD Status Bands



Total ammonia concentrations at Afon Lwyd, Llanyrayon were predominantly consistent with the WFD standard to support good status for fish and invertebrates (0.3 mgN/l), being thoroughly indicative of general high water quality. A few instances where this standard was not achieved are evident throughout the record. A seasonal pattern can be detected throughout the record, with higher total ammonia concentrations being observed during winter and spring.

Total ammonia concentrations at Afon Lwyd, Llantarnam Bridge were reviewed and data presented in **Figure B3.9** against the relevant WFD standards for an upland low alkalinity river¹⁰.

Figure B3.9: Total Ammonia Concentrations at Afon Lwyd, Llantarnam Bridge, Incorporating Appropriate WFD Status Bands

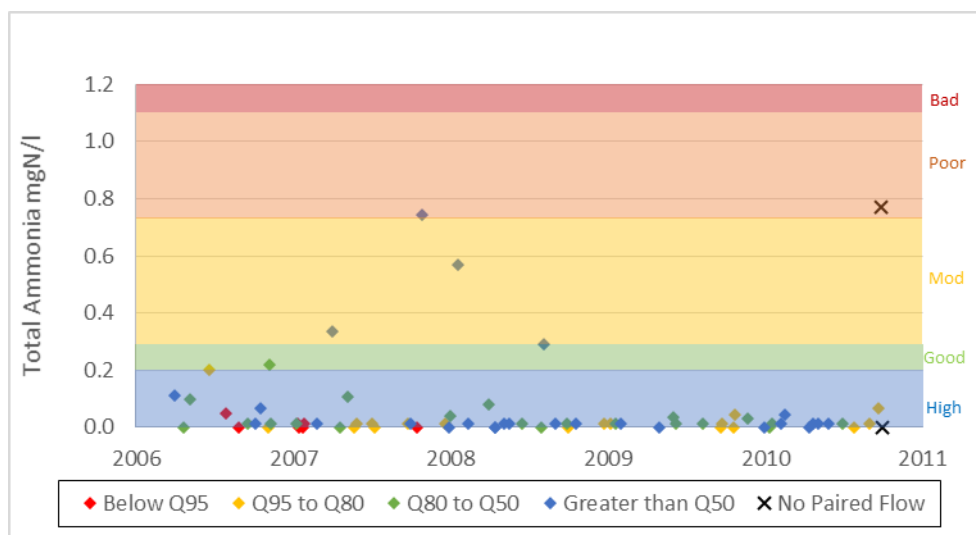


¹⁰ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Total ammonia concentrations at Afon Lwyd, Llantarnam Bridge were all consistent with the WFD standard to support good status for fish and invertebrates (0.3mgN/l), being thoroughly indicative of general high water quality.

Total ammonia concentrations on the Afon Lwyd at Ponthir G.S. were reviewed and data presented in **Figure B3.10** against the relevant WFD standards for an upland low alkalinity river¹¹.

Figure B3.10: Total Ammonia Concentrations on the Afon Lwyd at Ponthir G.S. Incorporating Appropriate WFD Status Bands



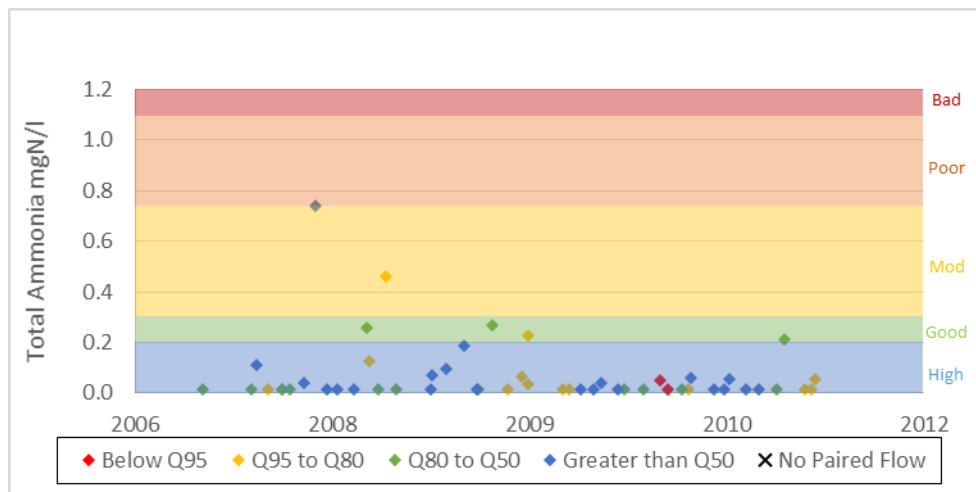
Total ammonia concentrations at Afon Lwyd at Ponthir G.S. were mostly consistent with the WFD standard to support good status for fish and invertebrates (0.3mg/l), being indicative of general high water quality. There were four events throughout the record when this standard was not met. An apparent association between increased total ammonia concentrations and medium-high flows (greater than Q₅₀) exists at this location.

Total ammonia concentrations on the Afon Lwyd, Pont Sadwrn were reviewed and data presented in **Figure B3.11** against the relevant WFD standards for an upland low alkalinity river¹².

¹¹ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

¹² The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Figure B3.11: Total Ammonia Concentrations on the Afon Lwyd, Pont Sadwrn, Incorporating Appropriate WFD Status Bands



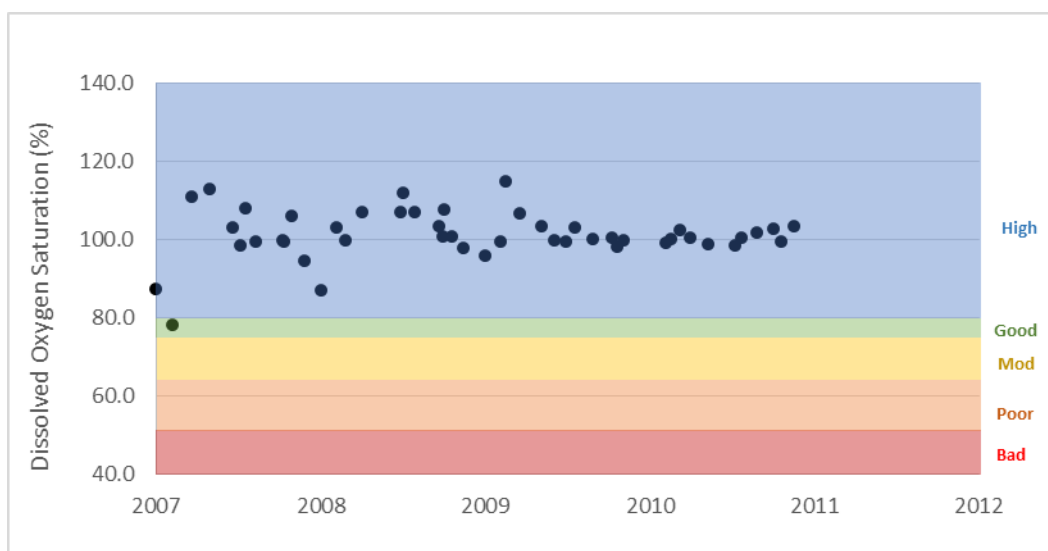
Total ammonia concentrations on the Afon Lwyd, Pont Sadwrn were relatively consistent with the WFD standard to support good status for fish and invertebrates (0.3mg/l), being almost always indicative of general high water quality. There were two instances when the standard was not met (2007 and 2008). No association between higher total ammonia concentrations and low flows is noted here.

Dissolved Oxygen Saturation

Dissolved oxygen saturation at Afon Lwyd, Pontrhydyrun was reviewed and data are presented in **Figure B3.12** against the relevant WFD standards for an upland low alkalinity river¹³.

¹³ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

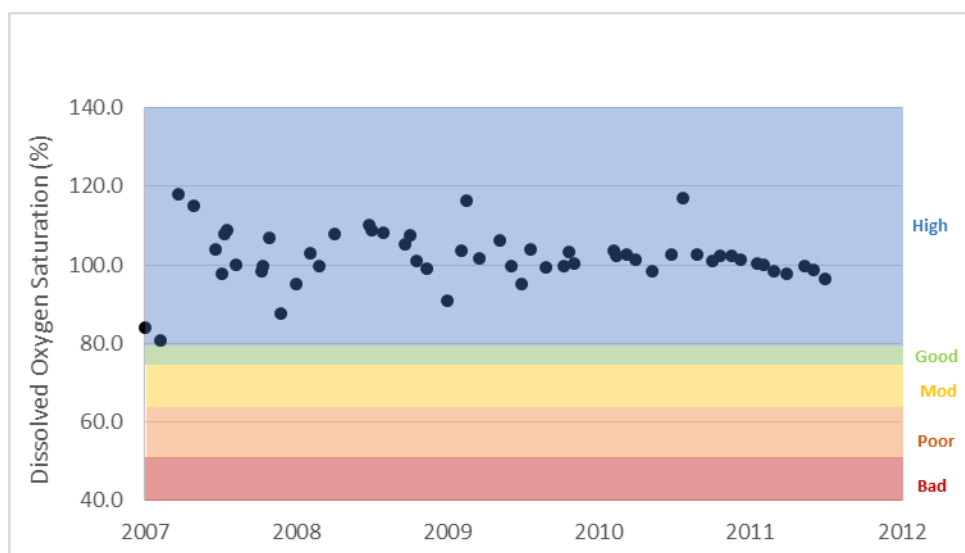
Figure B3.12: Dissolved Oxygen Saturation at Afon Lwyd, Pontrhydyrun, Incorporating Appropriate WFD Status Bands



Dissolved oxygen saturation measurements at Afon Lwyd, Pontrhydyrun were all consistent with the WFD standard to support good status for fish and invertebrates (75%), being thoroughly indicative of general high water quality.

Dissolved oxygen saturation on the Afon Lwyd, Llanyrayon was reviewed and data are presented in **Figure B3.13** against the relevant WFD standards for an upland low alkalinity river¹⁴.

Figure B3.13: Dissolved Oxygen saturation on the Afon Lwyd, Llanyrayon, Incorporating Appropriate WFD Status Bands

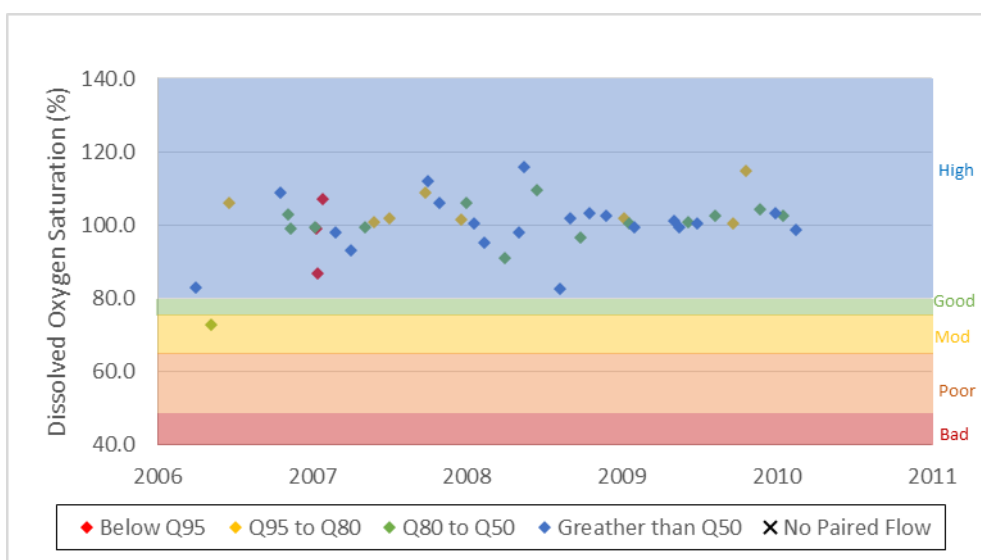


¹⁴ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Dissolved oxygen saturation measurements at Afon Lwyd, Llanyrayon were all consistent with the WFD standard to support good status for fish and invertebrates (75%), being thoroughly indicative of general high water quality.

Dissolved oxygen saturation at Afon Lwyd, Llantarnam Bridge were reviewed and data are presented in **Figure B3.14** against the relevant WFD standards for an upland low alkalinity river¹⁵.

Figure B3.14: Dissolved Oxygen concentrations at Afon Lwyd, Llanyrayon Bridge, Incorporating Appropriate WFD Status Bands



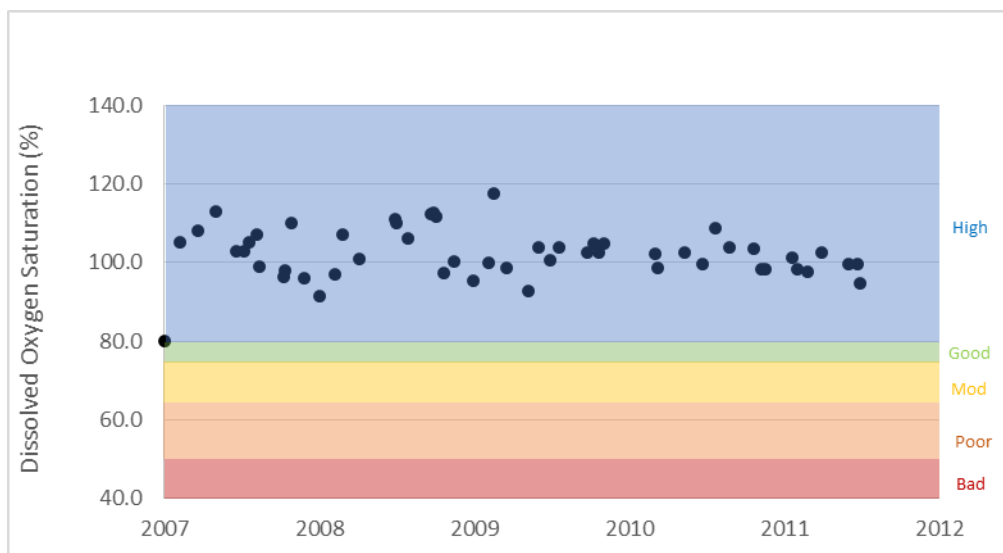
Dissolved oxygen saturation measurements at Afon Lwyd, Llantarnam Bridge were predominantly consistent with the WFD standard to support good status for fish and invertebrates (75% saturation). This standard was failed only once throughout the record.

Dissolved oxygen saturation at Afon Lwyd at Ponthir G.S. was reviewed and data are presented in **Figure B3.15** against the relevant WFD standards for an upland low alkalinity river¹⁶.

¹⁵ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

¹⁶ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

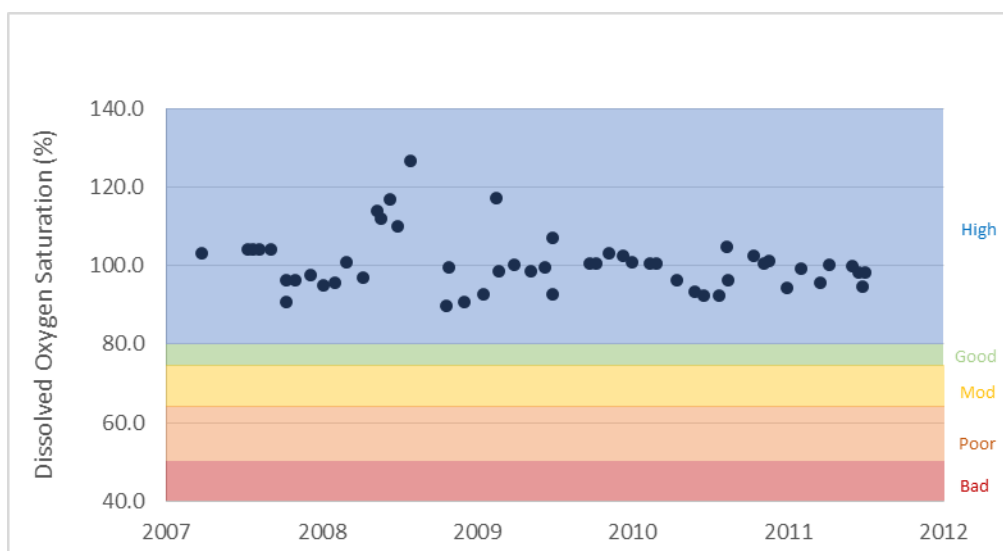
Figure B3.15: Dissolved Oxygen saturation at Afon Lwyd at Ponthir G.S. Incorporating Appropriate WFD Status Bands



Dissolved oxygen saturation measurements at Afon Lwyd at Ponthir G.S. (see **Figure B3.3**) were entirely consistent with the WFD standard to support good status for fish and invertebrates (75% saturation), indicative of general high water quality.

Dissolved oxygen saturation at Afon Lwyd, Pont Sadwrn was reviewed and data are presented in **Figure B3.16** against the relevant WFD standards for an upland low alkalinity river¹⁷.

Figure B3.16: Dissolved Oxygen saturation at Afon Lwyd, Pont Sadwrn, Incorporating Appropriate WFD Status Bands



Dissolved oxygen saturation measurements at Afon Lwyd, Pont Sadwrn were thoroughly consistent with the WFD standard to support good status for fish and invertebrates (75%),

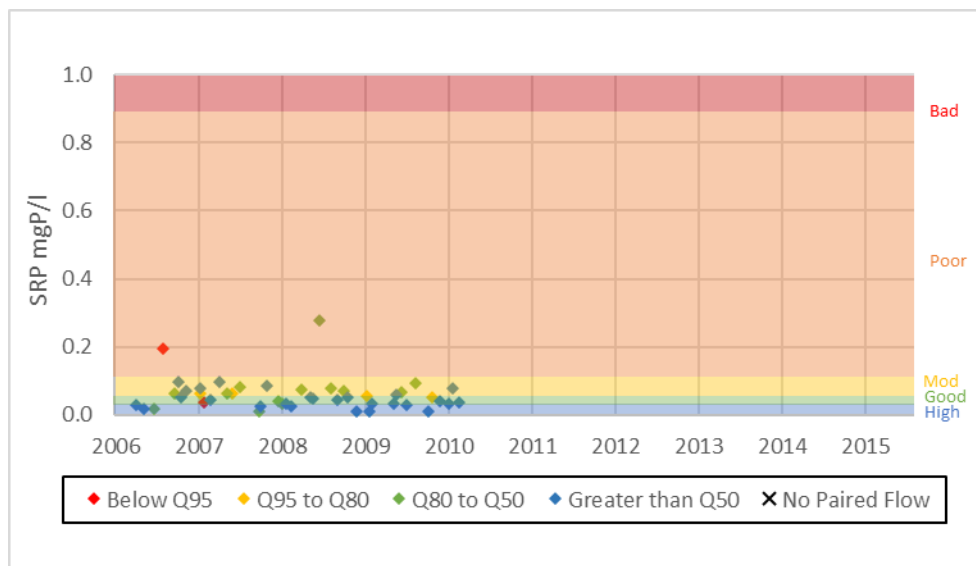
¹⁷ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

being thoroughly indicative of general high water quality.

Soluble Reactive Phosphorus

SRP concentrations at Afon Lwyd, Pontrhydyrun were reviewed and data are presented in **Figure B3.17** against the relevant WFD site specific standards provided by NRW¹⁸.

Figure B3.17 SRP concentrations at Afon Lwyd, Pontrhydyrun, Incorporating Appropriate WFD Status Bands



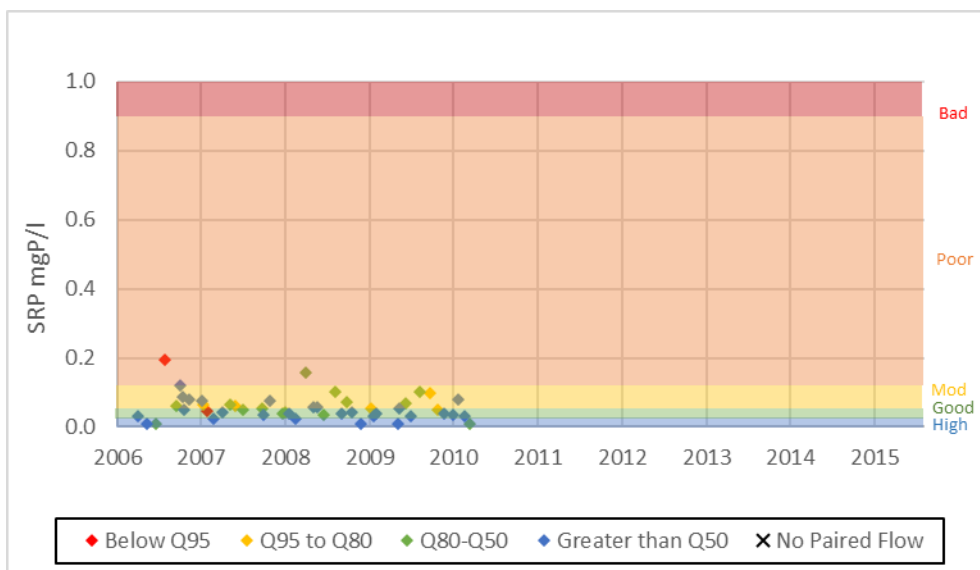
SRP concentrations at Afon Lwyd, Pontrhydyrun were moderately consistent with the WFD standard to support good status for fish and invertebrates (0.056mgP/l), with many occasions where concentrations were indicative of moderate and sometimes poor water quality status. Some degree of seasonality in SRP concentrations is evident throughout the record, although no association between these and flow are noted.

SRP concentrations at Afon Lwyd, Llanyrayon were reviewed and data are presented in **Figure B3.18** against the relevant WFD site specific standards provided by NRW¹⁹.

¹⁸ The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

¹⁹ The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Figure B3.18 SRP concentrations at Afon Lwyd, Llanyrayon, Incorporating Appropriate WFD Status Bands

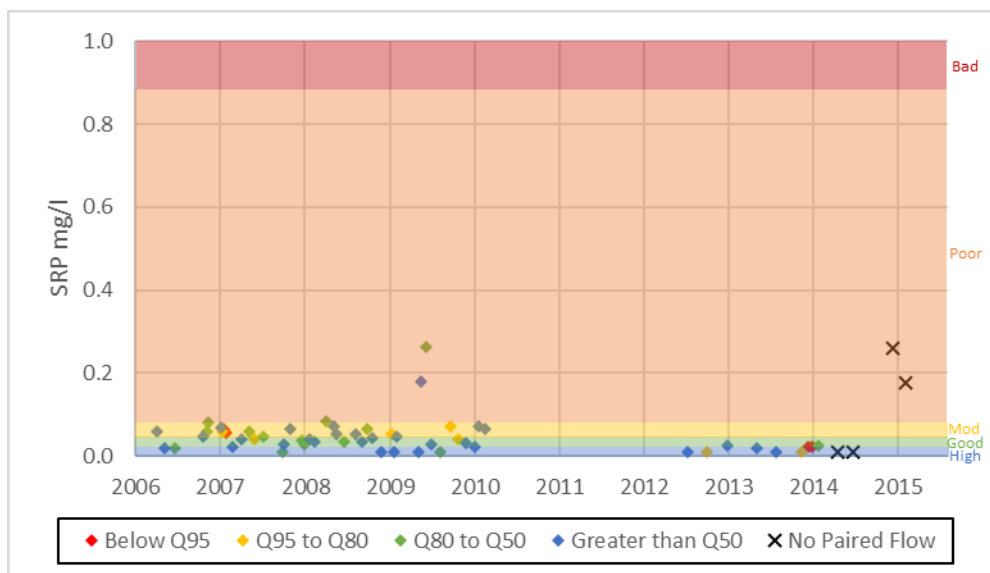


SRP concentrations at Afon Lwyd, Llanyrayon were moderately consistent with the WFD standard to support good status for fish and invertebrates (0.056mgP/l), with many instances in which this standard was not met. Some degree of seasonality in SRP concentrations is evident throughout the record, although no association between these and flow are noted.

SRP concentration at Afon Lwyd, Llantarnam Bridge were reviewed and data are presented in **Figure B3.19** against the relevant WFD site specific standards provided by NRW²⁰.

²⁰ The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Figure B3.19 SRP Concentrations at Afon Lwyd, Llantarnam Bridge, Incorporating Appropriate WFD Status Bands

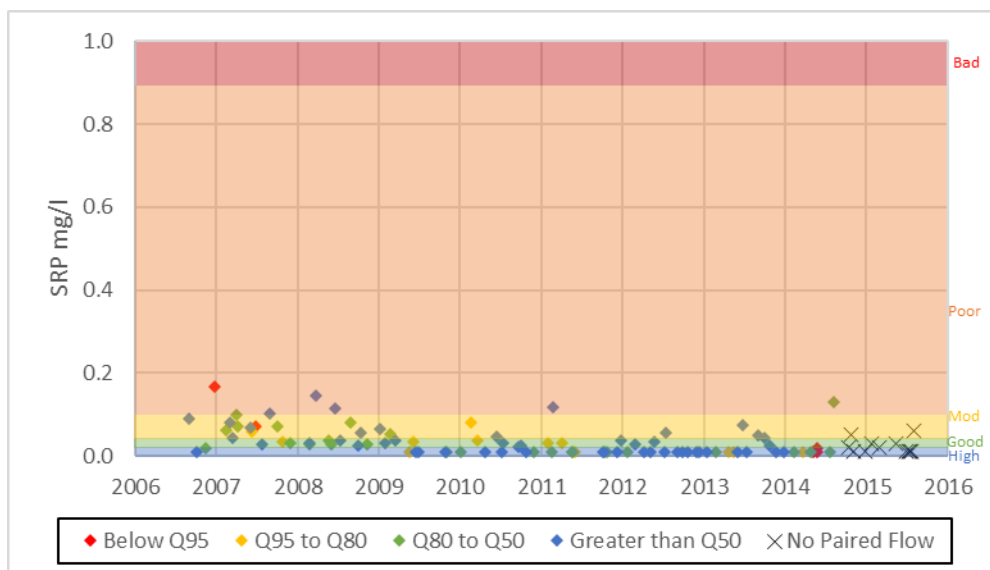


SRP concentrations at Afon Lwyd, Llantarnam Bridge were moderately consistent with the WFD standard to support good status for fish and invertebrates (0.056mgP/l), with many instances in which this standard was not met. Some degree of seasonality in SRP concentrations is evident throughout the record, although no association between these and flow are noted.

SRP concentrations on Afon Lwyd at Ponthir G.S. were reviewed and data are presented in **Figure B3.20** against the relevant WFD site specific standards provided by NRW²¹.

²¹ The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

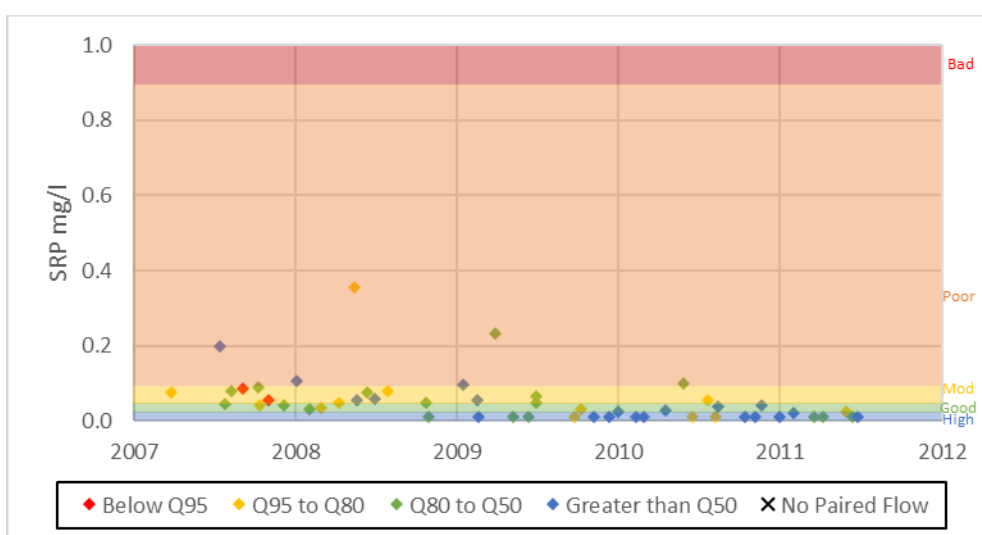
Figure B3.20 SRP concentrations on Afon Lwyd at Ponthir G.S. Incorporating Appropriate WFD Status Bands



SRP concentrations on Afon Lwyd at Ponthir G.S. were moderately consistent with the WFD standard to support good status for fish and invertebrates (0.056mgP/l), with many instances in which this standard was not met. Some degree of seasonality in SRP concentrations is evident throughout the record, although no association between these and flow are noted.

SRP concentrations at Afon Lwyd, Pont Sadwrn were reviewed and data are presented in **Figure B3.21** against the relevant WFD site specific standards provided by NRW²².

Figure B3.21 SRP concentrations at Afon Lwyd, Pont Sadwrn Incorporating Appropriate WFD Status Bands



SRP concentrations at Afon Lwyd, Pont Sadwrn were moderately consistent with the WFD

²² The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

standard to support good status for fish and invertebrates (0.056mgP/l), with many instances in which this standard was not met. Some degree of seasonality in SRP concentrations is evident throughout the record, although no association between these and flow are noted.

B.3.2.3 Water Quality Summary

The majority of total ammonia concentrations were consistent with the standard to support good status for fish and invertebrates throughout the zone of influence of the Afon Lwyd drought permit and their seasonal variability was negligible. The risk of the drought permit to total ammonia concentrations throughout Reach 1 of the Afon Lwyd is assessed to be **low** considering the general good water quality and the minor hydrological risk. However, in the future, this risk may be exacerbated due to the baseline trend of increasing ammonia concentrations in recent years. With respect to Reach 2, the risk is assessed to be **medium**, considering the major hydrological risk imposed by the drought permit which would hinder the natural ability of the river to buffer total ammonia inputs.

Dissolved oxygen saturations were highly consistent with the standard to support good status for fish and invertebrates throughout the zone of influence of the Afon Lwyd drought permit. With respect to Reach 1, the water quality deterioration risk is assessed to be **low** since the hydrology throughout this reach will not be majorly impacted by the drought plan. Despite the major hydrological risk throughout Reach 2, the water quality deterioration risk associated with dissolved oxygen is assessed as **low**. This is due to the fact that dissolved oxygen saturations seem to be unaffected by flow conditions.

With respect to SRP, the risk of water quality deterioration during the implementation of the drought option is assessed as **medium** in Reach 1 due to a history of good standard failures. In Reach 2, the risk is **high** due to the multitude of good standard failures at each monitoring site as well as the major hydrological impact expected in this reach.

B.3.3 Environmental Pressures

B.3.3.1 Flow Pressures

Surface Water Abstractions

During a drought, abstractions put pressure on flow by removing water from rivers and groundwater aquifers and potentially exacerbating natural low flows. As a result of a drought order, there may be less water available in the zone of influence for licence holders to abstract, and any abstractions that do occur may reduce the amount of surface water available – affecting the wetted perimeter of the habitat, velocities within the wetted area and the ability to dilute any pollutants entering the system. For surface water abstractions, this includes consumptive abstraction and partially consumptive / non-consumptive abstraction – where some or all of the water is returned to the river locally after use, with the potential to reduce flow in the river if the discharge is downstream of the abstraction.

An overview of licensed surface water abstractions is given below based on information

received from NRW (see **Table B3.3**). The risk to the surface water abstractions is **minor** due to the effect of the drought permit for Reach 1 and **major** for Reach 2 due to the effect of the drought permit.

Table B3.3 Surface Water Abstractions in Area of Influence of the Afon Lwyd drought permit

Licence Number	Use	Daily abstraction limit (ML/d)	Location	
			NGR	Description
WA/056/0012/001	Energy	12.96	SO2409	Reach 1
20/56/12/0046	Water supply	2.27	SO2608	Reach 1
20/56/12/0081	Industrial. Commercial and water supply	70	SO2706	Reach 1
20/56/12/0064	Amenity	1.36	ST3094	Reach 2
20/56/12/0060	Water supply	0.65	ST3293	Reach 2

B.3.3.2 Water Quality Pressures

Discharges put pressure on water quality during a drought as lower than normal river flows mean that there is less water available to dilute discharges such as effluent from STWs. Discharges affecting oxygen balance and ammonia concentration in the river reaches have been reviewed. Significant pressures (discharges of over 0.5ML/d) are shown in **Table 3.4**. Discharges may be considered as beneficial to river flow, but may also pose risks to water quality (noting that only abstractions are considered as flow pressures in the section above).

Surface Water Discharges

There are 32 intermittent discharge permits (surface water outflows and surface sewer outflows) from various sources within the zone of influence of the Afon Lwyd drought permit (**Table B3.5**). Due to the size of these discharges, all are considered of **negligible** risk.

An additional two disputed intermittent discharges (**Table B3.5**) are located in the zone of influence of the drought permit and they too are considered of negligible risk due to their size.

CSO discharges

There are 13 combined sewer overflows (CSO) from various sources within the zone of influence of the Afon Lwyd drought permit (**Table B3.6**). Due to the size and location of these discharges, all are considered of **negligible** risk.

Table B3.4 Summary of Contested Water Quality Pressures

Permit no.	Site Name	Location	Max daily total (Ml/d)	Dry weather flow (Ml/d)	BOD: 5 Day ATU (mg/l)	Ammoniacal N (mg/l)	Suspended Solids at 105 C (mg/l)	Zone of influence (<500m)	Consideration of water quality pressure (during baseline low flow conditions)
AA0026501	Storm Tanks at The Old Cwmbran Works, Ponthir	ST334829 2446	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	70	Negligible
AB0049901	Caerleon (Usk Road) PS	ST342319 1138	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	15	Negligible

Table B3.5 Summary of Intermittent Water Quality Pressures

Permit no.	Site Name	Location	Max daily total (Ml/d)	Dry weather flow (Ml/d)	BOD: 5 Day ATU (mg/l)	Ammoniacal N (mg/l)	Suspended Solids at 105 °C (mg/l)	Zone of influence (<500m)	Water quality pressure (during baseline low flow conditions)
AA0009701	Lower pontnewydd sso	ST3003095910	0	0	0	0	0	10	Negligible
AA0010901	Pontnewynydd sso	SO2779001610	0	0	0	0	0	10	Negligible
AA0018801	Pontypool (glass factory) sso	ST2990099380	0	0	0	0	0	2	Negligible
AA0024801	Cwmbran (grange ind. Estate)	ST2998094410	0	0	0	0	0	300	Negligible
AC0108801	Charlesville, pontnewydd, pontypool	SO2740002000	0	0	0	0	0	15	Negligible
AD0008001	Lower new inn, pontyfelin lane	ST3013099030	0	0	0	0	0	15	Negligible
AD0008201	Albion road sso	SO2822000470	0	0	0	0	0	400	Negligible
AD0008301	Leisure centre storm sewage overflow, troisant steet, pontypool, gwent	SO2859000570	0	0	0	0	0	0	Negligible
AD0010601	Limekiln road sso	SO2702002970	0	0	0	0	0	5	Negligible
AD0010604	Swo 19, new road, new inn, pontypool, gwent	ST2980099400	0	0	0	0	0	70	Negligible
AD0010607	Town bridge sso, pontypool	SO2818001100	0	0	0	0	0	5	Negligible

Permit no.	Site Name	Location	Max daily total (Ml/d)	Dry weather flow (Ml/d)	BOD: 5 Day ATU (mg/l)	Ammoniacal N (mg/l)	Suspended Solids at 105 °C (mg/l)	Zone of influence (<500m)	Water quality pressure (during baseline low flow conditions)
AD0010609	Lower crane street, pontypool	SO28220 01050	0	0	0	0	0	2	Negligible
AD0010610	Commercial street, pontypool	SO28230 00920	0	0	0	0	0	2	Negligible
AD0010611	Hanbury road sso, pontypool	SO28340 00780	0	0	0	0	0	10	Negligible
AD0010612	Swo 22, off rear lane access to fountain road, pontymoile, pontypool, gwent	SO29100 00400	0	0	0	0	0	40	Negligible
AD0010613	Herberts wood sso	SO28010 01520	0	0	0	0	0	0	Negligible
AD0010614	Penygarn sso	SO28070 01290	0	0	0	0	0	0	Negligible
AD0010616	Rising sun bridge sso, nr cwmffrwd halt	SO27040 04310	0	0	0	0	0	2	Negligible
AD0010617	Varteg terrace sso, cwmavon	SO26960 06300	0	0	0	0	0	10	Negligible
AD0010619	Lower mill sso, nr pilkintons glass works	SO29390 00250	0	0	0	0	0	0	Negligible
AD0010621	Chapel lane sso, pontrhydrun, edlogan	ST29940 97230	0	0	0	0	0	10	Negligible
AD0010622	Swo 48, old road, abersychan, pontypool, gwent	SO27000 03300	0	0	0	0	0	80	Negligible

Permit no.	Site Name	Location	Max daily total (Ml/d)	Dry weather flow (Ml/d)	BOD: 5 Day ATU (mg/l)	Ammoniacal N (mg/l)	Suspended Solids at 105 °C (mg/l)	Zone of influence (<500m)	Water quality pressure (during baseline low flow conditions)
AD0010623	Leigh road sso	SO26980 02640	0	0	0	0	0	2	Negligible
AD0010624	Snatchwood halt sso	SO26950 02560	0	0	0	0	0	2	Negligible
AD0010901	Jarrolds sso, lancaster road, pontypool	ST302709 9070	0	0	0	0	0	120	Negligible
AD0013801	Convent grounds, llantarnam sso	ST30800 93470	0	0	0	0	0	60	Negligible
AN0013901	Griffithstown subsidiary sewer	ST29980 98250	0	0	0	0	0	0	Negligible
AN0106101	Mill road, pontnewynydd, gwent	SO27500 01850	0	0	0	0	0	10	Negligible
AN0127701	Garndiffaith - stoney road victoria village	SO26720 04000	0	0	0	0	0	350	Negligible
AN0155401	Llanfrechfa - rose cottage	ST315309 3200	0	0	0	0	0	120	Negligible
AN0161501	Hospital road	SO27360 02280	0	0	0	0	0	80	Negligible
AN0224101	Swo 42, adjacent snatchwood road, snatchwood, pontypool, gwent	SO27050 02330	0	0	0	0	0	12	Negligible

Table B3.6 Summary of CSO discharges

Permit no.	Site Name	Location	Max daily total (Ml/d)	Dry weather flow (Ml/d)	BOD: 5 Day ATU (mg/l)	Ammoniacal N (mg/l)	Suspended Solids 105 (mg/l) at C	Zone of influence (<500m)	Consideration of water quality pressure (during baseline low flow conditions)
AA0009401	Trevethin CSO, Church Lane, Pontnewynydd,	SO2767501786	0	0	0	0	0	30	Negligible
AB0064002	Llanfrechfa CSO, Ponthir, Torfaen	ST3216392838	0	0	0	0	0	25	Negligible
AD0007901	Hospital Rd CSO, o/s St Johns ambulance hall, Pontnewynydd	SO2761701842	0	0	0	0	0	5	Negligible
AD0010605	Abersychan (twyn y ffrwd) cso coed yr eos farm abersychan, pontypool	SO2719003936	0	0	0	0	0	2	Negligible
AD0014801	Coed Farm CSO, Cwmavon	SO2577008234	0	0	0	0	0	0	Negligible
AN0155301	Brookland Terrace Recreation Ground CSO, Cwmbran	ST2933296569	0	0	0	0	0	450	Negligible

Permit no.	Site Name	Location	Max daily total (Ml/d)	Dry weather flow (Ml/d)	BOD: 5 Day ATU (mg/l)	Ammoniacal N (mg/l)	Suspended Solids at 105 (mg/l)	Zone of influence (<500m)	Consideration of water quality pressure (during baseline low flow conditions)
AN0161801	Cwmavon cso, nr rose cottage, cwmavon rd, cwmavon	SO2701905809	0	0	0	0	0	2	Negligible
AN0250001	Pontypool (rosemary car park) cso	SO2822301010	0	0	0	0	0	2	Negligible
AD0015001	Forge side iron bridge picnic area nr forge side blaenavon	SO2493008740	0	0	0	0	0	0	Negligible
AC0108901	Blaenavon trunk sewer cso, playground of bridge street, blaenavon	SO2522408597	0	0	0	0	0	2	Negligible
AN0261001	Rosemary lane car park cso, pontypool	SO2823000970	0	0	0	0	0	2	Negligible
AN0261101	St albans school (cso) pontypool	SO2827000850	0	0	0	0	0	5	Negligible

B4 PHYSICAL ENVIRONMENT IMPACT SUMMARY

Potential impacts on the physical environment associated with the Afon Lwyd Drought Permit are summarised in **Table B4.1**.

Table B4.1 Summary of Potential Changes to the Physical Environment of the Impacted Reaches from Implementation of Afon Lwyd Drought Permit

Llandegfedd Reservoir	
Water levels in Llandegfedd Reservoir <i>Minor beneficial impacts in summer/autumn period</i>	<ul style="list-style-type: none"> The hydrological impact of this option is assessed as being minor (beneficial).
Afon Lwyd (Reach 1)	
Flows in the Afon Lwyd <i>Minor impacts during the period of implementation from September to November inclusive</i>	<ul style="list-style-type: none"> No reduction in flows is anticipated, but the hydrological impact has been assessed as minor due to localised ponding effects from the temporary weir which would be located at the proposed abstraction point.
Geomorphology <i>Negligible impacts in summer/autumn period</i>	<ul style="list-style-type: none"> Impacts on geomorphology in Reach 1 related to the ponding effects of the temporary weir are assessed as negligible.
Water quality <i>Low to medium risk in summer/autumn period</i>	<ul style="list-style-type: none"> Low risk linked to total ammonia and dissolved oxygen. Medium risk linked to soluble reactive phosphorus due to history of standard failure
Consented Discharges <i>Negligible impacts in summer/autumn period</i>	<ul style="list-style-type: none"> Negligible risk
CSOs <i>Negligible risk in summer/autumn period</i>	<ul style="list-style-type: none"> Negligible risk
Afon Lwyd (Reach 2)	
Flows in the Afon Lwyd <i>Major impacts in summer period (September); moderate impacts in winter period (October to November inclusive)</i>	<ul style="list-style-type: none"> The impact on hydrological reach 2 has been assessed as major in summer, with a 36% reduction in the summer Q₉₅ flow and a 59% reduction in the summer Q₉₉ flow. In winter months there is a 9.7% reduction in the year round median flow (Q₅₀) and a 30.9% reduction in year round low flow (Q₉₅); this is assessed as a moderate impact.
Geomorphology <i>Negligible impacts in summer/autumn period</i>	<ul style="list-style-type: none"> Impacts on geomorphology due to a reduction in the wetted depth during the operation of a drought permit have been assessed as negligible.
Water quality <i>Low to high risk during summer/autumn period</i>	<ul style="list-style-type: none"> Medium risk linked to total ammonia and low risk from dissolved oxygen. High risk linked to soluble reactive phosphorus due to standard failure and major hydrological impacts
Consented Discharges <i>Negligible impacts in summer/autumn period</i>	<ul style="list-style-type: none"> Negligible risk
CSOs <i>Negligible risk in summer/autumn period</i>	<ul style="list-style-type: none"> Negligible risk

B5 CUMULATIVE IMPACTS

The focus of this EAR is the Afon Lwyd drought permit. The assessment, as described in previous sections, has considered how the proposed drought permit may affect the environment in combination with the effects of existing licences and consents. In accordance with the DPG, the assessment also considers the potential cumulative effects of Welsh Water implementing other drought orders/permits within a similar timeframe. The potential for options to act in combination is set out in **Table B5.1**.

Consideration has also been given to the potential for cumulative impacts of drought options implemented by neighbouring water companies (see **Table B5.1**). The assessment of the potential for cumulative impacts of Welsh Water's supply side and drought order / permit options with drought options listed in neighbouring water companies' drought plans has also been undertaken as part of the Strategic Environmental Assessment (SEA) of Welsh Water's Draft Statutory Drought Plan. The SEA was informed by the most recent information available on the neighbouring water companies' drought plans.

Table B5.1 Cumulative Impacts of the Afon Lwyd Drought Permit with other Drought Options

Organisation	Potential In-combination Impacts	Further Consideration Required (Yes/No)
Welsh Water - other drought options in the SEWCUS Llwynon / Sluvad / Court farm WRZ / Afon Lwyd / River Usk catchments	8109-1 (Reduce compensation water releases from Llwynon Reservoir) – The impacts of this option do not occur within the same catchment and therefore no in-combination effects are anticipated.	No
	8116-3 (Utilise Talybont dead storage) - The Afon Lwyd tributary joins the River Usk below the tidal limit and therefore no in-combination effects with other River Usk catchment options are anticipated.	No
	8201-1 (Reduce Crai compensation) – The Afon Lwyd tributary joins the River Usk below the tidal limit and therefore no in-combination effects with other River Usk catchment options are anticipated.	No
Natural Resources Wales - Drought options in the Afon Lwyd / River Usk catchment	No previous drought order applications have been made in the South East Wales region.	No

APPENDIX C

ENVIRONMENTAL FEATURES

ASSESSMENT METHODOLOGY

A.1 ENVIRONMENTAL FEATURES ASSESSMENT METHODOLOGIES

The assessments undertaken in the EARs will use available environmental data. The following methodologies detail the preferred approach to impact assessment for the sensitive receptors identified in the screening process.

However, in certain circumstances the supporting data on hydrological conditions, habitat availability and species occurrence may not be currently available. In these cases, other supporting data will be used, where available, and the assessment will be undertaken using expert judgement. An example may be where flow-induced river habitat for fish would ideally be defined through the total wetted area, depth and flow velocities to describe the habitat preferences of a species and its lifestages. Where these data are currently unavailable, the use of habitat walkover, RHS and / or aerial survey data may be used in combination with judgements on the hydrological change resulting from the drought option (e.g. reduction in river flows) to arrive at a statement on habitat reduction and consequent impact on the fish species. The analysis will detail the increased uncertainty prevalent in the approach and will therefore adopt a precautionary approach to impact prediction (possibly assigning a higher impact where fewer substantiating data are available).

The gaps in data and evidence will be noted and monitoring proposals established.

Assessment sheets are included for the following features:

- Flow pressures
- Water quality pressures.
- WFD Status: Fish
- WFD Status: Aquatic macroinvertebrates
- Environment (Wales) Act Section 7 species, designated sites and other sensitive fauna and flora.

FLOW PRESSURES

Potential Effects

In support of understanding the physical environment and the risk assessment in the zone of influence of each drought option, a review will be undertaken of additional flow pressures from licensed surface water and groundwater abstractions. Relevant pressures have been identified and risk assessed in terms of in-combination flow impacts from implementation of a drought option. Abstractions have the potential to exacerbate low river flows or, in the case of groundwater-dominated catchments where rivers seasonally run dry (ephemeral watercourses), to increase the length of river that is dry and the period of time for which it remains so, potentially beyond the period for which the drought option is in place.

As a result of a drought option, there may be less water available in the zone of influence (rivers and groundwater bodies) for licence holders to abstract, and any abstractions that do occur reduce the amount of surface water available – affecting the wetted perimeter of the habitat, velocities within the wetted area and the ability to dilute any pollutants entering the system. For surface water abstractions, this includes consumptive abstraction and partially consumptive/non-consumptive abstraction – where some or all of the water is returned to the river locally after use, with the potential to reduce flow in the river if the discharge is downstream of the abstraction.

Definition of Risk

Continuously flowing watercourses

In order to define the potential risk to flow from river and groundwater abstractions in a readily understandable manner, a series of criteria have been defined. The assessment is informed by long term gauged flow data. The impact of the drought option will be considered against baseline ‘drought’ conditions (without drought option implementation). The assessment will use the following criteria, based on the potential severity of the risk to river water quality and flow during an ongoing drought.

- **High:** A major reduction in low river flows, including the influence of the drought option - typically >25% reduction in summer Q95 (with drought option in place)
- **Medium:** A moderate risk to low river flows (as above) , including the influence of the drought option - typically 10-25% reduction in summer Q95 (with drought option in place)
- **Low:** A minor risk to low river flows, including the influence of the drought option - typically <10% reduction in summer Q95 (with drought option in place)
- **Negligible:** Indicative of no significant change from the “without drought” option baseline situation.

Ephemeral watercourses

In line with the methodology for hydrology, an alternative approach to risk is required for

watercourses that naturally dry for part of the year that are potentially impacted upon by the drought option. Such watercourses are identified from previous investigations and available data. The assessment will use the following criteria, based on the potential severity of the risk to river water quality and flow during an ongoing drought.

- **High:** If the abstraction resulted in sections drying (with drought option in place) that would not (without drought option in place)
- **Medium:** If the abstraction resulted in sections drying earlier (by more than a handful of days) and/or returning to flow later (by more than a handful of days) and hence flow reduction occurring in the channel for more than just a handful of days (with drought option in place)
- **Low:** If the abstraction resulted in sections drying earlier (by just a handful of days) and/or returning to flow later (by just a handful of days) and hence flow reduction occurring in the channel for more than just a handful of days OR if the abstraction were a secondary flow driver (e.g. flow through gravels being primary cause of flow losses rather than the drought permit) (with abstraction in place)
- **Negligible:** Indicative of no significant change from the “without drought” option baseline situation.

Data Requirements

- Relevant zone of influence (as identified from screening)
- Surface water and groundwater abstraction licences in the zone of influence
- River flow representative of the zone of influence (daily gauged flow and spot flow surveys) – all available records
- Flow predictions and zones of hydrological impact for each drought option.

Assessment Methodology and Uncertainty

1. Identify relevant abstraction licences within the zone of hydrological impact for the drought option: both groundwater abstractions from the aquifer(s) impacted by the drought option (confined and unconfined) and surface water abstractions from the impacted river reaches.

Groundwater abstractions

2. For groundwater abstractions, identify which aquifer they abstract from and key characteristics of the aquifer (confined/unconfined) if available. List relevant details from each abstraction licence including licence number, holder, use, depth abstracted from and maximum daily abstraction rate.
3. Use depths of abstraction to identify which of these abstractions are likely to be affected by reduced groundwater levels in the aquifer with the drought option in place. If depth information is not available, take a precautionary approach and assume all abstractions within the relevant area (or, if known, from the relevant aquifer) are affected.
4. Calculate the maximum volume of groundwater abstractions from each aquifer at low flows (i.e. the sum of abstractions of sufficient depth from the aquifer) with a drought option in place.

5. Use expert judgement to assess the in-combination significance of these groundwater abstractions on river flows in impacted reaches (both continuously flowing and ephemeral watercourses), based on known (measured or modelled) relationships between groundwater levels and river flows in that area and the definition of risk set out above.

Surface water abstractions – continuously flowing watercourses

6. Assign relevant abstraction licences to an impacted river reach, and list relevant details from the licence including licence number, holder, use, type (consumptive or non-consumptive), location (mainstem or tributary) and daily maximum abstraction rate (including any Hands-Off Flow restrictions). Identify which of these abstractions are likely to be affected by reduced water levels in the river with the drought option in place.
7. Calculate the maximum volume of surface water abstractions in each reach at low flows (i.e. the sum of consumptive, unrestricted abstractions on the main stem of the river) as a proportion of summer Q95 river flow with a drought option in place.
8. Assess the in-combination significance of these pressures on river flow with respect to hydrological assessment methodologies described in Section 2.2.2 of the main report.
9. Use expert judgement to assess the significance of these pressures on river flows based on the definition of risk set out above.

Surface water abstractions – ephemeral watercourses

10. Assign relevant abstraction licences to an impacted river reach, and list relevant details from the licence including licence number, holder, use, type (consumptive or non-consumptive), location (mainstem or tributary) and daily abstraction maximum (including any Hands-Off Flow restrictions). Identify which of these abstractions are likely to be affected by reduced water levels in the river with the drought option in place.
11. Use expert judgement to assess the significance of these pressures on river flows based on the definition of risk set out above.

All abstractions

12. For both groundwater and surface water abstractions, incorporate any flow pressure risks identified as significant into the assessment of impacts on significant features and the selection of appropriate mitigation measures for the drought option.

WATER QUALITY PRESSURES

Potential Effects

In support of the physical environment understanding and risk assessment in the zone of influence of each drought option, a review will be undertaken of additional water quality pressures from consented surface water discharges. Discharges put pressure on water quality during a drought as lower than normal river flows mean that there is less water available to dilute discharges such as final effluent from STW. A drought option may exacerbate these low flows and contribute to a reduction in water quality, with potentially detrimental impacts on sensitive features in the impacted reach. Discharges impacting the oxygen balance and ammonia concentration (to support fish and macroinvertebrates, where these are identified as sensitive features) and soluble reactive phosphorus (SRP) concentration (to support macrophytes and algae, where these are identified as sensitive features) in the river have been reviewed.

Intermittent discharges from combined sewer overflows (CSOs) may also contribute to a reduction in water quality during an environmental drought. CSOs relieve strain on the sewers during storm events by temporarily diverting water into nearby watercourses to prevent sewer flooding. As there is usually a time lag between discharges from CSOs and rises in river levels during a storm event, the potential exacerbation of low flows by the drought option may decrease the amount of water immediately available to dilute CSO discharges, leading to a temporary reduction in river water quality if a storm event occurs during implementation of the drought option.

Definition of Risk

Continuously flowing watercourses

In order to define the potential risk to water quality from discharges into the river in a readily understandable manner, a series of criteria have been defined. The assessment will use the following criteria, based on the potential severity of the risk to water quality during an ongoing drought.

- **High:** A major risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); and exacerbation of the risk by the flow reduction from the drought option
- **Medium:** A moderate risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); or exacerbation of a minor risk by the flow reduction from the drought option
- **Low:** A minor risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); or exacerbation to a minor risk by the flow reduction from the drought option
- **Negligible:** Indicative of no significant risk without the drought option nor exacerbation of risk by the flow reduction from the drought option

Ephemeral watercourses

In line with the methodology for hydrology, an alternative approach to risk is required for

watercourses that naturally dry for part of the year that are potentially impacted upon by the drought option. Such watercourses are identified from previous investigations and available data. The assessment will use the following criteria, based on the potential severity of the risk to river water quality during an ongoing drought.

- **High:** A major risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); and exacerbation of the risk if the drought option resulted in sections drying (with drought option in place) that would not (without drought option in place)
- **Medium:** A moderate risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); or exacerbation of a minor risk by the flow reduction from the drought option occurring in the channel for more than just a handful of days.
- **Low:** A minor risk to water quality under low river flow conditions (without the drought option) which affects the suitability of the water quality to support *Good* or *High* status for fisheries and macroinvertebrates, macrophytes and algae (as relevant); or exacerbation to a minor risk by the flow reduction from the drought option occurring in the channel for just a handful of days.
- **Negligible:** Indicative of no significant risk without the drought option nor exacerbation of risk by the flow reduction from the drought option

Data Requirements

- Relevant zone of influence (as identified from screening)
- Surface water discharge consents in the zone of influence (including numeric water quality and flow conditions)
- Routine NRW / Environment Agency riverine water quality monitoring data for the water quality determinands dissolved oxygen saturation, SRP concentration and total ammonia concentration for relevant monitoring sites in the zone of influence and significant tributaries
- River flow representative of the zone of influence (daily gauged flow and spot flow surveys) – all available records
- Flow predictions and zones of hydrological impact for each drought option
- CSO locations and previous assessments of intermittent discharges from Welsh Water.

Assessment Methodology and Uncertainty

1. Identify sensitive features (fish, macroinvertebrates, macrophytes and algae) which may be impacted by the drought option. Use this information to determine whether assessment of oxygen balance, ammonia concentration and/or SRP concentration is required.
2. Identify all discharge consents within the zone of hydrological impact for the drought option.
3. Assign relevant discharge consents to an impacted reach, and list relevant details from the consent including consent number, holder, use, location (mainstem or tributary) and relevant numeric

consent conditions (Dry Weather Flow, BOD, ammonia (N), total phosphorous)¹.

4. Identify those discharge consents which relate to effluent from Welsh Water's sewage treatment works (STWs).

Continuously flowing watercourses

5. Model the maximum current contribution of each STW to BOD, ammonia (N) and total phosphorous concentrations (as relevant) in the river at low flows (based on the water quality consents, DWF and upstream flows).
6. Model the maximum potential increase in each STW's contribution to river BOD, ammonia (N) and total phosphorous concentrations (as relevant) at low flows as a result of the drought option (based on the water quality consents, DWF, upstream flows and maximum flow reduction from drought option).
7. Assess the potential risk that the STW could pose to river ammonia quality (using the consented discharge condition total ammonia) using modelled data and the appropriate matrix below. This combines an acknowledgement of existing conditions and potential variation as a result of the drought option.

Upland low alkalinity river		% increase in contribution as result of drought option(s)	
		< 20%	≥ 20%
Current contribution to ammonia concentrations at low flows ^a	< 0.2mgN/l	Minor	Moderate
	≥ 0.2mgN/l	Moderate	Major

^a Standards are WFD high/good threshold for ammonia (N) of 0.2mg/l for upland low alkalinity rivers².

Lowland high alkalinity river		% increase in contribution as result of drought option(s)	
		< 20%	≥ 20%
Current contribution to ammonia concentrations at low flows ^b	< 0.3mgN/l	Minor	Moderate
	≥ 0.3mgN/l	Moderate	Major

^b Standards are WFD high/good threshold for ammonia (N) of 0.3mg/l for lowland high alkalinity rivers³.

8. Assess the potential risk that the STW could pose to river oxygen balance (using the consented discharge condition BOD) using modelled data and the matrix below. This combines an acknowledgement of existing conditions and potential variation as a result of the drought option.

Upland low alkalinity river		% increase in contribution as result of drought option(s)	
		< 20%	≥ 20%
Current contribution to BOD concentrations at low flows ^c	< 1mg/l	Minor	Minor
	1-3mg/l	Minor	Moderate
	≥ 3mg/l	Moderate	Major

^c Standards are WFD high/good threshold for BOD of 3mg/l and good/moderate threshold of 4 mg/l for upland low alkalinity rivers⁴.

Lowland high alkalinity river		% increase in contribution as result of drought option(s)	
		< 20%	≥ 20%
Current contribution to BOD concentrations at low flows ^d	< 1mg/l	Minor	Minor
	1-4mg/l	Minor	Moderate
	≥ 4mg/l	Moderate	Major

^d Standards are WFD high/good threshold for BOD of 4 mg/l and good/moderate threshold of 5mg/l for lowland high

¹ Note that not all STWs have water quality consents relating to ammonia or total phosphorous (depends on size and location of STW). Consents are set with respect to total phosphorous rather than SRP.

² The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

³ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

⁴ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

alkalinity rivers⁵.

9. Assess the potential risk that the STW could pose to river phosphorous quality (using the consented discharge condition total phosphorous) using modelled data and the matrix below. This combines an acknowledgement of existing conditions and potential variation as a result of the drought option. Consents are set with respect to total phosphorous rather than SRP (on which WFD river standards are based), therefore this approach conservatively assumes that all phosphorous from STWs is reactive and has direct implications for ecology in the river.

Upland low alkalinity river		% increase in contribution as result of drought option(s)	
		< 20%	≥ 20%
Current contribution to ammonia concentrations at low flows ^e	< 0.2mgN/l	Minor	Moderate
	≥ 0.2mgN/l	Moderate	Major

^e Standards are WFD high/good threshold for SRP of 0.02mg/l and good/moderate threshold of 0.04mg/l for upland low alkalinity rivers⁶.

Lowland low alkalinity river ⁷		% increase in contribution as result of drought option(s)	
		< 20%	≥ 20%
Current contribution to ammonia concentrations at low flows ^f	< 0.03mgN/l	Minor	Moderate
	≥ 0.03mgN/l	Moderate	Major

^f Standards are WFD high/good threshold for SRP of 0.03mg/l and good/moderate threshold of 0.05mg/l for lowland low alkalinity rivers⁸.

Upland/ lowland high alkalinity river		% increase in contribution as result of drought option(s)	
		< 20%	≥ 20%
Current contribution to ammonia concentrations at low flows ^g	< 0.05mgP/l	Minor	Moderate
	≥ 0.05mgP/l	Moderate	Major

^g Standards are WFD high/good threshold for SRP of 0.05mg/l and good/moderate threshold of 0.12mg/l for upland/lowland high alkalinity rivers⁹.

10. Identify those discharges which relate to effluent from Welsh Water's combined sewer overflows (CSOs).
11. If required, carry out qualitative analysis using previous assessments of intermittent discharges to evaluate whether any CSOs are likely to present a significant water quality pressure as a result of the drought option.
12. Use expert judgement to assess the significance of these pressures on river flows based on the definition of risk set out above.
13. Incorporate any water quality pressure risks identified as significant into the assessment of impacts on significant features and the selection of appropriate mitigation measures for the drought option.

Ephemeral watercourses

14. Calculate the maximum concentrations of BOD, ammonia (N) and SRP (as relevant) in the final effluent of each STW under consented conditions (i.e. concentrations in the river with no natural dilution).

⁵ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

⁶ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

⁷ Note that "Lowland low alkalinity" is a category that only exists for SRP standards, and not for total ammonia or BOD.

⁸ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

⁹ The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

15. Identify those discharges which relate to effluent from Welsh Water's combined sewer overflows (CSOs).
16. If required, carry out qualitative analysis using previous assessments of intermittent discharges to evaluate whether any CSOs are likely to present a significant water quality pressure as a result of the drought option.
17. Use expert judgement to assess the significance of these pressures on river flows based on the definition of risk set out above.
18. Incorporate any water quality pressure risks identified as significant into the assessment of impacts on significant features and the selection of appropriate mitigation measures for the drought option.

WATER FRAMEWORK DIRECTIVE STATUS: FISH

Potential Effects
For WFD river waterbodies within the zone of influence of the drought option, where screening of the drought option has identified that the fish element of biological status is <i>High</i> or <i>Good</i> , the potential impact is to be investigated. This investigation is specific to the risk of deterioration below the <i>Good</i> status band to the <i>Moderate</i> status band, as advised by NRW / Environment Agency.
Definition of Impacts
<p>In order to define the potential WFD status impacts for fish in a readily understandable manner, a series of criteria have been defined. The assessment will use the following criteria, based on the potential severity of the drought option impacts during an ongoing drought.</p> <ul style="list-style-type: none"> • Major: A major impact is one that results in deterioration in the WFD classification of the waterbody, or specifically the fish biological element of the classification. • Moderate: A moderate impact on fish status occurs when the fish population is predicted to be materially influenced, including effects on density, abundance or community composition, but where no deterioration in WFD classification is predicted. Consideration should be given to the scale of the impact and the potential for recovery of the populations. • Minor: A minor impact occurs when there is a predicted impact on fish abundance, density or community composition that is within the usual variability for the site and which will recover within a short timescale. • Negligible: A negligible impact is one where the predicted impact will not result in a detectable change in the fish population.
Data Requirements
<p>Fish status baseline assessment requires data from standard NRW / Environment Agency monitoring programmes in the potentially impacted zone, and preferably in a control site outside of the zone of influence. Fish data should include species presence, abundance and density. Environmental supporting data should include habitat availability, hydrology (flow, velocity, wetted area (width and depth) as follows:</p> <ul style="list-style-type: none"> • Relevant study area (as identified in the screening report) • Hydrology at or close to the monitoring sites to link to fish data, including full flow hydrograph, wetted width and depth, velocity profile. Will include daily gauged flow and spot flow surveys, all available records • Meteorology (where flow data insufficient) from available NRW / Environment Agency rain gauges • Habitat data for the monitoring sites, which may include recent RHS or Habscore surveys • Routine NRW / Environment Agency water quality monitoring data (dissolved oxygen, BOD, ammonia, pH, hardness, water temperature, conductivity) representative of the study area.

Assessment Methodology and Uncertainty

The WFD classification for the waterbody will be identified and the reasons for classification established from the NRW / Environment Agency. The data used to support the assessment will be reviewed to ensure that the classification is accurate.

Baseline conditions for sites within the zone of influence of the drought option will be established through existing data. These will include graphing the hydrology, water quality, habitat and fish variation temporally over the monitored period.

The analysis will consider the relationship between fish status and the supporting environmental variables over the period, with an emphasis on changes to fish status and environmental conditions between low, average and high flow years. The purpose of the analysis is to establish whether fish status responds to changes in flow and associated environmental variables inter-annually relating to changes in flow, climate, quality (dissolved oxygen and temperature) and/or habitat quality and availability.

Having established the baseline conditions and variability outside the drought option conditions (care will be taken to avoid using periods in the baseline analysis within which a drought option may have been in operation), a prediction will be made of the changes in the supporting environmental variables (flow, habitat and water quality) resulting from application of the drought option. This will be undertaken for the hydrological data by overlaying the drought option flows over the baseline flow hydrograph, and, where cross sectional data are available, how the wetted width and depth will vary with the drought option. This can be extrapolated to the habitat data to consider whether the key features are compromised by the change in water depth.

Once the flow, habitat and water quality drought option predictions have been established, their implications for existing fish species will be assessed. The flow and habitat environmental envelope of the key fish species is known. The predicted changes in supporting environmental variables (flow, depth, velocity, habitat quality, dissolved oxygen levels and temperature) due to the drought option will be assessed against the fish population data. Where the supporting environmental variables for fish species are modified to take them outside of their preferred envelope it can be assumed that there will be a moderate or major impact on that fish population. Consideration will be given to the potential for density dependent mortality where data show that the fish population has an existing good density, and where the drought option reduces habitat availability significantly. The assessment will consider the scale and longevity of any fish status impacts. The WFD classification is calculated on a 3 year rolling basis. A deterioration in classification would require a long term (2+ breeding seasons) and significant effect on fish population structure to allow prediction of a deterioration in status.

Where data are not available the assessment will be undertaken using expert judgement and drawing on broad-scale evidence from other similar catchments if applicable.

The prediction of impacts of hydrological and water quality changes on aquatic ecology remains subject to significant uncertainty. This is exacerbated where few data or

surveillance data are used for impact assessment purposes. Lastly the environmental envelopes within which fish species can successfully exist, and the relationship between populations in stressed river conditions remains subject to debate. The assessment must therefore be undertaken in recognition that the outcome prediction will be subject to large potential variability. The study will therefore adopt a precautionary approach, with potential impact highlighted where doubt exists. Monitoring and mitigation proposals for the drought option can then be specified so that, should an option be enacted, the actual impact can be recorded and adaptive mitigation/management of the option undertaken to safeguard where possible the fish populations.

WATER FRAMEWORK DIRECTIVE STATUS: MACROINVERTEBRATES

Potential Effects
For Water Framework Directive (WFD) river waterbodies within the zone of influence of the drought option, where screening of the drought option has identified that the aquatic macroinvertebrate component of ecological status is <i>High</i> or <i>Good</i> , the potential impact is to be investigated. This investigation is specific to the risk of deterioration below the <i>Good</i> status band to the <i>Moderate</i> status band.
Definition of Impacts
<p>In order to define the potential WFD status impacts for aquatic macroinvertebrates in a readily understandable manner, a series of criteria have been defined. The assessment will use the following criteria, based on the potential severity of the drought option impacts during an ongoing drought.</p> <ul style="list-style-type: none"> • Major: A major impact is one that results in deterioration in the WFD classification of the waterbody, or specifically the macroinvertebrate biological element of the classification. • Moderate: A moderate impact on macroinvertebrate status occurs when the macroinvertebrate community is predicted to be materially influenced, including reduction in the LIFE score, or in community density +/- or abundance, but where no deterioration in WFD classification is predicted. Consideration should be given to the scale of the impact and the potential for recovery of the community. • Minor: A minor impact occurs when there is a predicted impact on macroinvertebrate abundance, density or composition that is within the usual variability for the site and which will recover within a short timescale. • Negligible: A negligible impact is one where the predicted impact will not result in a detectable change in the macroinvertebrate community.
Data Requirements
<p>The baseline for macroinvertebrates will be established from existing data together with a comparison of species flow preference and taxon abundance. The analysis will provide an assessment of the community type and its sensitivity.</p> <p>Macroinvertebrate status baseline assessment requires data from standard NRW / Environment Agency monitoring programmes in the potentially impacted zone, and preferably in a control site outside of the zone of influence. Macroinvertebrate data should include the LIFE and BMWP scores, together with abundance and density data where available. Environmental supporting data should include habitat availability, hydrology (flow, velocity, wetted area (width and depth) and other environmental variables as follows:</p> <ul style="list-style-type: none"> • Relevant study area (as identified by screening) • Hydrology at or close to the monitoring sites to link to macroinvertebrate data, including full flow hydrograph, wetted width and depth, velocity profile. Will include daily gauged flow and spot flow surveys, all available records • Meteorology (where flow data insufficient) from available NRW / Environment Agency

rain gauges

- Habitat data for the monitoring sites, which may include recent RHS or Habscore surveys, to calculate HQA / HMS.
- Routine NRW / Environment Agency water quality monitoring data (dissolved oxygen, BOD, ammonia, pH, hardness, water temperature, conductivity) representative of the study area.

Assessment Methodology and Uncertainty

Having established the baseline, the relative changes expected as a result of the drought actions (in relation to normal drought conditions) in river hydrology, geomorphology and water quality will be identified (see WFD fish assessment). An assessment will then be made of the habitat requirements of the key riverine macroinvertebrate communities present, using existing knowledge of their range of preferences. Depending on the resolution of baseline data available, detailed statistical analysis of the datasets may be possible. However, in some cases, where relatively limited spatial and/or temporal datasets are available, the impact assessment of the drought actions will be based on qualified expert judgement of the potential effects of the predicted changes in the environmental variables on the macroinvertebrate communities. The analysis is supplemented by consideration of the implications of environmental change on the key macroinvertebrate metrics, including LIFE scores.

The WFD macroinvertebrate classification for the water body will be identified and the reasons for classification established from the NRW / Environment Agency. The data used to support the assessment will be analysed to ensure that the classification is accurate.

Baseline conditions for sites within the zone of influence of the drought option will be established through existing data. These will include graphing the hydrology, water quality, and macroinvertebrate (ASPT and LIFE scores) variation temporally over the monitored period.

The analysis will consider the relationship between macroinvertebrate status and the supporting environmental variables over the period, with an emphasis on changes to status and environmental conditions between low, average and high flow years. The purpose of the analysis is to establish whether status responds to changes in flow and associated environmental variables inter-annually relating to changes in flow, climate, quality (dissolved oxygen and temperature) and/or habitat quality and availability.

Having established the baseline conditions and variability outside the drought option conditions (care will be taken to avoid using periods in the baseline analysis within which a drought option may have been in operation), a prediction will be made of the changes in the supporting environmental variables (flow, habitat and water quality) resulting from application of the drought option. This will be undertaken for the hydrological data by overlaying the drought option flows over the baseline flow hydrograph, and, where cross sectional data are available, how the wetted width and depth will vary with the drought option. This can be extrapolated to the habitat data to consider whether the key features are compromised by the change in water depth. These data may have been developed for the WFD fish status assessment and duplication of effort will be avoided.

Once the flow, habitat and water quality drought option predictions have been established, their implications for the existing macroinvertebrate community will be assessed. The linkage between flow and habitat environmental envelope for upland macroinvertebrate communities is subject to continuing debate but has been shown to be linked (see for example, Dunbar *et al* 2009; 2010). The predicted changes in supporting environmental variables (flow, habitat quality) due to the drought option should be assessed against the macroinvertebrate community LIFE scores. Consideration will be given to the relationships between flow, habitat and LIFE scores in the DRIED-UP research papers. The predicted relative change in Q_{95} low flow value for the drought option should be compared to the Q_{95} /reduction in LIFE score; HQA/reduction in LIFE score in Dunbar *et al* 2010 to develop an approximation of the scale of change in macroinvertebrate community that could be expected.

The assessment will consider the scale and longevity of any macroinvertebrate community impacts. The WFD classification is calculated on a 3 year rolling basis. A deterioration in classification would require a long term and significant effect on macroinvertebrate community structure to establish prediction of a deterioration in status.

Where data are not available the assessment will be undertaken using expert judgement and drawing on broad-scale evidence from other similar catchments within the reservoir group.

The prediction of impacts of hydrological and water quality changes on aquatic ecology remains subject to significant uncertainty. This is exacerbated where few data or surveillance data are used for impact assessment purposes. Lastly the environmental envelopes within which the macroinvertebrate community can successfully exist, and the relationship between populations in stressed river conditions remains subject to debate. For macroinvertebrates the evidence base for the prediction of flows and changes to LIFE score remain subject to significant debate. The assessment must therefore be undertaken in recognition that the outcome prediction will be subject to large potential variability. The study should therefore adopt a precautionary approach, with potential impact highlighted where doubt exists. Monitoring and mitigation proposals for the drought option can then be specified so that, should an option be enacted, the actual impact can be recorded and adaptive mitigation/management of the option undertaken to safeguard where possible the macroinvertebrate community.

NOTABLE SPECIES, DESIGNATED SITES AND OTHER SENSITIVE FAUNA AND FLORA

Potential Effects

Where screening of the drought option has identified that a notable species or designated site is present within the zone of influence of the drought option and screening has indicated that it is sensitive to the impacts of the drought option, the potential impact is to be investigated. Notable species are defined as Environment (Wales) Act Section 7 species or species with significant ecological sensitivity in the specified locality including species listed on IUCN red list and those not included in the red list which are nonetheless uncommon. This investigation will consider the habitat preferences of the species and its lifestages (if appropriate) and the impacts of the variation in flow (and consequent physical habitat and ecosystem) on these preferences. Potential effects are associated either 1) directly to a reduction in river flow; or 2) a reduction in water quality; 3) secondary effects of reduced velocity, for example on sediment characteristics.

Definition of Impacts

In order to define the potential impacts for sensitive ecological features in a readily understandable manner, a series of criteria have been defined. The significance of impacts upon the sensitive ecological feature will be identified following the Institute of Ecology and Environmental Management (CIEEM) Ecological Impact Assessment (EcIA) guidance¹⁰. The potential significance of the impacts is identified using the following:

- **Value of the Ecological Receptor** – each ecological receptor is attributed a geographic value based upon its legislative and conservation status, as identified in Table 1.

Table 1 Value of Ecological Receptor

Ecological Value	Example
International	Existing or warranting designation as a e.g SPA and/or of significant conservation status for Europe (e.g European Protected Species (EPS)).
National	Existing or warranting designation as a SSSI and/or of significant conservation status for England (i.e. identified as a NERC / Environment Act (Wales) Section 7 species).
Regional	Habitats or species valuable at a regional level and/or of significant conservation status for the region (e.g viable breeding populations of Nationally Scarce species).
County	For example, existing or warranting designation as a County Wildlife Site (CWS) and/or of significant conservation status for the county (e.g viable breeding populations of species of county/metropolitan rarities).
District	For example, habitats or species of significant conservation status for the district (e.g viable breeding populations of species listed as rare in the district or borough).
Parish (local)	Species whose presence is considered to appreciably enrich biodiversity within the context of the parish or local neighbourhood, including as a local recreational/educational resource.
Site (within zone of influence only)	Species which are so low grade or widespread so as to be considered as not contributing to biodiversity value outside the boundaries of the site.

- **Positive or Negative Impact** – all impacts are considered to be negative unless

¹⁰ CIEEM (2018) *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine*. Chartered Institute of Ecology and Environmental Management, Winchester.

otherwise stated in the feature assessment.

- **Extent** – the extent of the impact is covered as part of the magnitude consideration.
- **Magnitude** – the magnitude of the impact is identified using the criteria identified in **Table 2**

Table 2 Magnitude of Impact

Impact Magnitude	Description
High	There is a long-term large-scale (i.e. catchment) change in the ecological receptor and/or changes in the overall integrity of the ecological receptor.
Medium	There is a short-term large-scale change or long-term short-scale (i.e. reach) change in the ecological receptor, however no changes in the overall integrity of the ecological receptor.
Low	There is a short-term small-scale change in the ecological receptor, but its overall integrity is not impacted.
Negligible	No perceptible change in the ecological receptor.

- **Duration** – the duration of impact is considered to be for 6 months, which is the duration for which a drought option is implemented, unless otherwise stated.
- **Reversibility** – all impacts are considered to be reversible unless they are identified to have a likely impact upon the overall integrity of the ecological receptor.
- **Timing and Frequency** – the drought option could be implemented at any point in the year, however the different life stages of the sensitive ecological features will be taken into account. The assessment is based upon the operation of a single drought permit, with subsequent applications for a drought permit required to consider cumulative effects of multiple drought permits.
- **Probability** – all impacts are considered to be probable, unless otherwise stated.

Once the value of the ecological receptor, magnitude of impacts and other parameters listed above have been identified, these are used to inform the assessment of significance of impact on the ecological receptor.

Data Requirements

Sensitive ecological features baseline review requires data from standard NRW / Environment Agency monitoring programmes in the potentially impacted zone, and preferably in a control site outside of the zone of influence. Data should include species presence, abundance and density. It is likely that most fisheries data will be for O and O+ lifestages, with some indication of older echelons. Environmental supporting data should include habitat availability, hydrology and water quality as follows:

- Relevant study area (as identified in the screening report)
- Hydrology at or close to the monitoring sites to link to fish data, including full flow hydrograph, wetted width and depth, velocity profile. Will include daily gauged flow and spot flow surveys, all available records

- Meteorology (where flow data insufficient) from available NRW / Environment Agency rain gauges
- Habitat data for the monitoring sites, which may include recent RHS or Habscore surveys
- Routine NRW / Environment Agency water quality monitoring data (dissolved oxygen, BOD, ammonia, pH, hardness, water temperature, conductivity) representative of the study area
- Habitat preferences for the given sensitive ecological features will be described, against which habitat change can be assessed.

Assessment Methodology and Uncertainty

The NERC / Environment (Wales) Act Section 7 species status for the watercourses will be identified and the reasons for its inclusion in the NERC / Environment (Wales) Act Section 7 established from the relevant bodies (start with NRW / Environment Agency). The data used to support the Environment (Wales) Act Section 7 assessment will be reviewed to ensure that it is accurate.

Baseline conditions for sites within the zone of influence of the drought option will be established through existing data. These should include graphing the hydrology, water quality, habitat and fish variation temporally and, if multiple sites, spatially over the monitored period. The analysis will consider the relationship between sensitive ecological feature lifestages and the supporting environmental variables over the period, with an emphasis on changes to status and environmental conditions between low, average and high flow years. The purpose of the analysis is to establish whether the sensitive ecological features population responds to changes in flow and associated environmental variables inter-annually relating to changes in flow, climate, quality (dissolved oxygen and temperature) and/or habitat quality and availability.

Having established the baseline conditions and variability outside the drought option conditions (care will be taken to avoid using periods in the baseline analysis within which a drought permit may have been in operation), a prediction will be made of the changes in the supporting environmental variables (flow, habitat and water quality) resulting from application of the drought option conditions. Ideally this will be undertaken for the hydrological data by overlaying the drought option flows over the baseline flow hydrograph, and, where cross sectional data are available, how the wetted width and depth will vary with the drought option. This can be extrapolated to the habitat data to consider whether the key features are compromised by the change in water depth. In many cases these data are currently unlikely to exist and proxy measures such as RHS and/or aerial survey data will be used.

Once the flow, habitat and water quality drought option predictions have been established, their implications for the sensitive ecological features will be assessed. The flow and habitat environmental preferences of the sensitive ecological features will be described. The predicted changes in supporting environmental variables (flow, depth, velocity, habitat quality, dissolved oxygen levels and/or temperature) due to the drought option should be assessed against the sensitive ecological features population data.

Where data are not available the assessment will be undertaken using expert judgement and

drawing on broad-scale evidence from other similar catchments.

The prediction of impacts of hydrological and water quality changes on aquatic ecology remains subject to significant uncertainty. This is exacerbated where few data or surveillance data are used for impact assessment purposes. Lastly the environmental preferences within which species can successfully exist, and the relationship between populations in stressed river conditions remains subject to debate. The assessment must therefore be undertaken in recognition that the outcome prediction will be subject to large potential variability. The study will therefore adopt a precautionary approach, with potential impacts highlighted where doubt exists. Monitoring and mitigation proposals for the drought option can then be specified so that, the actual impact can be recorded and adaptive mitigation/management of the option undertaken to safeguard where possible the sensitive ecological features populations.

Habitat Preferences

Habitat Preferences		Unfavourable Habitat	Potential Impacts
Type/ Age Class	Description		
Atlantic salmon <i>Salmo salar</i> and Brown/Sea trout <i>Salmo trutta</i>			
Spawning	<ul style="list-style-type: none"> Clean and unconsolidated gravels typically in the transitional area between pools and riffles where the flow is accelerating and depth is decreasing 	-	Deposition of silt Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth
Nursery (fry and parr life stage)	<ul style="list-style-type: none"> Shallow areas with a low water velocity and pebble substrate, often at the margins of riffles 	<ul style="list-style-type: none"> Deep and/or high velocity habitats. 	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth Increased risk of entrainment into water intake Deterioration in water quality
Adults	Deep habitats that provide shelter including one or more of the following: <ul style="list-style-type: none"> submerged structures undercut banks overhanging vegetation < 50cm above the water surface water surface turbulence causing a broken surface Deep pools downstream of obstacles and sufficient water quantity through structures to enable passage across obstacles. 	<ul style="list-style-type: none"> Open and shallow habitats, but will use these during migration to reach spawning gravels. Habitats upstream of significant obstructions. 	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth Increased risk of entrainment into water intake Increased significance of barriers to impede migration as a result of decreased flows Deterioration in water quality
Brook lamprey <i>Lampetra planeri</i>			
Spawning	<ul style="list-style-type: none"> Clean, unconsolidated spawning gravels with suitable sheltering areas, usually located at the tail end of pools where flows are increasing. 	-	Deposition of silt Reduction in velocity, depth or wetted width resulting in exposure of river bed Increased water velocity and depth
Nursery	<ul style="list-style-type: none"> Areas of sandy silt with slow water velocity, often in the margins of watercourses, above the estuary. Variation in depth between 2 cm and 30 cm (>15cm is optimal) with a relatively high organic content. 	-	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth Increased risk of entrainment into water intake

Habitat Preferences		Unfavourable Habitat	Potential Impacts
Type/ Age Class	Description		
Adults	<ul style="list-style-type: none">Cover (stones and vegetation) in the vicinity of spawning gravels.		Deterioration in water quality
			Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
River lamprey <i>Lampetra fluviatilis</i>			
Spawning	<ul style="list-style-type: none">Clean and unconsolidated spawning gravels with suitable sheltering areas, usually located at the tail end of pools where flows are increasing.	-	Deposition of silt
			Reduction in velocity, depth or wetted width resulting in exposure of river bed
			Increased water velocity and depth
Nursery	<ul style="list-style-type: none">Areas of sandy silt with slow water velocity, often in the margins of watercourses, above the estuary. Variation in depth between 2 cm and 30 cm (>15cm is optimal) with a relatively high organic content.	-	Reduction in velocity, depth or wetted width resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Adults	<ul style="list-style-type: none">Suitable estuarine conditions, that is free from pollution and with suitable prey species available.Clear migration routes from the estuary to spawning grounds with suitable river flows and no barriers.	<ul style="list-style-type: none">Areas with significant pollution or limited prey availability.Habitats upstream of significant obstructions.	Increased significance of barriers to impede migration as a result of decreased flows
			Increased risk of entrainment into water intake
			Deterioration in water quality
Sea lamprey, <i>Petromyzon marinus</i>			
Spawning	<ul style="list-style-type: none">Clean and unconsolidated spawning gravels with suitable sheltering areas, usually located at the tail end of pools where flows are increasing.	-	Deposition of silt
			Reduction in velocity, depth or wetted width resulting in exposure of river bed
			Increased water velocity and depth
Nursery	<ul style="list-style-type: none">Areas of sandy silt with slow water velocity, often in the margins of watercourses, above the estuary. Variation in depth between 2 cm and 30 cm (>15cm is optimal) with a relatively high organic content.	-	Reduction in velocity, depth or wetted width resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Adults	<ul style="list-style-type: none">Suitable estuarine conditions, that is free from pollution and with suitable prey species available.Clear migration routes from the estuary to spawning grounds with suitable river flows and no barriers.	<ul style="list-style-type: none">Areas with significant pollution or limited prey availability.Habitats upstream of significant obstructions.	Increased significance of barriers to impede migration as a result of decreased flows
			Increased risk of entrainment into water intake
			Deterioration in water quality
Bullhead, <i>Cottus gobio</i>			
Spawning	<ul style="list-style-type: none">Coarse, hard substrate of gravel and stones.	<ul style="list-style-type: none">Deep, silty watercourses with high flow velocities and little or no cover.	Deposition of silt
			Reduction in velocity, depth and/or wetted width
			Increased water velocity and depth

Habitat Preferences		Unfavourable Habitat	Potential Impacts	
Type/ Age Class	Description			
Nursery	<ul style="list-style-type: none">Shallow, stony riffles		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth Increased risk of entrainment into water intake Deterioration in water quality	
Adult	<ul style="list-style-type: none">Sheltered sections created by woody debris, tree roots, leaf litter, macrophyte cover or larger stones.	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth Increased risk of entrainment into water intake Deterioration in water quality		
European eel, <i>Anguilla anguilla</i>				
Juvenile (<30cm)	<ul style="list-style-type: none">Wetland habitats within 30km of tidal limit with high diversity and cover of vegetation, soft substrates and high productivity.	<ul style="list-style-type: none">Low productivity watercourses with dominance of coarse substrates and low macrophyte cover and diversity.Habitats upstream of significant obstructions.	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth Increased risk of entrainment into water intake Deterioration in water quality	
Adult (>30cm, female >45cm)	<ul style="list-style-type: none">Deep, slow flowing watercourses and wetland habitats within 80km of tidal limit with high diversity and cover of vegetation, soft substrates and high productivity.		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased significance of barriers to impede migration as a result of decreased flows Increased water velocity and depth Increased risk of entrainment into water intake Deterioration in water quality	
Barbel <i>Barbus barbus</i>				
Spawning	<ul style="list-style-type: none">Run/glide flowLess than 50cm deepVelocities greater than 0.5m/sSubstrate composed of clean and uncompacted gravel		-	Deposition of silt Reduction in velocity, depth or wetted width resulting in exposure of river bed Increased water velocity and depth
Nursery	<ul style="list-style-type: none">Marginal shallow bays set back from or within margins of main channelDepths between 1cm and 30cmNo discernible to minimal flowSubstrate composed of >30% gravel and sand with low silt contentLack of or very little riparian shading			Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth Increased risk of entrainment into water intake Deterioration in water quality
Adults	<ul style="list-style-type: none">Commonly associated with stretches of clean gravel and macrophyte beds, showing a preference to relatively fast-flowing stretches in the middle reaches of larger rivers.The species also occupies deep water habitats at the foot of weirs,			Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Impedance to movement upstream Increased water velocity and depth Increased risk of entrainment into water intake

Habitat Preferences		Unfavourable Habitat	Potential Impacts
Type/ Age Class	Description		
	in the lee of large woody debris, rock ledges or other obstructions on the river bed.		Deterioration in water quality Increased water velocity and depth
Fine-lined pea mussel, <i>Pisidium tenuilineatum</i> and depressed river mussel <i>Pseudanodonta complanata</i>			
All life stages	<ul style="list-style-type: none"> Fine sediments of lowland rivers and canals, 	<ul style="list-style-type: none"> High velocity watercourses with coarse substrates. 	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
White-clawed crayfish <i>Austropotamobius pallipes</i>			
All life stages	<ul style="list-style-type: none"> Slow-flowing sections of stony rivers Boulder riffles in chalk or clay streams Submerged tree roots Debris dams Crevices in old or damaged submerged brickwork, stonework, cracked concrete or rotten wooden structures Un-mortared stone revetting which protects banks from erosion Stands of submerged and emergent aquatic plants Old gravel workings and chalk pits Good water quality 	<ul style="list-style-type: none"> Uniform clay channels Areas of deep or soft silt Dense filamentous algae Narrow fast-flowing channels Areas of sand and gravel, or bedrock, which are lacking in cobble or boulder (though they may feed in or commute through these areas) Pebble or cobble shingle regularly exposed by changing river levels Areas of armoured bed where the substrate is compacted by the river flow Acidic streams or ochreous drainage Poor water quality or salinity 	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth Increased risk of entrainment into water intake Transfer of non-native species or disease Deterioration in water quality

APPENDIX D

ENVIRONMENTAL FEATURES

ASSESSMENT

D1 INTRODUCTION

This appendix presents information regarding the environmental features associated with the Afon Lwyd drought permit. Baseline data and impact assessments are presented for environmental features that form part of the scope of the assessment (established by the screening exercise described in Section 3.2.2 of the Environmental Assessment Report (EAR) and results of which are summarised in Section 5.2). The features assessment presented in full below is summarised in Section 5.3 of the EAR. Points of interest referred to throughout the text in are indicated in **Figure D1.1**.

The approach to the assessment addresses the following: i) potential effects on each sensitive receptor; ii) definitions for impacts (adverse / beneficial), i.e. the significance criteria (quantitative and / or qualitative measures used to grade the severity of impacts of the drought permit for the impact criteria major, moderate, minor, negligible; following the requirements of the Drought Plan Guidance (DPG)); iii) the data requirements; iv) assessment methodology (including the treatment of uncertainty where the complete data requirements are not available).

The assessment of environmental features is informed by the assessment of the physical environment (which includes hydrology and hydrodynamics; geomorphology; and water quality). This is summarised in Section 4 and presented in full in **Appendix B**.

The ecological assessment has been undertaken recognising the Institute of Environmental Management and Assessment (IEMA¹²) and the Chartered Institute of Ecology and Environmental Management (CIEEM) study guidelines³. The assessment of impacts on other environmental receptors (e.g. recreation and landscape) has been carried out largely by qualitative expert judgement. Specific assessment methodologies for key environmental features are set out in **Appendix C**.

Desk-based assessments have been completed for each of the sensitive receptors in order to determine the magnitude of impact in the relevant lake and river reaches for the Afon Lwyd drought permit. Each feature assessment describes the analyses carried out and a statement of the assessed impact. All impacts are considered to be negative / adverse unless otherwise stated in the feature assessment.

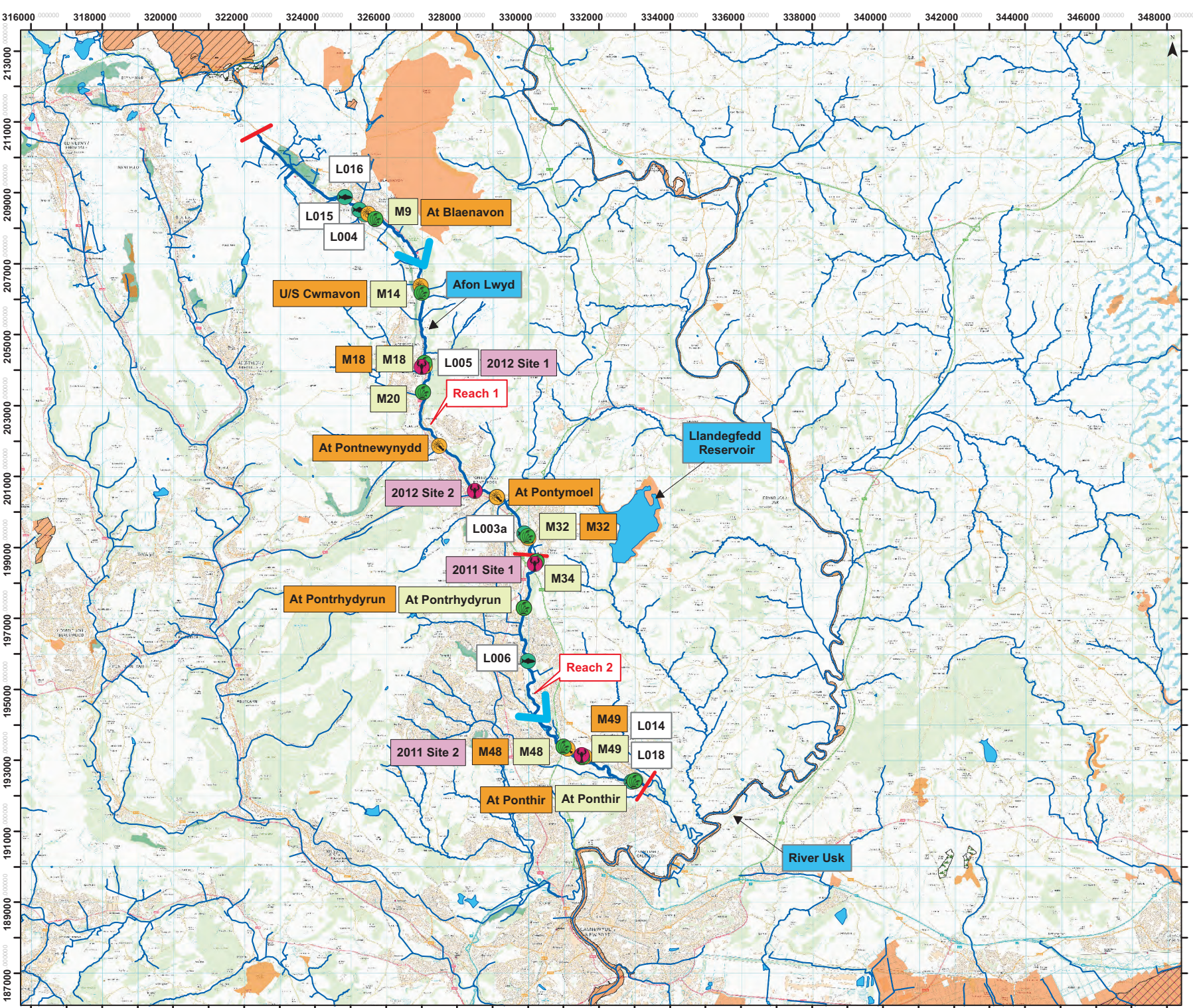
This appendix is set out in the following sections:

- Section D.2 Designated Sites
- Section D.3 WFD Status and Community Assessment
- Section D.4 Invasive Flora and Fauna
- Section D.5 Landscape and Recreation

¹ IEMA (2004) Guidelines for Environmental Impact Assessment.



² IEMA (2011) Special Report – The State of Environmental Impact Assessment Practice in the UK

³ CIEEM (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland.



Legend

- Hydrological Reach
- Water Courses
- Flow Direction
- Reservoir
- RAMSAR Site
- Site of Special Scientific Interest
- Special Area of Conservation
- Local Nature Reserve
- National Nature Reserve
- Area of Natural Beauty
- Fish Survey
- Macrophyte Survey
- White-clawed Crayfish Survey Site
- Macroinvertebrate Survey Site



1:100,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey Information
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Project Title: Welsh Water Drought Plan
Environmental Assessment

Figure Title: Environmental Features: 8109-4
Afon Lwyd
Increase in the aggregate abstraction

Figure Number: Figure D1.1	Date: February 2019
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D2 DESIGNATED SITES

D.2.1 River Usk SAC/SSSI

D.2.1.1 Baseline

There are no statutory designated sites within the zone of hydrological influence of the drought permit. The Afon Lwyd is, however, a tributary of the River Usk, which is recognised as an important conservation area both nationally and internationally, and is designated as both a Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). The confluence of the Afon Lwyd with the River Usk SAC is at Caerleon.

The Annex I habitats for which the River Usk SAC has been designated are:

- Water courses of plain to montane levels with the *Ranunculus fluitantis* and *Callitriche-Batrachium* vegetation.

The Annex II species for which the River Usk SAC has been designated are:

- Atlantic salmon *Salmo salar*;
- Twaite shad *Alosa fallax*;
- Allis shad *Alosa alosa*;
- Sea lamprey *Petromyzon marinus*;
- River lamprey *Lampetra fluviatilis*;
- Brook lamprey *Lampetra planeri*;
- Bullhead *Cottus gobio*;
- Otter *Lutra lutra*.

Natural Resources Wales (NRW) have assessed the condition status of the Annex I habitat as 'unfavourable: unclassified'. River lamprey, brook lamprey and otter have all been assessed as 'favourable'. Atlantic salmon, sea lamprey, bullhead and twaite and allis shad have been assessed as 'unfavourable: unclassified'⁴.

The impacted reaches of the Afon Lwyd drought permit are all located within the Afon Lwyd and therefore are not located within the River Usk SAC/SSSI. However, migratory fish species including anadromous fish species (those which migrate from the sea to freshwater to spawn) and catadromous fish species (those which spawn at sea and return to freshwaters as juvenile life stages) are present within the Afon Lwyd, and will migrate through the River Usk estuary between the confluence with the Afon Lwyd and the downstream boundary of the SAC/SSSI during upstream and downstream migrations. Impacts to these species within the zone of influence may foreseeably affect the fish population of the designated site. The mouth of the

⁴ Countryside Council for Wales (2008) *Core Management Plan Including Conservation Objectives, River Usk SAC*. 7 March 2008.

River Usk to the confluence with the Afon Lwyd is located within management unit 1 of the SAC. Fish species present in the Afon Lwyd which are SAC features of the River Usk are limited to Atlantic salmon, which is categorised as a feature for which the SAC should be sympathetically managed.

Table D2.1 Status of SAC features within Management Unit 1 – Lower Usk

River Usk (Lower Usk) SSSI	Management Unit
SAC Features	1
Sea Lamprey	KS
River Lamprey	Sym
Brook Lamprey	x
Twaite Shad	KS
Allis Shad	Sym
Atlantic Salmon	Sym
Bullhead	x
European Otter	KS
Rivers with floating vegetation often dominated by water-crowfoot	x
Key for Table D2.1	
KS	Key species in the management unit
Sym	Features of importance the unit but are not the main focus of management or monitoring. These features will benefit from management for the key feature(s) identified in the unit. These may be classed as 'Sym' features because: <ul style="list-style-type: none"> they are present in the unit but are of less conservation importance than the key feature; and/or they are present in the unit but in small areas/numbers, with the bulk of the feature in other units of the site; and/or their requirements are broader than and compatible with the management needs of the key feature(s).
X	Features not present in Management unit

There are six component SSSIs within the River Usk SAC. The reach of the River Usk at the confluence of the Afon Lwyd is designated as the River Usk (Lower Usk) SSSI. The River Usk (Lower Usk) SSSI is a rare example of a large mesotrophic lowland river which has not been subject to significant modification by man. Of particular significance to the river's morphology and biology are the extensive deposits of fluvio-glacial and alluvial material in the Usk valley between Abergavenny and Newport. The Lower Usk has developed a wide floodplain with a complex and active system of meanders, cut-off and back channels which contribute to the biological interest and diversity of the site. The site is designated for its plant and invertebrate communities and otter, as well as a wide range of migratory and non-migratory fish species. The SSSI incorporates adjacent areas of riparian habitat. The SSSI is designated for three migratory fish species, brown/sea trout *Salmo trutta*, European eel *Anguilla Anguilla* and Atlantic salmon, the latter also being a feature of the SAC.

D.2.1.2 Assessment

Implementation of the Afon Lwyd drought permit is expected to impact migratory fish species within the Afon Lwyd, which may impact fish populations which migrate into the River Usk SAC/SSSI. Assessment of the impacts on the features of the SAC/SSSI is detailed below.

Atlantic Salmon

The River Usk is an important migratory pathway for Atlantic salmon (both upstream-migrating adults and out-migrating smolt). In the section of the River Usk between the confluence with the Afon Lwyd and the mouth of the Usk, the watercourse is estuarine, and as such will be utilised primarily as a pathway to and from the sea with the species using tidal currents to migrate passively in their preferred direction⁵. Impacts to species within the Afon Lwyd are detailed in Section D.3.3.2.

Impacts detailed in Section D3.3.2 ultimately impact upon recruitment in the Lwyd, and therefore the River Usk and the condition of the associated designated site. Delays and possible cessation of adult migration due to reduced flows and obstruction caused by the sandbag weir would be expected to impair migration of adults out of the lower reaches of the Afon Lwyd in the upstream direction, although it would not impact migration through the River Usk itself. Water quality deterioration is associated with implementation of this drought permit, and would be expected to have impacts in tandem with those listed above.

Sea trout

The River Usk is also an important migratory pathway for sea trout. Impacts on the species are likely to be similar to those of the Atlantic salmon in nature and significance, as outlined above and in Section D3.3.2. However, sea trout migrate from freshwaters into estuarine and near shore areas, as such the species is likely to stay within the River Usk SAC/SSSI for a longer period of time. This does not influence the magnitude of impact on this species.

European eel

Impacts to this species are detailed within Section D.3.3.2. Elver will enter the River Usk in early spring and will migrate upstream into the Afon Lwyd throughout the year. Impacts to eel within the Afon Lwyd will not influence the migration of elvers from the sea into the Afon Lwyd. The downstream migration of mature (silver) eels tends to occur between September and December in most rivers, and there is therefore the potential for a significant impact on the out-migration of mature European eels.

⁵ Arahamian M. (1998) Movement of adult Atlantic salmon in the Usk estuary, Wales, Journal of fish biology, Volume 53, Issue 1, July 1998, Pages 221–225

Summary

In the context of the extent of potential impacts from the Afon Lwyd drought permit influencing features of the downstream River Usk SAC/SSSI, it is considered that the migratory fish species currently utilising the habitat provided by the Afon Lwyd provide only a very small contribution to the population of migratory fish in the River Usk SAC/SSSI. Therefore impacts from the implementation of the Afon Lwyd drought permit on the River Usk SAC/SSSI are assessed as **minor adverse**.

The potential impacts of the Afon Lwyd drought permit on the features of SAC and SSSI are summarised in **Table D2.2**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Section 4.3 of the main report) and the sensitivities of the key species of the designated site. The impacts presented in **Table D2.2** are related to fish species which may migrate between the designated site and the impacted reaches and represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D2.2 Summary of Impacts on Designated Sites

Feature	Impact	Significance of Impact
Reach 1 and 2		
River Usk SAC / Lower Usk SSSI	<ul style="list-style-type: none">Impacts on Atlantic salmon, brown/sea trout and European eel within the zone influence to impact upon the fish population of the designated site.	Minor

D3 WFD STATUS AND COMMUNITY ASSESSMENT / NERC SPECIES

D.3.1 Macrophytes

D.3.1.1 Baseline

Macrophyte surveys on the Afon Lwyd have been undertaken at a number of sites between 2004 and 2013. The data has been collected by NRW and Cascade Consulting on the behalf of Welsh Water. The sample sites, samplers and the year of data available is presented in **Table D3.1**.

Table D3.1 Macrophyte Survey Sites on the Afon Lwyd

Site Name	NGR	Sampler	Survey Year
Reach 1			
M9	SO2569308263	Cascade	2011
M14	SO2700706181	Cascade	2011
M18	SO2708104208	Cascade	2011, 2012
M20	SO2703503395	Cascade	2011
M32	ST2998199329	Cascade	2011, 2012
Reach 2			
M34	ST3024298607	Cascade	2011
AT PONTRHY DY RUN	ST2989097300	NRW	2004 and 2006
M48	ST3100793384	Cascade	2011, 2012
M49	ST3151893095	Cascade	2011, 2012
AT PONTIR	ST3300092420	NRW	2009, 2012 and 2013

Macrophyte analysis results were calculated using the standard LEAFACS2 methodology⁶ in accordance with the requirements of the Water Framework Directive (WFD). This methodology is based on the principle that different combinations, quantities, and numbers of macrophytes are associated with different flow conditions and nutrient availability in a river. The LEAFACS2 method assesses the condition of river macrophyte communities using data on presence and abundance of species and groups of species recorded during a standard survey comprising a 100m river section. These indices are briefly described below:

- (i) River Macrophyte Nutrient Index (RMNI): an index of eutrophication (high scores indicate enriched conditions);
- (ii) River Macrophyte Hydraulic Index (RMHI): an index of flow preference (high scores indicate low energy flows)
- (iii) Number of macrophyte taxa which are truly aquatic, i.e. hydrophytes (NTAXA);
- (iv) Number of functional groups of macrophyte taxa which are hydrophytes (NFG): an assessment of the structural diversity of the plant community; and
- (v) Percentage cover of all green filamentous algal taxa over the whole of the

⁶ WFD-UKTAG (2014) UKTAG river assessment method – macrophytes and phytobenthos (River LEAFACS2).

surveyed river sections (ALG).

RMNI and RMHI are biotic indices used to determine the nutrient preference and flow preference of macrophyte communities respectively and are updated versions of the MTR and MFR biotic indices. To calculate RMNI scores, macrophyte communities are identified and assessed on a scale of 1 to 10 based on individual species cover values and their combined preference for nutrient enrichment. High scores are associated with communities in eutrophic waters, low scores are associated with oligotrophic waters. Following the same premise communities with high RMHI scores are associated with low energy flow velocities and low scores are associated with high energy flow velocities. The available biotic index results for each survey occasion are presented in **Figure D3.2**.

Table D3.2 LEAFPAC2 Assessment Indices

River Name	Site	Date	RMNI	RMHI	NTAXA	NFG	ALG
Reach 1							
Afon Lwyd	M9	Aug-11	6.3	-	9.0	5.0	5.5
Afon Lwyd	M14	Aug-11	5.9	-	10.0	4.0	4.3
Afon Lwyd	M18	Aug-11	5.9	-	10.0	5.0	5.5
Afon Lwyd	M18	Jul-12	5.9	-	10.0	5.0	3.9
Afon Lwyd	M20	Aug-11	6.1	-	7.0	5.0	3.4
Afon Lwyd	M32	Aug-11	6.7	-	9.0	5.0	19.2
Afon Lwyd	M32	Jul-12	6.7	-	8.0	4.0	63.0
Reach 2							
Afon Lwyd	At Pontrhydyrun	Aug-08	7.7	6.72	6.0	4.0	0.6
Afon Lwyd	At Pontrhydyrun	Jul-06	6.6	6.31	3.0	3.0	0.1
Afon Lwyd	M34	Aug-11	6.0	-	10.0	5.0	7.5
Afon Lwyd	M48	Aug-11	6.7	-	8.0	4.0	8.0
Afon Lwyd	M48	Jul-12	6.5	-	8.0	4.0	17.6
Afon Lwyd	M49	Aug-11	6.9	-	7.0	4.0	9.2
Afon Lwyd	M49	Jul-12	7.2	-	6.0	3.0	38.0
Afon Lwyd	At Ponthir	Jun-09	7.8	6.57	6.0	4.0	17.6
Afon Lwyd	At Ponthir	Aug-12	6.9	6.38	7.0	4.0	17.5
Afon Lwyd	At Ponthir	Aug-13	6.7	6.32	9.0	6.0	17.6

RMNI scores from all sites across the monitoring period range from 5.9 to 7.8. This indicates the macrophyte community was consistent with the composition we would expect to find in mesotrophic to eutrophic waters. There appear to also be a trend for elevated RMNI scores in Reach 2 in comparison to Reach 1 with sites in this reach, particularly at M14 and M18, reflecting relatively lower nutrient preference. At Pontrhydyrun and At Ponthir, RMHI scores range from 6.31 to 6.72 across the five survey occasions, this indicates that the macrophyte community at these sites are consistent with that found in waterbodies with moderate energy flows.

During the 2011 and 2012 surveys, the water was predominantly clear and considered to be at near 'normal' summer levels. The river had higher water levels during the present survey than

the previous survey in 2011. Also, it was noted that there were fewer macrophytes found at the edges of bars or along the base of the bank, which is likely to be due to relatively recent high flows and wash-out.

The river macrophyte community reflects the underlying geology (mudstone and hard limestone) and indicates base-rich, water chemistry. Typical species include *Cinclidotus fontinaloides*, *Cladophora glomerata*, *Rhynchostegium (Platyhypnidium) riparioides* and *Leptodictium riparium*. The watercourse is characteristic of a bryophyte-dominated river and included only relatively sparse marginal herbs along the bars. Channel macrophytes were predominantly sparse, due to shading and water force (e.g. spates and mobile substrate). In addition, the influence of urbanisation and channel modification affected channel structure and water quality in most of the sections surveyed.

Apart from bryophytes, the channel flora frequently included abundant filamentous algae and there was some evidence for the influence of nutrient inputs e.g. a milky grey tint to the river water was observed at M32. Moderately eutrophic conditions are indicated by the extent of filamentous algae at some locations. River banks were generally tree-lined, but frequently included non-native species such as Himalayan balsam *Impatiens glandulifera* and Japanese knotweed *Fallopia japonica*.

The macrophyte community within the zone of influence of the drought permit is not subject to any conservation designations, and are considered to be of local/site importance and therefore, minor environmental sensitivity.

Notable Species

There were no notable macrophyte species recorded in the available survey data provided by NRW and Cascade Consulting.

D.3.1.2 Assessment

Reach 1

Reach 1 will not experience a reduction in flow during implementation of the Afon Lwyd drought permit, however a localised area upstream of the temporary weir may become impounded and slow flowing. The reduction in velocity is likely to increase siltation and promote the growth of marginal species which thrive in slow flowing and stable conditions, such as *Oenanthe crocata* and algae (*Cladophora glomerata* and filamentous green algae). These species may outcompete species which need higher velocities. This change in community structure within the impacted section of Reach 1 towards species with preference for relatively low energy flows would likely be reflected by higher RMHI scores. This index is not a component of the WFD classification through the LEAFACS2 tool, although it does provide an insight into flow factors which may influence change in community composition. Due to the steepness of the upper catchment, the area impacted by the ponded reach is

predicted to be small and as a result the magnitude of this impact on the macrophyte community in this reach is negligible.

The risk of water quality deterioration associated with soluble reactive phosphorus (SRP) has been assessed as medium for the 50m of impoundment in Reach 1. In this reach the macrophyte community is considered to be sensitive to nutrient enrichment, as evidenced by relatively low RMNI scores indicating community preference to mesotrophic conditions. Increased SRP concentrations could increase the occurrence of more opportunistic, nutrient tolerant taxa, epiphytes, and filamentous algae. In turn, this could affect macrophyte condition or potentially community composition if slower growing species or those that prefer lower nutrient conditions are outcompeted. The drought order could be implemented from September to November, which is largely outside of the macrophyte growing season and is therefore unlikely to pose a significant risk to this life stage. Overall, considering the small extent of the affected reach, the time of year that the permit is likely to be implemented, and the short term, temporary duration, the impact to the macrophyte community is assessed as being **negligible**.

Reach 2

Reach 2 is where the largest flow reductions would occur. The drought baseline would have significantly reduced the wetted width and depth of the river, exposing many macrophytes such as bryophytes. However, bryophytes are generally well adapted to tolerate desiccation and rewetting and communities can take a long time to react to changes in environmental conditions⁷. Marginal species, such as *Apium nodiflorum*, *Mentha sp.* and *Oenanthe crocata* are likely to spread out into the channel to occupy this new habitat provided there is sufficient soil moisture. This may bring additional benefits such as the narrowing of the river flow. However, there is significant shading at a number of sites which will limit macrophyte growth.

The risk of water quality deterioration associated with SRP has been assessed as high. In this reach the baseline macrophyte community is considered to be tolerant of eutrophic conditions, as evidenced by the relatively high RMNI scores provided in the available data. Further increases in SRP concentration as a result of the implementation of this drought permit will further favour nutrient tolerant taxa, and in the short term increase proliferation of filamentous algae species. Species less tolerant of high nutrient levels are expected to reduce in abundance. The drought order could be implemented from September to November, which is largely outside of the macrophyte growing season and is therefore unlikely to pose a significant risk to this life stage.

Given the limited duration and time of year for implementation of the drought permit, it is expected that any effects on the macrophyte community would be reversed following a return

⁷ Demars, B. O. L. and Britton, A. (2011). Assessing the impacts of small scale hydroelectric schemes on rare bryophytes and lichens. *Scottish Natural Heritage and Macaulay Land Use Institute Funded Report. Scottish Natural Heritage Commissioned Report No.421*

to the normal hydrological regime. Therefore, the impacts of the drought permit on the macrophyte communities of Reach 2 are expected to be **moderate adverse**, short term, and reversible.

Summary

The potential impacts of the Afon Lwyd drought permit on the macrophyte community are summarised in **Table D3.3**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability; see Section 4.3 of the main report) and the sensitivities of the macrophyte community. The impacts presented in **Table D3.3** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.3 Summary of Impacts on Macrophyte Community

Feature	Impact	Significance of Impact
Reach 1 - Source to the temporary abstraction point		
Macrophytes	<ul style="list-style-type: none"> Increased water depth, siltation and growth of marginal plants Decrease in species diversity and smothering of macrophytes by filamentous algae due to increase in soluble reactive phosphorous 	Negligible
Reach 2 – Temporary abstraction point and the tidal limit		
Macrophytes	<ul style="list-style-type: none"> Reduction in wetted area and velocities. Desiccation of some species such as bryophytes Increase in marginal species Decrease in species diversity and smothering of macrophytes by filamentous algae due to increase in soluble reactive phosphorous 	Moderate

There is a risk of short-term deterioration in status of the macrophyte component of the Afon Lwyd - below Mon and Brecon Canal Water Framework Directive (WFD) waterbody (GB109056032911) due to implementation of the Afon Lwyd drought permit. The waterbody is currently assessed as Moderate and the macrophyte element assessed as High under the 2018 cycle 2 interim WFD classification. Impacts of drought permit have been summarised as negligible to moderate adverse, short-term, temporary and reversible. Consequently, the macrophyte component of these waterbodies is considered to be at **minor** risk of short-term deterioration. Afon Lwyd - source to Mon and Brecon Canal (GB109056032912) has not been classified for macrophytes under WFD.

D.3.2 Macroinvertebrates

D.3.2.1 Baseline

Baseline data was provided by NRW for seven macroinvertebrate sites within the impacted reaches of the Afon Lwyd drought permit. For this data set sample dates range between 1990 and 2014 and samples were collected during spring and autumn seasons.

Further to this in 2011 and 2012 macroinvertebrate monitoring was carried out by Cascade

Consulting on the behalf of Welsh Water at four sites in spring, summer and autumn seasons. Two sites represent ‘impact’ sites, downstream of the temporary weir location, and two sites are located upstream of the temporary weir, and are considered to be control sites. Four additional sites were surveyed previously in 2011 although monitoring of these sites was discontinued as these sites were located upstream of the temporary weir, and as such these sites were excluded from this assessment. All NRW and Welsh Water sites are detailed in **Table 3.4.**

Table 3.4 Macroinvertebrate Survey Locations and Date of Survey

Site	NGR	Sampler
Reach 1		
AT PONTNEWYNYDD	SO2750001870	NRW
AT PONTYMOEL	SO2912000420	NRW
AT BLAENAVON	SO2550008410	NRW
U/SCWMAVON	SO2697106379	NRW
M18	SO2708504112	Cascade
M32	ST3001799260	Cascade
Reach 2		
AT PONTRHYDYRUN	ST2989097300	NRW
AT PONTIR	ST3300092420	NRW
AT PONTYMOEL	SO2912000420	NRW
M48	ST3111893332	Cascade
M49	ST3159693097	Cascade

These datasets are used to calculate a series of standard biotic indices; Biological Monitoring Working Party (BMWP) scores, Average Score Per Taxon (ASPT) scores, Lotic Invertebrate Flow Evaluation (LIFE) and number of taxa. NRW data are displayed in Figures **D.3.1, D.3.2 and D.3.3** and Welsh Water data is detailed in Figure **D.3.4.**

Figure D.3.1 Observed Family LIFE Score Sites on the Afon Lwyd

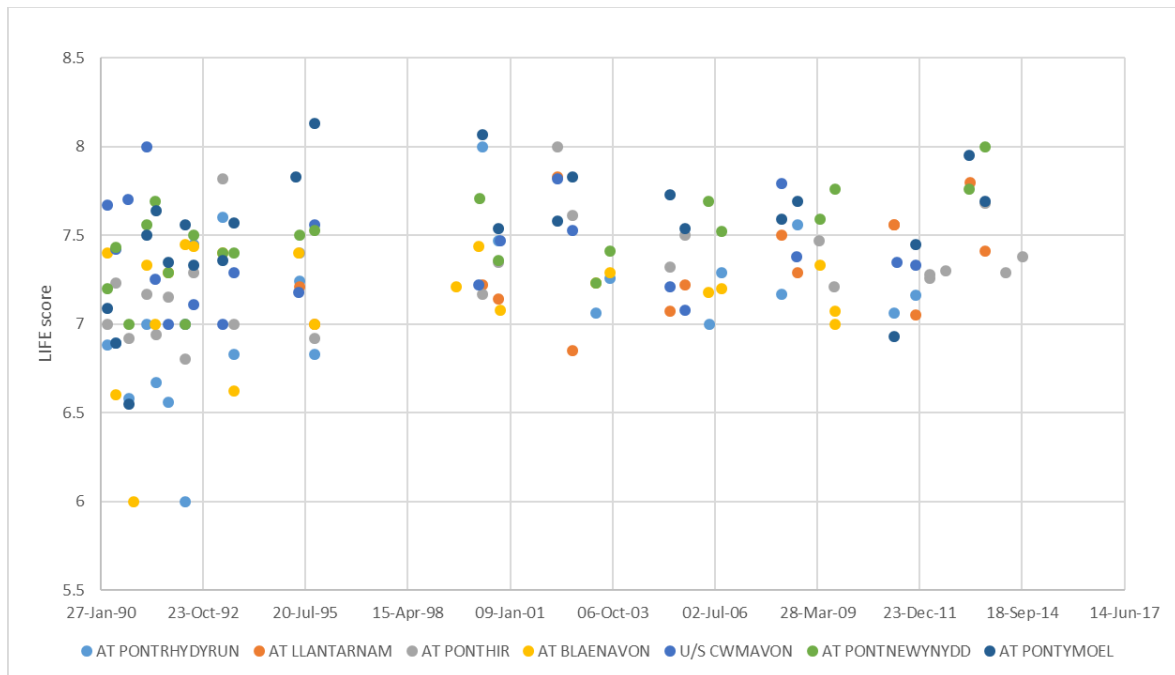


Figure D.3.2 Observed Family ASPT Score for Afon Lwyd

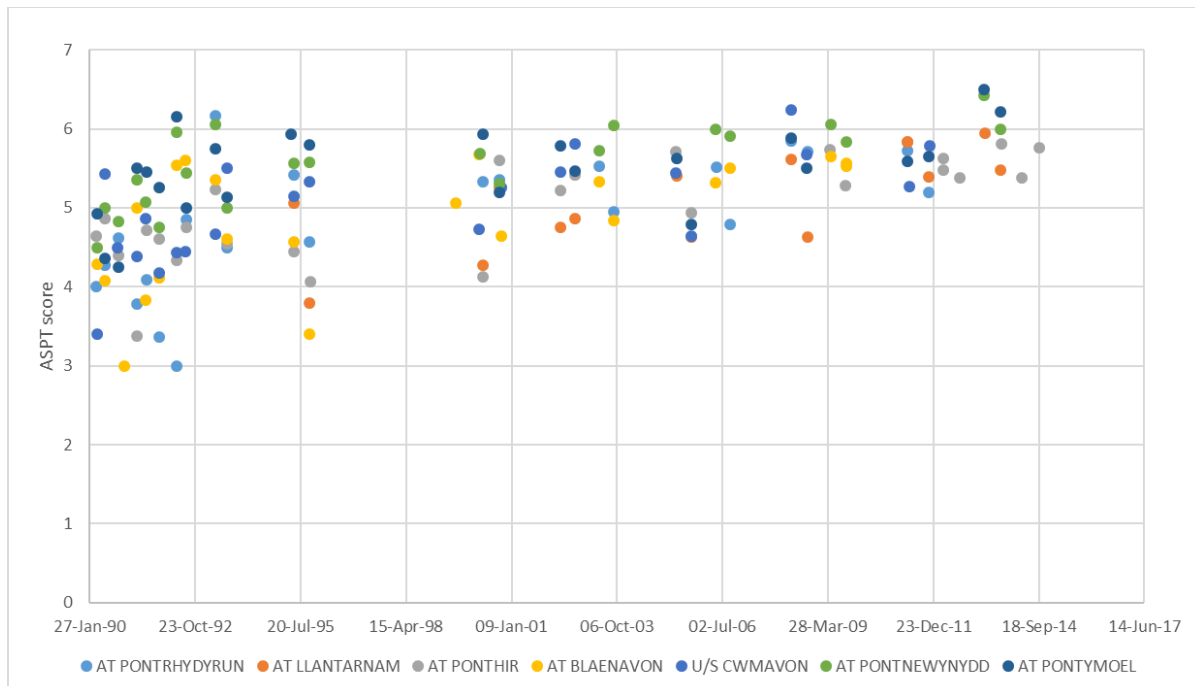


Figure D.3.3 Observed Family BWMP Score for Afon Llyd

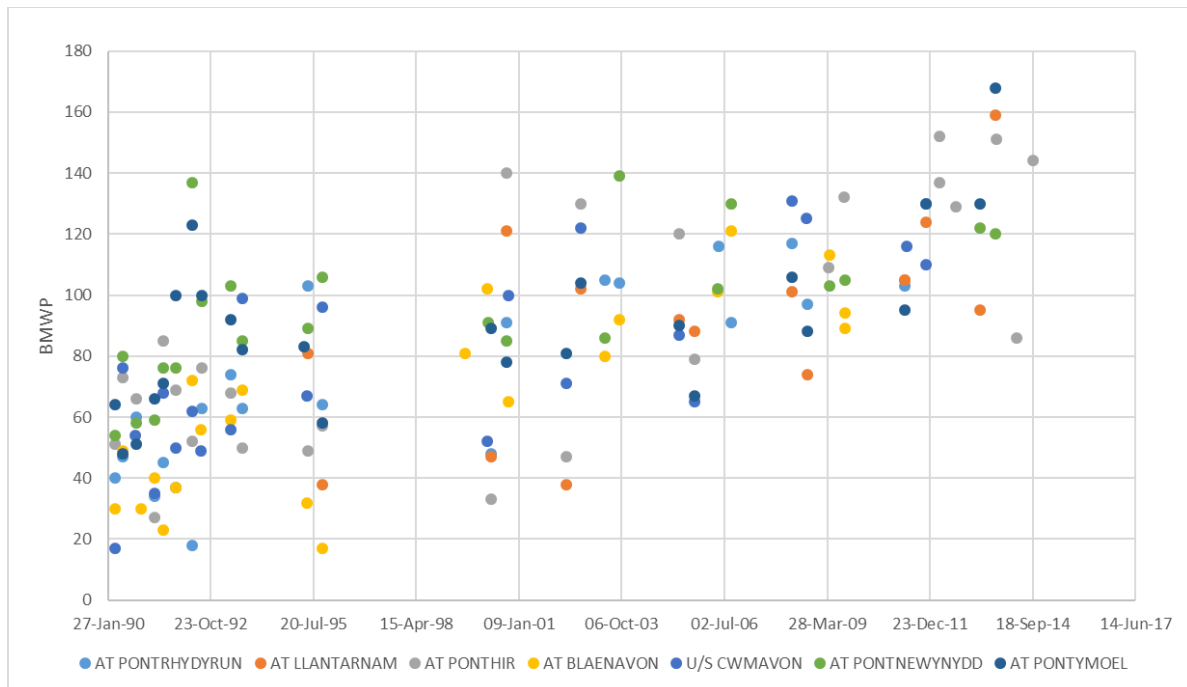
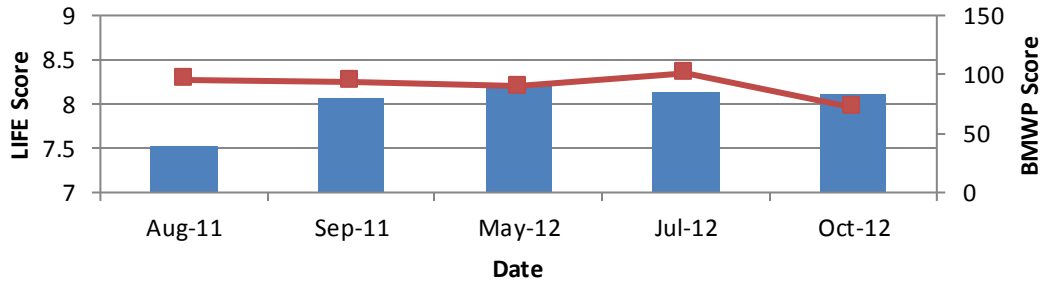
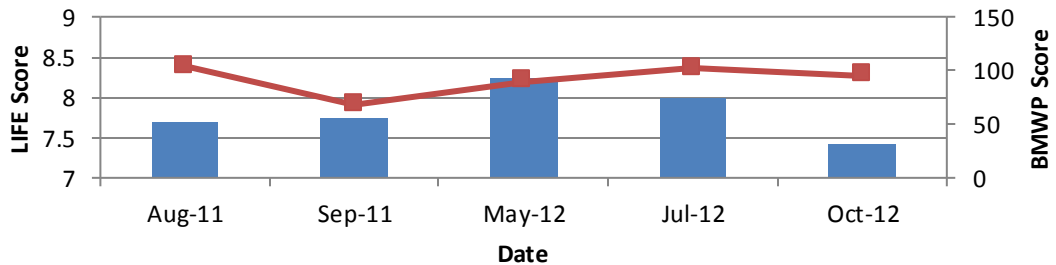


Figure D.3.4 Macroinvertebrate Indices from August 2011 to October 2012 from Sites M18, M32, M48 and M49.

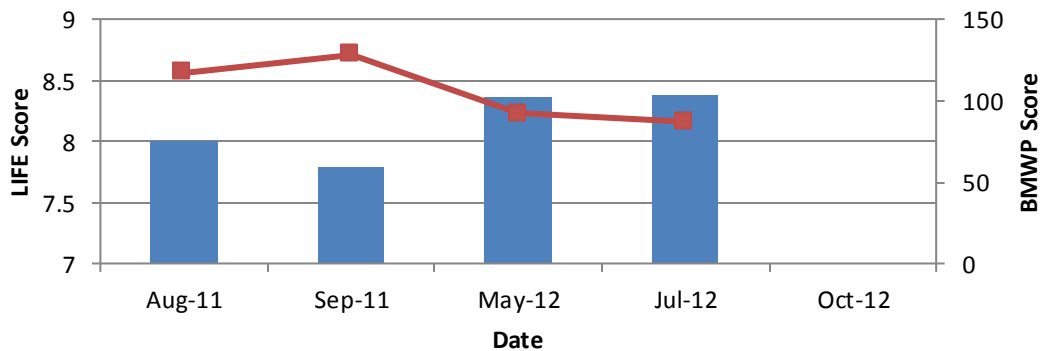
Site M18



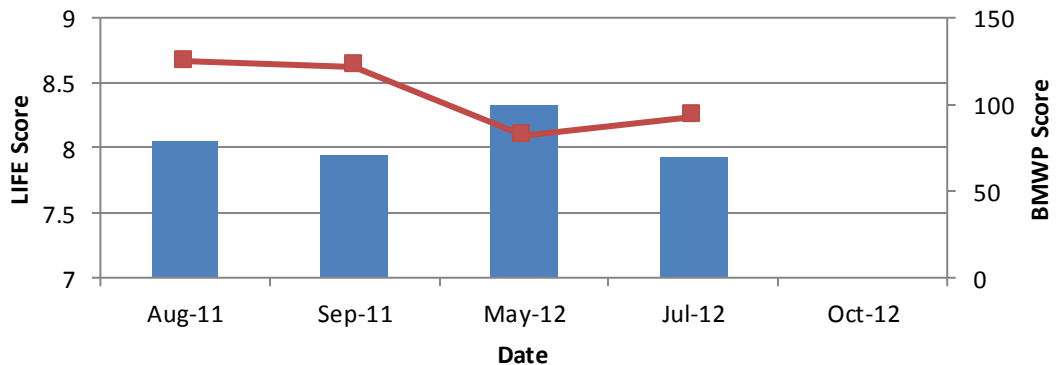
Site M32



Site M48



Site M49



The LIFE scores obtained from NRW data and Welsh Water's data indicate the presence of invertebrate families that predominantly prefer high energy flows, with a community that has moderate to high sensitivity to reductions in flow velocity. The LIFE scores across the

monitoring period suggest an increased sensitivity to flow reductions post 2000. This indicates that the community present post 2000 was composed of a higher proportion of taxa with preference for high energy flow, relative to the community present pre 2000.

There are no quality bands for BMWP scores and ASPT scores. However, as a guide, BMWP scores of 200 with ASPT values above six are indicative of rivers of exceptionally good quality, while BMWP scores of 100 with ASPT values of five are indicative of reasonably good water quality.

The NRW data describes ASPT scores between 3 and 6.5, indicating that pressures such as organic pollution may have been acting upon the invertebrate community historically. However, there has been a significant improvement over time where post 2000 most of the ASPT scores are at four and since 2009 above five, indicating an increase in the proportion of taxa sensitive to pressures including organic pollution in the reach. BWMP has also shown a similar increase over time, further suggesting water quality improvements. Welsh Water's data appears to support these findings with BMWP scores which are consistently around 100 at the four sampling locations. ASPT scores were not available for this data set. Overall there is evidence that the community is likely to be reduced below what would be expected in pristine conditions and this may be associated with chronic water quality pressures within the waterbody, however this cannot be substantiated based upon the available data and such pressures appear to have alleviated over time. Presently the invertebrate community is considered to be moderately sensitive to pressures including water quality deterioration and highly sensitive to flow reductions.

Notable Species

The notable species of gastropod *Omphiscola glabra* was recorded at the site At Ponthir in 2014. One specimen was present in the sample. This species is listed in NERC Act Section 42 as a species of principal importance as well as being listed on the IUCN red list as near threatened. At Ponthir is located at the bottom of Reach 2.

D.3.2.2 Assessment

Reductions in flow regime can impact macroinvertebrate communities either through physical habitat loss (e.g. changes to wetted width etc) or changes to habitat parameters (e.g. flow, sediment dynamics, water quality etc). These changes can result in reductions in populations, or shifts in community structure, i.e., from a predominance of species which favour fast flowing environments to a predominance of those species which are adapted for slow flowing environments. However, in lotic environments, macroinvertebrates can quickly recolonise once suitable conditions are restored due to immigration from upstream habitats.

Baseline macroinvertebrate data for the Afon Lwyd indicate that the community present is indicative of average to good water quality conditions. An increasing trend in BMWP and ASPT scores were observed at all sites, indicative of water quality improvements. The community

includes several species which favour relatively high velocity habitats, including stoneflies and mayflies. It is noted that during a natural drought prior to implementation of a drought permit, the macroinvertebrate community will naturally experience low flow conditions.

Reach 1

Reach 1 is upstream of the drought permit abstraction location, as a result the drought permit does not reduce the flow regime beyond the drought baseline. However, the temporary weir will have a local ponding effect, increasing wetted depth and wetted width, while reducing velocities and potentially increasing fine sediment deposition. The extent of this ponding will be dependent on the height and siting of the sandbags, which themselves will form a physical barrier in the river. The ponding effect will primarily affect macroinvertebrates which prefer faster flow conditions. The upper reaches of the river are steep and therefore the ponding effect created by the weir is likely to be limited to a small reach.

In addition to effects on velocity and habitat availability, the drought permit has been assessed as having a low risk to deterioration of ammonia and dissolved oxygen concentrations in Reach 1, which has the potential to affect macroinvertebrate communities during drought permit implementation. This may manifest as a marginal reduction in pollution sensitive taxa in this reach. Taxa from mayfly, stonefly and caddisfly orders with requirements for high dissolved oxygen levels would be most susceptible. BMWP and ASPT scores from a community impacted by this pressure will be slightly reduced. A number of crustacean taxa such as freshwater shrimps (Gammaridae) are particularly sensitive to ammonia. Consequently, there is potential that in the short-term this impact will modify the macroinvertebrate community with a reduction in abundance of ammonia sensitive species. Soluble Reactive Phosphorus (SRP) is not expected to have a direct impact on the macroinvertebrate community, although significantly elevated concentrations can lead to accelerated growth of algae and other plants. The impact on the composition and abundance of plant species can have adverse implications for other aspects of water quality, such as dissolved oxygen levels and thereby indirectly impacting macroinvertebrates. The medium risk to SRP in the reach is not expected to lead to significant impacts to macroinvertebrates through this pathway. Overall, the impact on the macroinvertebrates for Reach 1 has been classified as **negligible**.

Reach 2

Reach 2 is where the largest hydrological impact would occur. The drought permit will reduce the wetted width and depth beyond that of the drought baseline between the months of September and November (inclusive). This effect will mostly affect flow sensitive taxa, including stonefly, mayfly, and caddisfly taxa such as Heptageniidae and Rhyacophilidae. It is likely that in the short-term, this impact will modify the macroinvertebrate community, with a loss of species which prefer fast flows and proliferation of invertebrates which favour slow flows. The drought permit is most likely to affect species with a spring emergence as the larval stages are likely to be present during the autumn and winter period.

Marginal habitats are the most sensitive to flow reduction, with many slow-flow favouring species such as *Sphaeriidae* utilising this habitat. Depending on the rate of flow reduction, species in these marginal sediments may become stranded and ultimately die.

In Reach 2, dissolved oxygen has also been assessed as being of low risk of deterioration, whereas ammonia has been assessed as a medium risk of deterioration. This elevates the impact to ammonia sensitive taxa and may result in further impairment to macroinvertebrate BMWP and ASPT scores. While SRP is not expected to have a direct impact on the macroinvertebrate community, considering the high risk of deterioration to SRP in Reach 2 indirect effects as specified in Reach 1 are likely to have a significant impact upon the macroinvertebrate community.

Restoration of favourable ammonia and dissolved oxygen conditions is expected following recovery of flow. Hence given the ability of macroinvertebrate communities to recover as a result of effective re-colonisation strategies, the magnitude of impact of water quality changes is considered to be medium to low.

Overall, considering the composition of the baseline macroinvertebrate community, the short-term, temporary and reversible hydrological impacts of the drought permit and the effective re-colonisation strategies of macroinvertebrate species, impacts are on the macroinvertebrate community are assessed as **moderate adverse** for Reach 2.

Notable Species

Impacts in Reach 2 include a reduction in wetted width, reduced flow velocity and risk of deterioration to water quality, particularly ammonia concentrations. *Omphiscola glabra* is a species of Lymneidae which is adapted to inhabit temporary freshwater habitats such as ponds, pools and ditches. The species is well adapted to temporary drought as they bury into soft mud, becoming inactive until their habitat becomes wet again⁸. As such, physical habitat changes to widths and depths of the Afon Lwyd drought permit are unlikely to impact the species. The sensitivity of the species to ammonia and dissolved oxygen is not known, and no BMWP score can be attributed to the species. However, their family taxon *Lymnaeidae* has a BMWP score of 3, indicating tolerance to organic pollution. A cause of their decline nationally has been attributed partially to pollution, and as such they are expected to be sensitive to any deterioration in water quality in Reach 2. Overall impacts to this species are expected to be **minor adverse**.

Summary

The potential impacts of the Afon Lwyd drought permit on the macroinvertebrate community are summarised in **Table D3.5**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical

⁸ Buglife (2013) Species Management Sheet, Pond mud snail,
https://www.buglife.org.uk/sites/default/files/Pond%20mud%20snail_o.pdf Accessed 17/11/2016

environment (including geomorphology, water quality and likely habitat availability; see Section 4.3 of the main report) and the sensitivities of the macroinvertebrate community. The impacts presented in **Table D3.5** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.5 Summary of Impacts on Macroinvertebrate Community

Feature	Impact	Significance of Impact
Reach 1 - Source to the temporary abstraction point		
Macroinvertebrates	<ul style="list-style-type: none"> Increased depth directly upstream of the temporary weir, potentially leading to increased siltation 	Negligible
Reach 2 – Temporary abstraction point and the tidal limit		
Macroinvertebrates	<ul style="list-style-type: none"> Reduction in wetted area and velocities Water quality deterioration 	Moderate
<i>Omphiscola glabra</i>	<ul style="list-style-type: none"> Water quality deterioration 	Minor

There is a risk of short-term deterioration in status of the macroinvertebrate component of the Afon Lwyd - source to Mon and Brecon Canal (GB109056032912) and Afon Lwyd - below Mon and Brecon Canal (GB109056032911) waterbodies due to the drought permit. The waterbodies have High (GB109056032912) and Good (GB109056032911) status for macroinvertebrates. Impacts of drought permit implementation have been summarised as moderate to negligible adverse, short-term, temporary and reversible. Consequently, the macroinvertebrate component of these waterbodies is considered to be at **minor** risk of short-term deterioration.

D.3.3 Fish

D.3.3.1 Baseline

In 2011 and 2012, the Afon Lwyd was subject to intensive fisheries monitoring as part of a programme of ecological surveys (recommended in the Environmental Monitoring Plan for Afon Lwyd (SE23)⁹) commissioned by Welsh Water to fulfil requirements of the first iteration of the 'Environmental Assessment of the Afon Lwyd at New Inn (SE23) Drought Permit'¹⁰ in 2012. Fisheries monitoring undertaken by OHES in 2011 and 2012 is described in Cascade (2012)¹¹ and Cascade (2013)¹² respectively. Fisheries monitoring is also undertaken on the Afon Lwyd by NRW. Relevant previous studies and recent NRW fish survey data have been reviewed and analysed and an updated summary baseline is provided below.

⁹ Cascade (2007). Environmental Monitoring Plan for Afon Lwyd (SE23). A report for Dŵr Cymru Welsh Water. March 2009.

¹⁰ Cascade (2012). Environmental Assessment of the Afon Lwyd at New Inn (SE23) Drought Permit. A report for Dŵr Cymru Welsh Water. April 2012.

¹¹ Cascade (2012). Environmental Assessment of the Afon Lwyd at New Inn (SE23) Drought Permit. A report for Dŵr Cymru Welsh Water. April 2012

¹² Cascade (2013). Environmental Monitoring Studies for Afon Lwyd at New Inn (SE23) Drought Permit. A report for Dŵr Cymru Welsh Water. January 2013.

The Afon Lwyd borders the River Usk SAC/SSSI and the Atlantic salmon population (which is a Habitats Directive Annex II species that is a primary reason for selection of the site) is likely to utilise habitats within the Afon Lwyd.

Existing Data

The fisheries monitoring undertaken by OHES in 2011 and 2012 consisted of a suite of surveys in a study area providing adequate coverage of the predicted extent of hydrological influence of the proposed drought permit. Monitoring consisted of standard electric fishing surveys at eight sites in Reach 1 and six sites in Reach 2 of the Afon Lwyd. Detailed methodologies are provided in the relevant reports¹³¹⁴[Error! Bookmark not defined.](#).

Fish survey data from ten sites (see **Table D3.6** below) on the main stem of the Afon Lwyd were provided by NRW following a data request to inform this assessment. The sites have not been sampled consistently across years or in terms of methodology, and there are no data post-2013. However, the data provide a useful insight into the likely species assemblage within the hydrological zone of influence and complements the more detailed data collected by OHES.

Table D3.6 NRW fisheries monitoring locations

Hydrological Reach	NRW Site Code	NGR	Sampling Years
1	Lo04	SO 25400 08400	2005
	Lo05	SO 27070 04132	1996, 2000, 2005, 2011, 2013
	Lo15	SO 25250 08520	1999
	Lo16	SO 24840 08890	1999
2	Lo03a	ST 29900 99400	1996, 2000, 2005
	Lo06	ST 30000 95800	1996, 2000, 2005
	Lo14	ST 32926 92405	1996, 2000 – 2002, 2005, 2007
	Lo18	ST 33028 92440	2009, 2010, 2013

The Afon Lwyd - source to Mon and Brecon Canal (GB109056032912) waterbody was assessed as Poor for the fish element in the 2018 cycle 2 interim classification, with salmon and bullhead outlined as the species driving the failure. The Afon Lwyd - below Mon and Brecon Canal (GB109056032911) was assessed as being at Good for the fish element in the 2018 cycle 2 interim classification.

Data Limitations

The available data may be sufficient to fully describe the potential impacts of a drought permit over and above a natural drought, however, there are no fish survey data available for the hydrological zone of influence post-2013 (and no detailed data post 2012) and further baseline

¹³ Cascade (2012). Environmental Assessment of the Afon Lwyd at New Inn (SE23) Drought Permit. A report for Dŵr Cymru Welsh Water. April 2012

¹⁴ Cascade (2013). Environmental Monitoring Studies for Afon Lwyd at New Inn (SE23) Drought Permit. A report for Dŵr Cymru Welsh Water. January 2013.

surveys will be required after 2017 in order that the baseline data remains relevant. In addition, the baseline data available requires considerable additional analysis. The analysis and reporting methodologies between NRW and OHES surveys are not directly comparable¹⁵, and further data analysis would be required in order to allow detailed assessment. Analysis of HABSCORE¹⁶ surveys undertaken in 2012 is also required.

Due to these limitations, a conservative approach has been used in this assessment which assumes that in the absence of definitive data, significant populations of the relevant species are present in the hydrological zone of influence and that worst-case impacts would occur.

Species Composition

Eight fish species have been recorded within the hydrological zone of influence on the Afon Lwyd, including Atlantic salmon, bullhead, brown/sea trout, European eel, flounder *Platichthys flesus*, minnow *Phoxinus phoxinus*, stone loach *Barbatula barbatula* and three-spined stickleback *Gasterosteus aculeatus*.

The available data suggest that recruiting brown trout populations are present throughout the Lwyd catchment, with juvenile densities highest in Reach 1. Fish populations in Reach 2 are dominated by lower densities of larger, mature brown trout. Limited numbers of juvenile Atlantic salmon are present in Reach 2 only. OHES surveys in 2011 and 2012 did not record Atlantic salmon upstream of Site 6 (in Reach 1) just above Pontypool (SO 26900 02600). The data suggest that Atlantic salmon spawning occurs below the downstream end of Reach 1 only, and that in-stream structures (e.g. weirs) upstream of OHES Site 6 constitute a significant barrier to migration. This is highlighted in NRW data from Site L005 (SO2700004100) (see **Table D3.7** Error! Reference source not found. below) with Atlantic salmon absent in all three years and generally very good juvenile brown/sea trout densities (although with significant inter-annual variation).

Table D3.7 Error! Reference source not found. **NFC Grades¹⁷ for NRW Site L005**

Year	NFC Grades ¹⁷		
	Atlantic salmon (o+ & >o+)	o+ brown/sea trout	>o+ brown/sea trout
2005	F (Absent)	B	C
2011	F (Absent)	A	A
2013	F (Absent)	D	B

¹⁵ Cascade (2013) provides overall densities for brown/sea trout and Atlantic salmon per site rather than o+ and 1+ densities for each species which can then be compared using the NFC Grade system (see below) allowing increased resolution in terms of analysis of recruitment success as well as comparability with standard NRW data outputs.

¹⁶ HABSCORE is a system of salmonid stream habitat measurement and evaluation based on empirical models of fish density against combinations of site and catchment features.

¹⁷ For salmonids, a grading system is used based on the original Fisheries Classification System called the National Fisheries Classification (NFC). The electric fishing data are analysed to produce a juvenile salmon and trout density score for each site, using average values from the early 1990s as a baseline. The proportion of sites falling into different salmon abundance Classes (A to F) provides a measure of the health of the juvenile salmon populations for each river. Sites are typically grouped into those that are at or above average (Classes A to C), below average (Class D) and well below average or fishless (Classes E or F).

European eel and bullhead appear to be present throughout the middle and lower reaches of the Afon Lwyd but in limited numbers only.

Flounder appear in the NRW data at Sites LO14 and LO18 (both near Ponthir at the lower end of Reach 2 close to the tidal limit) and are likely to represent juveniles which utilise freshwater habitat in the lower reaches of rivers, generally in their first year, prior to migrating to estuarine and marine environments.

No lamprey *Petromyzontidae* or shad *Alosinae* species have been recorded during any fisheries monitoring on the Afon Lwyd.

Ecological Value of Fisheries Receptors

The Atlantic salmon (a NERC Act Section 41 and Habitats Directive Annex II species) is a primary reason for selection of the River Usk SAC, and fish utilising spawning and nursery habitat within the Afon Lwyd are likely to contribute to this population and are therefore considered to be of international importance. Bullhead (a NERC Act Section 41 and Habitats Directive Annex II species), brown/sea trout (a NERC Act Section 41 species) and European eel (a NERC Act Section 41 species and IUCN Red List 'critically endangered' species) are considered to be of national importance. Flounder, minnow, stone loach and three-spined stickleback are considered to be of local importance.

D.3.3.2 Assessment

Hydrological variability in rivers can have a significant influence on the distribution of fish. When extreme low flows, or prolonged periods of low flow, are experienced (e.g. under continued water abstraction during drought conditions), the resultant changes in the hydrological regime can have significant impacts on resident fish communities. Abstraction of water from a river or stream reduces the wetted area and volume with the potential for subsequent impacts on fish populations as a result of, for example, intra- and inter-specific interactions (e.g. increased competition for optimal habitat and food)^{18,19}, reduced water quality and reduced reproductive success, growth and condition²⁰. In this instance, the temporary sandbag dam also has an impounding effect thereby potentially impacting sensitive fish habitat upstream (e.g. salmonid spawning or juvenile habitat) and acting as a barrier to fish migration.

Potential impacts relating to habitat loss, water quality and migration are of relevance. These are discussed for key fish species in the sections which follow with particular focus on those

¹⁸ Magoulick, D.D. (2000). Spatial and temporal variation in fish assemblages of drying stream pools: the role of abiotic and biotic factors. *Aquatic Ecology* 34, 29-41

¹⁹ Davey A.J.H. & Kelly D.J. (2007). Fish community responses to drying disturbances in an intermittent stream: a landscape perspective. *Freshwater Biology* 52, 1719-1733.

²⁰ Magoulick, D.D. and Kobza, R.M. (2003). The role of refugia for fishes during drought: a review and synthesis. *Freshwater Biology* 48, 1186-1198.

aspects of fish ecology (e.g. migrations and juvenile life-stages) most susceptible during the likely impact period (the Drought Permit is likely to be implemented between September and November).

Reach 2 (Afon Lwyd, from the temporary abstraction at New Inn to the tidal limit) is predicted to undergo a reduction in flow of up to 59% at Q_{99} with a drought permit and, whilst mortality under these conditions may be significant, fish species have evolved mechanisms in order to cope with low flow conditions, for example, avoidance behaviour (i.e. moving downstream as water levels drop) or the ability to persist in pooled areas of deeper water. However, flow sensitive species such as Atlantic salmon and brown/sea trout are, nonetheless, susceptible to reduced flows.

Atlantic Salmon

Atlantic Salmon Migration

Recent records of successful Atlantic salmon spawning and recruitment in the Afon Lwyd are scarce (last record in 2001), suggesting the watercourse does not currently support a healthy population. This is further recognised in the 2018 WFD interim cycle 2 designating which highlights the species as a reason for the fish element of the waterbody not achieving Good status. Any Atlantic salmon migrating into the Afon Lwyd are likely to do so from October to December; coinciding with the implementation of the drought permit. The majority of out-migrating smolt would be likely to migrate between mid-March and mid-May depending on water temperature; outside of the drought permit implementation period.

Adult Atlantic salmon migrations are linked to flow increases, and river flow is considered to be a primary cue. Very low flows are likely to delay migration, thereby increasing mortality due to increased predation and stress. Any impacts are likely to be exacerbated by the additional barrier caused by the proposed sandbag weir associated with the abstraction point on the Lwyd. The temporary weir would limit passage from Reach 2 into Reach 1, therefore posing an additional risk to salmon recruitment in both reaches of the river. The impact is therefore considered to be of high magnitude, short-term, temporary and reversible for both reaches. The impact on adult Atlantic salmon migration is therefore considered to be **major adverse** in Reach 1 and 2 from September to November.

Water Quality

Potential water quality impacts (e.g. reduced dissolved oxygen and increased water temperature) as a result of a reduction in flow are likely to act in tandem with a reduction in available habitat and delays to migration to increase stress and subsequent loss of condition. Atlantic salmon are susceptible to poor water quality, in particular dissolved oxygen and water temperature. A medium and high risk to deterioration of SRP in Reach 1 and 2 respectively also poses an indirect risk to Atlantic salmon recruitment, caused by detrimental algal growth smothering gravel spawning habitats prior to the winter spawning period. The impact on

Atlantic salmon is therefore considered to be of low magnitude in Reach 1 and medium magnitude in Reach 2, short-term, temporary and reversible for both reaches. The impact on Atlantic salmon is therefore considered to be **negligible** in Reach 1 and **minor adverse** in Reach 2 due to a potential reduction in water quality.

Juvenile Atlantic Salmon habitat and spawning habitat

In Reach 2 there is the potential for reduced flow to result in a decrease in river levels and wetted width. There is therefore the potential for a loss or degradation of juvenile habitat, along with gravel spawning habitat. Provided minimum low flows are available, juvenile Atlantic salmon are likely to relocate to areas of suitable habitat if river levels decrease, however, competition and stress would increase. In Reach 1, the impoundment which will occur behind the temporary weir will increase water width and depth and decrease flow velocity over a very small area of the total reach. Due to the likely timing of a drought permit, gravels containing alevins and/or early-stage fry (likely to occur in April and May) are not considered to be affected. The impact is therefore considered to be of low magnitude in Reach 1 and high magnitude in Reach 2, short term, temporary and reversible in both reaches. The impact on juvenile Atlantic salmon is therefore considered to be **negligible** in Reach 1 and **major adverse** in Reach 2.

Brown / Sea Trout

Sea Trout Migration

Reach 2 of the Afon Lwyd is likely to be an important migratory pathway for sea trout, both upstream-migrating adults and out-migrating smolt. The majority of upstream adult sea trout migration into the Afon Lwyd is likely to occur from July to November; coinciding with the implementation of the drought permit. The majority of out-migrating smolt would be likely to migrate between mid-March and mid-May depending on water temperature; outside of the drought permit implementation period.

In Reach 2 adult migrations are linked to flow increases, and river flow is considered to be a primary cue. Very low flows are likely to delay migration, thereby increasing mortality due to increased predation and stress. Any impacts are likely to be exacerbated by the additional barrier caused by the proposed sandbag weir associated with the abstraction point on the Lwyd. The temporary weir would limit passage from Reach 2 into Reach 1, therefore posing a high risk to salmon recruitment in both reaches of the river. The impact is therefore considered to be of high magnitude, short-term, temporary and reversible for both reaches. The impact on adult sea trout migration is therefore considered to be **major adverse** in Reach 1 and 2 from September to November.

Water Quality

Potential water quality impacts (e.g. reduced dissolved oxygen and increased water temperature) as a result of a reduction in flow are likely to act in tandem with a reduction in

habitat and delays to migration to increase stress and subsequent loss of condition. Brown/sea trout are susceptible to poor water quality, in particular dissolved oxygen and water temperature. A medium and high risk to deterioration of SRP in Reach 1 and 2 respectively also poses an indirect risk to brown / sea trout recruitment, caused by detrimental algal growth smothering gravel spawning habitats prior to the winter spawning period. The impact on brown / sea trout is therefore considered to be of low magnitude in Reach 1 and medium magnitude in Reach 2, short-term, temporary and reversible for both reaches. The impact on brown / sea trout is therefore considered to be **negligible** in Reach 1 and **minor adverse** in Reach 2 due to a potential reduction in water quality.

Juvenile Brown / Sea Trout

In Reach 2, there is the potential for reduced flow to result in a decrease in river levels and wetted width. There is therefore the potential for a loss or degradation of juvenile habitat along with gravel spawning habitat. Provided minimum low flows are available, juvenile brown/sea trout are likely to relocate to areas of suitable habitat if river levels decrease, however, competition and stress would increase. Due to the likely timing of a drought permit, gravels containing alevins and/or early-stage fry (likely to occur in April and May) are not considered to be affected. The impact is therefore considered to be of high magnitude in Reach 2, short-term, temporary and reversible. In Reach 1, the impoundment which will occur behind the temporary weir will increase water width and depth and decrease flow velocity, this may reduce the suitability of the spawning habitat within the small section of backed up water although the extent of this impact will be limited. The impact on juvenile brown/sea trout is therefore considered to be **minor adverse** in Reach 1 and **major adverse** in Reach 2.

Bullhead

Bullhead are thought to be present at low densities throughout Reaches 1 and 2. Spawning and egg incubation takes place from March to May; outside of the drought permit implementation period. The species is known to be particularly flow sensitive and reduced flows (and likely reduced water quality) associated with implementation of a drought permit may have a significant impact on bullhead populations in Reach 1 and 2. Bullhead require a clean gravel bed in which to thrive and spawn, therefore the medium and high risk of deterioration in SRP in Reach 1 and 2 respectively may pose an adverse impact to the species. Flow and water quality related impacts are therefore considered to be of high magnitude, short-term, temporary and reversible. The impact on bullhead is therefore considered to be **minor adverse** in Reach 1 and **major adverse** in Reach 2.

European Eel

Elvers enter rivers in early spring and a general upstream migration occurs throughout the year. Elver migration is not linked to periods of increased flow and low flow conditions are unlikely to impact migration. The downstream migration of mature (silver) eels tends to occur between September and December in most rivers, and there is therefore the potential for a

significant impact on the out-migration of mature European eels. European eels of a wide age range are present in low densities throughout the catchment, but the species is tolerant of high temperatures and relatively poor water quality and is considered relatively resilient to drought conditions. The impacts on European eel are therefore limited to silver eel migration and this is considered to be **moderate adverse** in Reach 1 and 2 due to the barrier to downstream migration caused by the temporary weir associated with the abstraction point during the period September to November. Impacts on other European eel life-stages are considered to be **negligible**.

Other Fish Species

Flounder are only likely to be present in the lower part of Reach 2 and are not expected to be significantly impacted by a drought permit. Minnow, stone loach and three-spined stickleback spawning and egg incubation occurs in spring and summer; largely outside of the drought permit implementation period. However, the sensitive life-stages of these species are susceptible to impacts associated with low flows and water quality deterioration during the drought permit implementation period. The impact is therefore considered to be of low magnitude in Reach 1 and high magnitude in Reach 2, short-term, temporary and reversible for both reaches. The impact on other fish species is therefore considered to be **negligible** in Reach 1 and **major adverse** in Reach 2 due to impacts associated with reductions in flow.

Summary

The potential impacts of the Afon Lwyd drought permit on the fish community are summarised in **Table D3.8**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability; see Section 4.3 of the main report) and the sensitivities of the fish community. The impacts presented in **Table D3.8** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

There is a risk of short-term deterioration in status of the fish component of the Afon Lwyd - source to Mon and Brecon Canal (GB109056032912) and Afon Lwyd - below Mon and Brecon Canal (GB109056032911) waterbodies due to the drought permit. These waterbodies have been classified as Poor and Good for fish, respectively. Salmon and bullhead are outlined as the species driving the failure of the GB109056032912 waterbody, with the impacts of the drought permit summarised as negligible to major adverse, short-term, temporary and reversible. Consequently, the fish component of these waterbodies is considered to be at **major** risk of short-term deterioration.

Table D3.8 Summary of Impacts on Fish Community

Feature	Impact	Significance of Impact
Reach 1 - Afon Lwyd from headwater to temporary abstraction point at New Inn		
Atlantic salmon	• Delays and potential cessation of adult migrations due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point	Major
	• Reduced water quality	Negligible
	• Reduction in spawning and juvenile survival due to habitat loss	Minor
Brown/sea trout	• Delays and potential cessation of adult and smolt migrations due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point	Major
	• Reduced water quality	Negligible
	• Reduction in spawning and juvenile survival due to habitat loss.	Negligible
Bullhead	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow.	Minor
European eel	• Delays and potential cessation of silver eel migration due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point	Moderate
	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow.	Negligible
Other fish species	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow.	Negligible
Reach 2 - Afon Lwyd at New Inn to the tidal limit		
Atlantic salmon	• Delays and potential cessation of adult migrations due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point	Major
	• Reduced water quality	Minor
	• Reduction in spawning and juvenile survival due to habitat loss.	Major
Brown/sea trout	• Delays and potential cessation of adult and smolt migrations due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point	Major
	• Reduced water quality	Minor
	• Reduction in spawning and juvenile survival due to habitat loss.	Major
Bullhead	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow.	Major
European eel	• Delays and potential cessation of silver eel migration due to reduced flows and obstruction caused by the temporary weir associated with the abstraction point	Moderate
	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow	Negligible
Other fish species	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow	Major

D.3.4 Phytobenthos

D.3.4.1 Baseline

No baseline monitoring information for phytobenthos was received from NRW for the reaches subject to hydrological impacts.

D.3.4.2 Assessment

Impacts on the phytobenthos assemblages of the Afon Lwyd could occur due to implementation of the drought permit, including changes in community composition due to decreases in velocity, changes to grazing pressure, increases in nutrient level, increases in water temperature, and increases in filamentous algae smothering the substrate.

Due to the short lifecycle of algal species, phytobenthos communities can respond to rapidly to environmental change. Therefore, the major hydrological effects of operation of the drought permit in Reach 2 are likely to result in changes to the phytobenthos communities present during implementation of the drought permit.

WFD Ecological Quality Ratio (EQR) metrics for phytobenthos (TDI4 in DARLEQ)²¹ are designed to detect differences in nutrient levels rather than other environmental factors and should not, in theory, be affected unless nutrient levels increase due to the operation of the drought permit. However, it is recognised that other environmental factors can influence TDI4 scores (WFD-UKTAG, 2014), and potential changes to the micro-habitats supporting benthic phytobenthos growth are of such magnitude that there is potential for changes to the phytobenthos community to result in changes to EQR scores. This could result in a potential decrease in WFD ecological status in respect to phytobenthos.

Implementation of the drought permit in Reach 1 and 2 is expected to result in medium and high risk to water quality deterioration associated with SRP concentrations respectively. Any increase in SRP is likely to affect the phytobenthos community in terms of TDI score and associated WFD status.

Due to the rapid response of phytobenthos communities to environmental variables, this effect is expected to be short lived, with communities recovering rapidly following return to the normal hydrological regime. Flow and water quality impacts to the phytobenthos community are assessed as **minor adverse** for Reach 1 and **moderate adverse** for Reach 2. However, monitoring of phytobenthos communities within the affected reach would be required to fully assess the effects of the proposed drought permit.

Summary

The potential impacts of the Afon Lwyd drought permit on the diatom community are summarised in **Table D3.9**. The impacts, and their magnitude, have been based on the

²¹ WFD-UKTAG (2014) Phytobenthos: Phytobenthos for Assessing River and Lake Ecological Quality (River DARLEQ2)

hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Section 4.3 of the main report) and the sensitivities of the diatom community. The impacts presented in **Table D3.9** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.9 Summary of Impacts on Diatom Community

Feature	Impact	Significance of Impact
Reach 1 - Source to the temporary abstraction point		
Phy to benthos	<ul style="list-style-type: none"> Deterioration related to soluble reactive phosphorous 	Minor
Reach 2 – Temporary abstraction point and the tidal limit		
Phy to benthos	<ul style="list-style-type: none"> Reduction in wetted area Deterioration related to soluble reactive phosphorous 	Moderate

The diatom element for the Afon Lwyd - below Mon and Brecon Canal (GB109056032911) WFD waterbody has been classified as High in the 2018 cycle 2 interim classification. Consequently, the diatom component of these waterbodies is considered to be at **minor** risk of short-term deterioration. Afon Lwyd - source to Mon and Brecon Canal (GB109056032912) has not been classified for diatoms or phyto benthos.

D.3.5 Crustacea: White-clawed Crayfish

D.3.5.1 Baseline

White-clawed crayfish are designated as a species of principal importance in Wales under Section 42 of the NERC 2006 Act. White-clawed crayfish are expected to be present within the zone of influence of this drought permit due to historic records of their presence.

White-clawed crayfish surveys were carried out in 2011 and 2012, at four sites on the Afon Lwyd. Surveys in 2011 were undertaken in Reach 2, whilst surveys in 2012 were undertaken in Reach 1. Survey locations and results are given in **Table D.3.10**. The surveys were undertaken on both occasions by a CCW licensed surveyor for white-clawed crayfish (License number 33327: OTH: SA: 2011) (Licence number 38494: OTH: SA: 2012). The survey techniques employed for white-clawed crayfish and the assessment of the Afon Lwyd are similar to those used for surveying Special Areas of Conservation (SAC's) as stated in the Conserving Natura 2000 Rivers monitoring series of guidance²².

²² Peay S (2003). Monitoring the White-clawed Crayfish *Austropotamobius pallipes*. Conserving Natura 2000 Rivers Monitoring Series No. 1, English Nature, Peterborough.

Table D.3.10 2011 and 2012 Crayfish Survey Results

Site	Grid Reference	Species	Sex	Carapace length (mm)	Damage/disease	Breeding/moulting
Reach 1						
2012 Site 1	SO270041	-	-	-	-	-
2012 Site 2	SO285006	-	-	-	-	-
Reach 2						
2011 Site 1	ST 30193 98541	-	-	-	-	-
2011 Site 2	ST 31505 93150	<i>A. pallipes</i>	Male	83	None	None
		<i>A. pallipes</i>	Female	66	None	None
		<i>A. pallipes</i>	Male	56	None	None

The survey methodology for recording any crayfish catches includes; identification of species, measured (carapace length) and sexed, if possible. Additional notes are also taken relating to any damage to the crayfish (such as missing cheliped), whether they are breeding or berried female, moult status and the presence of any crayfish disease. In addition to the crayfish condition notes, further notes of the habitat features (such as substrate and flow conditions) are collected for each patch, including photographs. Precautionary measures were taken before and after the survey to prevent the spread of disease.

The surveys carried out in 2011 recorded that habitat for crayfish was frequent within the two survey reaches assessed in Reach 2. White-clawed crayfish were only recorded in the lower reaches of the Lwyd at Site 2 in 2011, consisting of three individuals. The low numbers of crayfish recorded indicate that either the population is very small or the unseasonably cool conditions at the time of the survey in August 2011 constrained the results (i.e. crayfish are less active at lower temperatures).

No white-clawed crayfish were found upstream in 2011 or 2012, despite suitable habitat and water quality conditions to support this species. This does not conclude that they do not exist in the rest of the Afon Lwyd, but rather that in the areas searched, no individuals or signs of crayfish (e.g. casts or bankside burrows) were present at the time of surveying. However, no non-native crayfish, such as the American signal crayfish were found, suggesting an absence from the catchment. The survey results in 2011 and 2012 suggest that the crayfish population present is likely to be very small and limited to the lower reaches of Reach 2.

D.3.5.2 Assessment

In Reach 1, the hydrological impacts will manifest as an impoundment of water being the temporary weir located at New Inn. This impoundment will result in reduced flow velocity, increased water depth and deterioration to water quality, which has been assessed as low for dissolved oxygen and ammonia and medium for SRP, although no direct interaction between SRP and white-clawed crayfish are anticipated. The species is tolerant of reduced flow velocity

as they are adapted to both fast flowing and lacustrine habitats, and furthermore increased water depth within the impoundment is not expected to exclude white-clawed crayfish. However, white-clawed crayfish are highly sensitive to reductions in water quality, with low ammonia and dissolved oxygen deterioration being expected to directly impact the species. Due to the mobility of the species, it is expected that during the short duration that the temporary weir is in place, individuals may move upstream away from the impoundment which may mitigate the impact in the reach. Considering the ecological value of the species, the significance of impact in Reach 1 is assessed as being **minor adverse**.

In Reach 2 where white-clawed crayfish were recorded, the hydrological impacts will manifest as a major reduction in flows and wetted depth/width. This reduction in water level could have a significant impact on this species as it has been identified that drought related impacts are a major cause of its decline²³. One of the principal reasons for this is the reduction in availability of refuges, particularly those in the river banks, which may then become a limiting factor on the population. In addition to a loss of shelter, the white-clawed crayfish population is particularly susceptible to predation²⁴. Individuals could also become stranded in refuges, particularly within the river banks, if water levels were to fall rapidly, individuals may be become stranded resulting in mortality.

Water quality impacts of implementation of this drought permit are likely to influence the native white-claw crayfish population. In Reach 2 there is a low risk to ammonia and dissolved oxygen deterioration. White-clawed crayfish are highly sensitive to reductions in water quality. Considering the ecological value of the species and the small population that is considered to be present in the Afon Lwyd, the significance of water quality related impacts on white-clawed crayfish in Reach 2 is assessed as **moderate adverse**.

Summary

The potential impacts of the Afon Lwyd drought permit on the white clawed crayfish population are summarised in **Table D3.11**. The impacts, and their magnitude, have been based on hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability; see Section 4.3 of the main report) and the sensitivities of the white clawed crayfish population. The impacts presented in **Table D3.11** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

²³ Holdich, D. and Rogers, D. (2000) Habitat requirements of the white-clawed crayfish *Austropotamobius pallipes*. In: Rogers, D. and Brickland J. (Eds) Cray fish Conference, Leeds.

²⁴ Lodge, D. M. and Hill, A. M. (1994) Factors governing species composition, population size and productivity of cool-water cray fishes. *Nordic Journal of Freshwater Research* 69, pp 111 - 136.

Table D3.11 Impacts on NERC Act Section 42 Crustacea Species

Species	Impact	Significance of Impact
Reach 1 - Source to the temporary abstraction point		
White-clawed crayfish	<ul style="list-style-type: none"> Increased mortality as a result of deterioration to water quality. 	Minor
Reach 2 - Temporary abstraction point and the tidal limit		
White-clawed crayfish	<ul style="list-style-type: none"> Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. Reduction in availability of refuges Increased mortality (density dependant) as a result of increased predation and competition Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats Increased mortality as a result of deterioration to water quality. 	Moderate

D4 INVASIVE FLORA AND FAUNA

D.4.1.1 Baseline

The macrophyte and walkover surveys recorded Himalayan balsam (*Impatiens glandulifera*) and Japanese knotweed (*Fallopia japonica*) at a number of locations (see Section D3.1.1).

D.4.1.2 Assessment

Pumping of water from the Afon Lwyd into Llandegfedd Reservoir may introduce non-native flora and fauna into the reservoir. Therefore the significance of this impact is assessed as **minor adverse**.

D5 LANDSCAPE AND RECREATION

D.5.1 Landscape

D.5.1.1 Baseline

There are no Areas of Outstanding Natural Beauty (AONBs) or National Parks within the immediate vicinity of the Afon Lwyd and the zone of hydrological influence of the drought permit. The headwaters of the Afon Lwyd arise on Waun Afon bog, an area of upland bog, and continues through a bleak, shallow U-shaped valley where the industrial past is very evident in the preserved landscape of spoil tips and workings, transport routes and structural remains²⁵. The town of Blaenavon, located to the east of the upstream sections of the study area, was designated as a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site (WHS) in November 2000. The purpose of the designation and the vision statement of the existing management plan for the area intends to protect the cultural landscape to allow future generations to understand the contribution South Wales made to the industrial revolution²⁶. The remaining study area is characterised by heavily urbanised areas with small pockets of woodland and amenity space.

D.5.1.2 Assessment

A review of the hydrological implications of implementing a drought permit at this site has identified a significant reduction in wetted width and wetted depth below those observed in the Afon Lwyd without the drought permit. The scheme would also involve the construction of a low, temporary weir, constructed of sandbags, across the Afon Lwyd and submersible pumps to enable abstraction. The temporary weir would have visual amenity impacts. The impact on wetted width and wetted depth will only be temporary and will be ameliorated once the drought has passed. The overall impact on landscape has been assessed as **negligible**.

²⁵Torfaen Borough Council (2008) *Landscape Character Study Summary Document*, Prepared on behalf of the Forgotten Landscapes Partnership, 2008.

²⁶Torfaen County Borough Council (2011) Blaenavon Industrial Landscape World Heritage Site, Draft Management Plan 2011-2016, 2011.

D.5.2 Recreation

D.5.2.1 Baseline

Recreation activities in the study area include cross country running, golf, horse riding, walking, angling and canoeing. Llandegfedd Reservoir to the east of the study reach is popular for bird watching, sailing, sub aqua activities and windsurfing. There are a number of public footpaths adjacent to the study reach utilised by both walkers and cross country runners. The study reach provides a grade II, 17km canoeing run from Pontypool to Caerleon²⁷.

Within the Afon Lwyd catchment, salmon and sea trout may be present. Brown trout are regularly sought by anglers and their numbers are supplemented by stocking. In the lower reaches of the Afon Lwyd, there is a limited coarse fishery with chub, dace and roach having been recorded²⁸, however, these species have not been reported in the available fisheries survey data.

D.5.2.2 Assessment

Any reduction in wetted width and depth may influence the angling resource on the Afon Lwyd flows in the study area. However, water levels will be naturally low in times of drought and impacts will be temporary in nature. The overall impact on recreation has been assessed as **negligible**.

Summary

The potential impacts of the Afon Lwyd drought permit on landscape, recreation and archaeology are summarised in **Table D5.1**. The impacts presented in **Table D5.1** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D5.1 Summary of Impacts on Landscape and Recreation

Feature	Impact	Significance of Impact
Reach 1 & 2		
Landscape	<ul style="list-style-type: none"> Flows during a drought will be low such that further reduction in flows due to the drought permit would not result in a further loss of aesthetic value 	Negligible
Recreation	<ul style="list-style-type: none"> Impacts on recreation activities (e.g. angling, canoeing, walking) are not anticipated over those from the natural drought conditions 	Negligible

²⁷Canoe Wales (2008) <http://www.canoe-wales.com/afon-lwyd.aspx>, accessed on 14/11/11.

²⁸Environment Agency Wales (1998) *Eastern Valley Area Local Environment Agency Plan, Consultation Report*, January 1998.