



Ricardo
Energy & Environment

Dŵr Cymru Welsh Water

Environmental Assessment of the Afon Rhondda Fawr Drought Permit (8112-1)

Final

March 2019

Client: Dŵr Cymru Welsh Water

Title: Environmental Assessment of Afon Rhondda Fawr
Drought Permit (8112-1)

Project No: ED10929

Date of Issue: March 2019

Status: Final

Version No: 1.0

Produced By **Authorised for Release By**



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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 Rhondda Fawr, over and above those arising due to natural effects of drought and those which would occur under "normal" abstraction licence conditions.

Afon Rhondda Fawr 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. Water from the Afon Rhondda Fawr combines with water from the Afon Rhondda Fach as the River Rhondda at Porth.

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 Rhondda Fawr, 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 for a temporary abstraction from the Afon Rhondda Fawr.

If granted, the drought permit involves a new, unsupported emergency river abstraction of 1Ml/d from the Afon Rhondda Fawr adjacent to Treherbert to support raw water supply to the raw water storage reservoir at Tynywaun Water Treatment

Works (WTW). To enable the abstraction, a low, temporary weir constructed of sandbags would be required across the Afon Rhondda Fawr. 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 would influence the Afon Rhondda Fawr for a short distance downstream during ongoing low flow conditions; and the Nant Selsig, Nant Ystrad Fferiol and Nant Rhondda Fawr Stream upstream of the temporary weir.

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 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 Rhondda Fawr. 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 Rhondda Fawr as a result of implementing the drought permit. Impacts on the Afon Rhondda Fawr from the confluence of the Afon Rhondda Fach to the confluence of the River Taff have been assessed as **negligible**. These hydrological impacts are assessed as leading to **minor** 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 WFD status and Community Assessment / Environment (Wales) Act Section 7 species, invasive fauna, landscape and recreation as environmental features for which an environmental assessment was required.

The assessment has concluded that during periods when abstractions from a temporary intake at Treherbert on the Afon Rhondda Fawr occur there are **major** impacts on fish, macrophytes and white-clawed crayfish and **moderate** impacts on macrophytes, macroinvertebrates and phytobenthos.

Cumulative Impacts

No cumulative effects of implementing the drought permit with 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 Rhondda Fawr.

MITIGATION AND MONITORING

The environmental assessment has identified significant impacts of implementation of a drought permit at the Afon Rhondda Fawr. 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 Rhondda Fawr 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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Appendix B – Hydrology and Physical Environment Assessment

Appendix C – Environmental Features Assessment Methodologies

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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 to 1Ml/d from a temporary intake at Treherbert on the Afon Rhondda Fawr for up to 3 months, for transfer to the raw water storage reservoir at Tynywaun WTW. Water abstracted from the Afon Rhondda Fawr is 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 Rhondda Fawr. 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 Rhondda Fawr drought permit, covers the following waterbodies:

- Rhondda River – source to confluence of the Afon Rhondda Fach (GB109057027230)
- Rhondda River – confluence of the Afon Rhondda Fach to confluence of the River Taff (GB109057027270)

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 9 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

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.

availability and makes recommendations for future data / information gathering and monitoring. Welsh Water will continue to engage closely with NRW to ensure that 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 Rhondda Fawr, 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: Environmental Monitoring Plan (EMP)

Section 10: 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

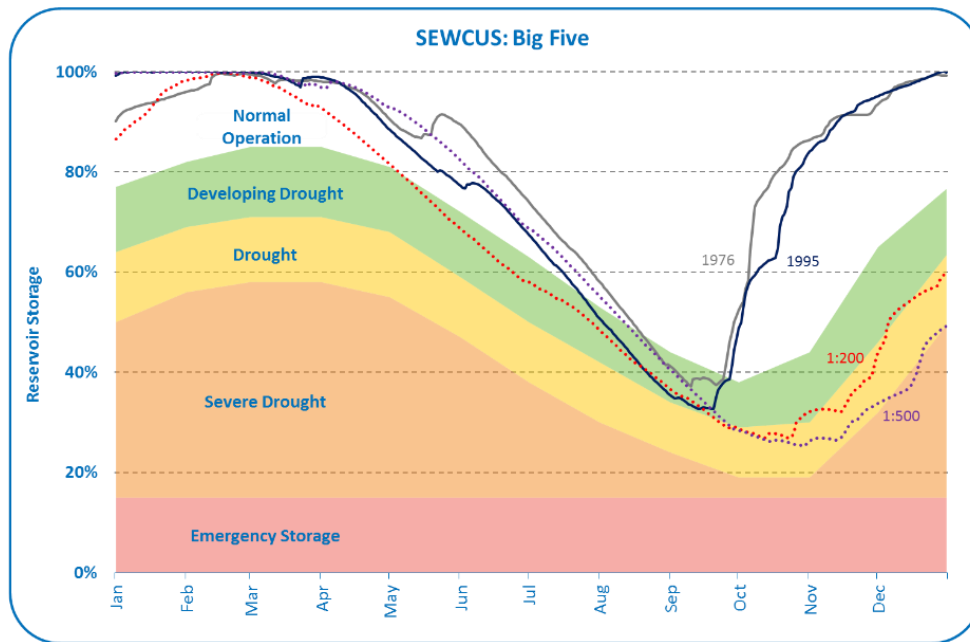


This SEWCUS WRZ is the largest of all Welsh Water's water resource zones and serves some 1.3 million domestic customers. It covers the large conurbations of Cardiff and Newport as well as the towns and villages of the South Wales valleys as far west as the Rhondda Valley and as far east as Chepstow.

The trigger levels for applying for a drought permit at the Afon Rhondda Fawr 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



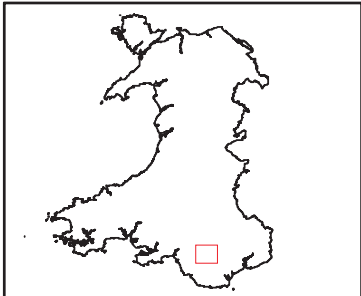
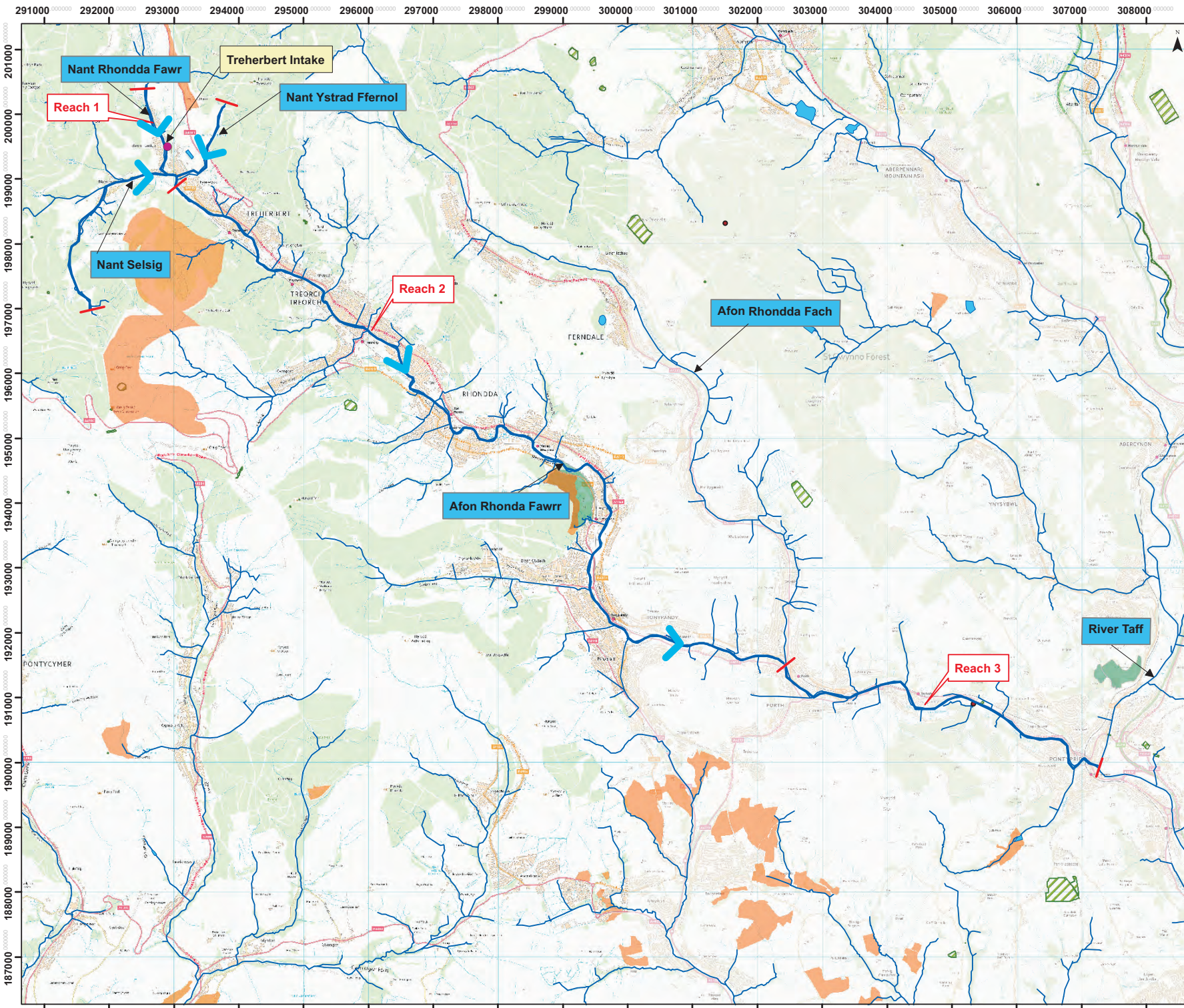
2.2 DESCRIPTION OF EXISTING ARRANGEMENTS AT THE AFON RHONDDA FAWR

Welsh Water have a number of licences to abstract water under the Water Resources Act 1991 which supply raw water to a raw water storage reservoir at Tynywaun water treatment works (WTW) on the outskirts of Treherbert:

- Llyn Fawr and Nant Garreg Lwyd (licence no. 21/57/24/0001).
- Nant Selsig (licence no. 21/57/24/0004).
- Nant Ystrad Ffernol (licence no. 21/57/24/0007).

No direct abstraction is currently made by Welsh Water from the Afon Rhondda Fawr to support raw water supply to the Tynywaun WTW. Water treated at Tynywaun WTW is put into local supply in the upper Rhondda Fawr valley, with any excess supplying the lower valley.

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



- Legend**
- Abstraction
 - Flow Direction
 - Hydrological Reach
 - Water Courses
 - Reservoir
 - ▨ Scheduled Ancient Monuments
 - Site of Special Scientific Interest
 - Local Nature Reserve



1:55,000
 Note: All locations are approximate
 This drawing incorporates Ordnance Survey Information
 © Crown copyright and database rights 2019

Project Title: **Welsh Water Drought Plan
Environmental Assessment**

Study area: 8112-1
**Afon Rhondda Fawr - Emergency abstraction
from the River Rhondda at Treherbert**

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 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

In order to protect essential public water supplies within Welsh Water's SEWCUSWRZ in the event of a future severe drought, Welsh Water may need to make an application to NRW for a drought permit for a temporary abstraction from the Afon Rhondda Fawr.

If granted, the drought permit involves a new, unsupported emergency river abstraction of 1Ml/d from the Afon Rhondda Fawr adjacent to Treherbert to support raw water supply to the raw water storage reservoir at Tynywaun WTW. To enable the abstraction, a low, temporary weir constructed of sandbags, would be required across the Afon Rhondda Fawr. 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 would influence the Afon Rhondda Fawr for a short distance downstream during ongoing low flow conditions; and the Nant Selsig, Nant Ystrad Fferiol and Nant Rhondda Fawr Stream upstream of the temporary weir.

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

Table 2.1 Afon Rhondda Fawr Existing and Proposed Drought Permit Abstraction

Abstraction Water Source	NGR	Normal Abstraction	Proposed Drought Permit Abstraction	Benefit Ml/d
Afon Rhondda Fawr	SS 93259 98687	<p>Welsh Water have a number of licences to abstract water under the Water Resources Act 1991 which supply raw water to a raw water storage reservoir at Tynywaun water treatment works (WTW) on the outskirts of Treherbert:</p> <ul style="list-style-type: none"> Llyn Fawr and Nant Garreg Lwyd (licence no. 21/57/24/0001). Nant Selsig (licence no. 21/57/24/0004). Nant Ystrad Ffernol (licence no. 21/57/24/0007). <p>No direct abstraction is currently made by Welsh Water from the Afon Rhondda Fawr to support raw water supply to the Tynywaun WTW. Water treated at Tynywaun WTW is put into local supply in the upper Rhondda Fawr valley, with any excess supplying the lower valley.</p>	<p>The drought permit involves a new, unsupported emergency river abstraction of 1 Ml/d from the Afon Rhondda Fawr adjacent to Treherbert to support raw water supply to the raw water storage reservoir at Tynywaun WTW. To enable the abstraction, a low, temporary weir constructed of sandbags, would be required across the Afon Rhondda Fawr. 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.</p>	1 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 Rhondda Fawr 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.

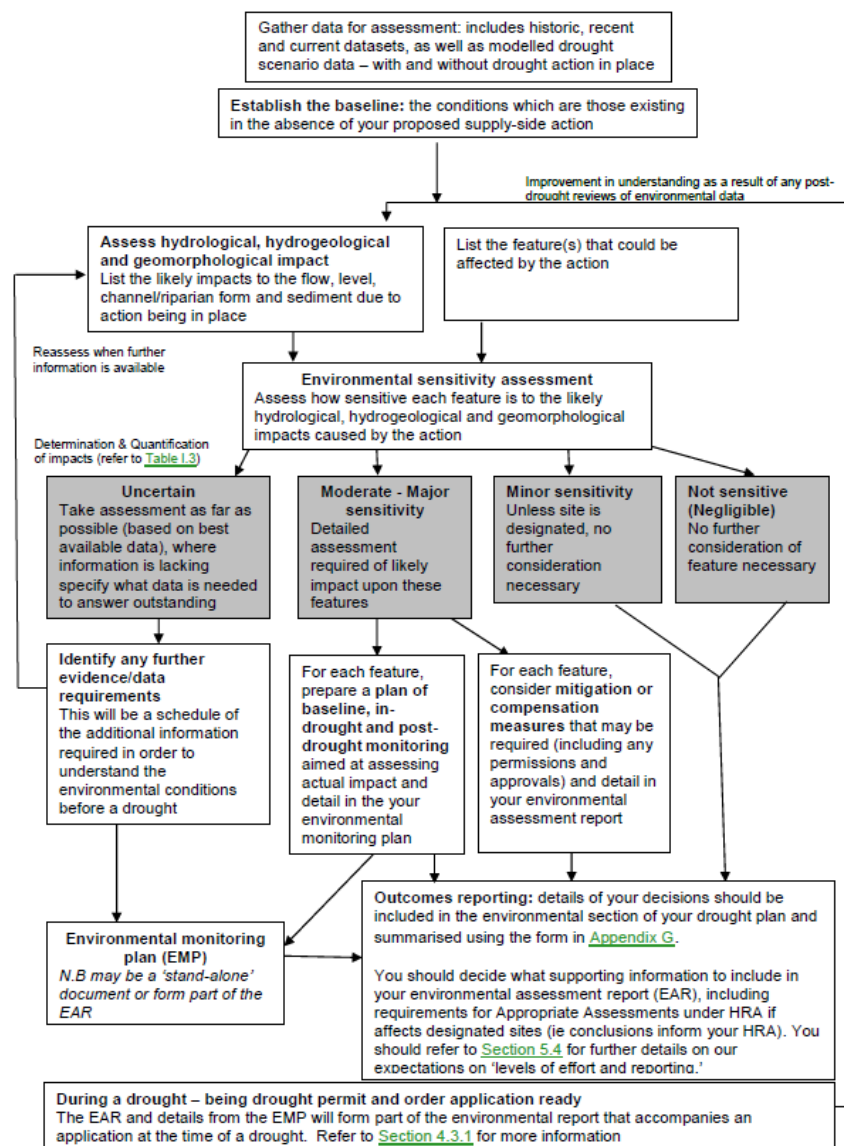
This is discussed further in Section 7.

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 Rhondda Fawr.

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), 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, bryophytes & 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 Rhondda Fawr 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

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

- The Convention on Wetlands of International Importance especially as Waterfowl Habitat , December 1975
- 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.

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.

Future data collection and monitoring can then be focused to identify the aquatic 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 RHONDDA FAWR 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 Rhondda Fawr 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:

The study area (see **Figure 2.3**) includes the Afon Rhondda Fawr from the headwater streams (Nant Rhondda Fawr, Nant Ystrad Ffernol, Nant Selsig) down to the confluence with the Afon Rhondda Fach, and its continuation the River Rhondda downstream to the confluence with the River Taff, comprising three distinct hydrological reaches.

2. 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 Rhondda Fawr, for a short distance downstream during ongoing low flow conditions, and the Nant Selsig, Nant Ystrad Ffernol and Nant Rhondda Fawr Stream upstream of the temporary weir.

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.

3. 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

Issue	Identified Impact
Afon Rhondda Fawr Headwaters	
Flows in the Afon Rhondda Fawr headwater streams <i>Minor impacts during the period of implementation from September to November inclusive</i>	<ul style="list-style-type: none"> No reductions in flow, but minor localised impacts due to ponding effects immediately upstream of temporary weir.
Water quality in the Afon Rhondda Fawr <i>Low risk in summer/autumn period</i>	<ul style="list-style-type: none"> Low risk of water quality deterioration for DO No data for other parameters available
Consented discharges <i>Negligible risk</i>	<ul style="list-style-type: none"> Negligible risk due to the size and nature of discharges
CSOs <i>Negligible risk</i>	<ul style="list-style-type: none"> Negligible risk due to the size and nature of discharges
Afon Rhondda Fawr	
Flows in the Afon Rhondda Fawr <i>Major impacts in (September); minor impacts in winter period (October to November inclusive)</i>	<ul style="list-style-type: none"> Reductions of up to 40% (September) or 13% (October to November) in flow in Reach 2.
Water quality in the Afon Rhondda Fawr <i>Low to High risk in summer/autumn period</i>	<ul style="list-style-type: none"> Low risk of water quality deterioration associated with total ammonia concentrations and DO High risk associated with SRP
Geomorphology <i>Minor impacts in summer/autumn period</i>	<ul style="list-style-type: none"> Minor risk to wetted width and sediment.
Consented discharges <i>Negligible risk</i>	<ul style="list-style-type: none"> Negligible risk due to the size and nature of discharges
CSOs <i>Negligible risk</i>	<ul style="list-style-type: none"> Negligible risk due to the size and nature of discharges
River Rhondda	
Flows in the River Rhondda <i>Negligible impacts during the period of implementation from September to November inclusive</i>	<ul style="list-style-type: none"> Reductions of up to 2.6% (September) or 1.5% (October to November) in flow in Reach 3.
Water quality in the River Rhondda <i>Unquantified risk</i>	<ul style="list-style-type: none"> No data
Consented discharges <i>Negligible risk</i>	<ul style="list-style-type: none"> Negligible risk due to the size and nature of discharges
CSOs <i>Negligible risk</i>	<ul style="list-style-type: none"> Negligible risks due to the size and nature of discharges

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 RHONDDA FAWR RESERVOIR 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 Rhondda Fawr 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 Rhondda Fawr – Reaches 1, 2 and 3				
Notable Species – Fish Atlantic salmon <i>Salmo salar</i> Brown trout (including sea trout), <i>Salmo trutta</i> Twaite shad <i>Alosa fallax</i> Allisshad <i>Alosa alosa</i> Bullhead <i>Cottus gobio</i> Sea lamprey <i>Petromyzon marinus</i> , Brook lamprey <i>Lampetra planeri</i> , River lamprey <i>Lampetra fluviatilis</i> and coarse fish species	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	A number of fish species are known to be present within the Afon Rhondda Fawr, 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 are may alter habitat and availability for the resident fish community.	Major	Yes
Notable Species – Invertebrates White Clawed Crayfish <i>Austropotamobius pallipes</i>	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	There are no records of white-clawed crayfish within the Afon Rhondda Fawr but they have been recorded elsewhere in the catchment. The Environment (Wales) Act Section 7 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.	Uncertain	Yes
Notable Species – Mammals Otter <i>Lutra lutra</i> Water voles <i>Arvicola terrestris</i>	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	Otter are known to be present within the Rhondda valley, including records of their presence along the Afon Rhondda Fawr. Otter are water-dependent, foraging in, over or adjacent to water for fish and aquatic invertebrates. However this species are 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 vole are not known to be present along the impacted reaches of the Afon Rhondda Fawr and would not be expected to be impacted by the implementation of this drought permit.	Negligible	No
Notable Species Small grey sedge <i>Glossosoma intermedium</i>	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	The Small grey sedge <i>Glossosoma intermedium</i> is one of Britain's rarest caddis flies; it is classified as a Rare (Red Listing based on pre 1994 IUCN guidelines). There is uncertainty surrounding the impact the drought permit will have on this species.	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)
Macrophyte community	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	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 Rhondda Fawr. Changes to wetted width and velocity could potentially reduce habitat availability and community composition.	Moderate	Yes
Macroinvertebrate community	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	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 Rhondda Fawr. Changes to wetted width and velocity could potentially reduce habitat availability and community composition.	Moderate	Yes
Phytobenthos community	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	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 Rhondda Fawr. Changes to wetted width and velocity could potentially reduce habitat availability and community composition.	Moderate	Yes
Invasive non-native flora Monkey flower <i>Mimulus guttatus</i>	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	There is uncertainty surrounding the influence of the hydrological impacts associated with the implementation of this drought permit and whether they will lead to increasing the distribution of invasive non-native species in the Afon Rhondda Fawr.	Uncertain	Yes
Landscape	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	The Afon Rhondda Fawr rises on the southern edge of the Brecon Beacons National Park. From here it flows through a deep narrow valley linking the scenic, unspoilt landscapes of the Brecon Beacons to the urban and industrial areas of Treherbert, Treorchy, Tonypandy and Porth. Reductions in flow may alter the visual amenity of the area during drought permit implementation.	Moderate	Yes
Recreation	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	The proximity of the Brecon Beacons National Park presents a range of recreational activities to the population within the study area such as walking and cycling. The Afon Rhondda Fawr also provides stocked and natural population of brown trout for angling. Reductions in river flows, width, depths and velocities may have significant impacts upon angling activities specifically.	Uncertain	Yes
Archaeology	Reach 1 (Minor) Reach 2 (Major) Reach 3 (Negligible)	There are no scheduled ancient monuments within 500m of the impacted reaches 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	Rhondda R – source to conf Afon Rhondda Fach (GB109057027200)		Rhondda R - conf Afon Rhondda Fach to conf R Taff (GB109057027230)	
Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Major		Negligible	
Heavily Modified Waterbody (Y/N)	No		No	
RBMP Cycle	RBMP2 (2015) ⁶	2018 C2 Interim ⁷	RBMP2 (2015)	2018 C2 Interim
Ecological	Good	Moderate	Good	Good
Fish	Good	Moderate	Not assessed	Not assessed
Macrophytes and Phytobenthos combined	Not assessed	Not assessed	Not assessed	Not assessed
Macrophytes	Not assessed	Not assessed	Not assessed	Not assessed
Phytobenthos	Not assessed	Not assessed	Not assessed	Not assessed
Macro-invertebrates	High	High	Good	Good
Total P/ Phosphate	High	High	High	High
Ammonia	High	High	High	High
Dissolved Oxygen	High	High	High	High
pH	High	High	High	High
Sensitivity (Uncertain, Moderate/ Major, Minor, Not sensitive)	Major		Not sensitive	
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

⁶ NRW (2017) <https://drive.google.com/file/d/0B2hsDbbdxztZHIItRU9lNkg1YWw/view>.

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

completed for each of the sensitive receptors, where applicable, in order to determine the magnitude of impact in the Afon Rhondda Fawr 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 – 5.3.5.

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
Reach 1: Headwaters to new intake (Treherbert)													
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
Risk to WFD waterbody macroinvertebrate status		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/A
Brown / sea trout	Adult upstream migration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	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	N	N	N/A
European eel		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Other fish species- Minnow, threespined stickleback and stone loach		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
Phytobenthos		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
White-clawed crayfish		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 – New intake (Treherbert- Afon Rhondda Fach confluence)													
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>Glossosoma intermedium</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		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Other fish species - Minnow, three spined stickleback and stone loach		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A

Month		J	F	M	A	M	J	J	A	S	O	N	D
Risk to WFD waterbody fish status		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Phytobenthos		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
White-clawed crayfish		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A				N/A
Invasive Species - <i>Mimulus guttatus</i>		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	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 3- Afon Rhondda Fawr / Afon Rhondda Fach confluence- River Taff confluence													
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	N	N	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	N	N	N/A
	Juveniles (habitat loss)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	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	N	N	N/A
European eel		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Other fish species – Minnow, threespined stickleback and stone loach		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
Phytobenthos		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N/A
White-clawed crayfish		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	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 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 GES for the waterbody to be classified as GEP. 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 Waterbody		Significance of Impact
Rhondda R – source to confluence Afon Rhondda Fach (GB109057027200) Current status: Not classified	<ul style="list-style-type: none"> Not assessed 	N/A
Feature	Impact	Significance of Impact
Reach 1: Headwaters to new intake (Treherbert)		
Macrophytes	<ul style="list-style-type: none"> Increased water depth, siltation and growth of marginal plants. Risk of soluble reactive phosphorus deterioration 	Negligible
Reach 2 – New intake (Treherbert- Afon Rhondda Fach confluence)		
Macrophytes	<ul style="list-style-type: none"> Reduction in wetted area and velocities. Desiccation of some species such as bryophytes Increase in marginal species. Risk of soluble reactive phosphorus deterioration 	Moderate (September) Minor (October-November)
Reach 3- Afon Rhondda Fawr / Afon Rhondda Fach confluence- River Taff confluence		
Macrophytes	<ul style="list-style-type: none"> Very minor reduction in flows leading to a minor reduction in habitat availability. 	Negligible

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 Waterbody		Significance of Impact
Rhondda R – source to conf Afon Rhondda Fach (GB109057027200) Current status: High	<ul style="list-style-type: none"> There is a risk of short-term deterioration in status of the fish component due to the drought order. 	Minor
Feature	Impact	Significance of Impact
Reach 1: Headwaters to new intake (Treherbert)		
Macroinvertebrates	<ul style="list-style-type: none"> Increased depth directly upstream of the temporary weir, potentially leading to increased siltation. 	Negligible
Reach 2 – New intake (Treherbert- Afon Rhondda Fach confluence)		
Macroinvertebrates	<ul style="list-style-type: none"> Reduction in wetted area and velocities. Deterioration to ammonia and dissolved oxygen. 	Moderate (September) Minor (October- November)
Reach 3- Afon Rhondda Fawr / Afon Rhondda Fach confluence- River Taff confluence		
Macroinvertebrates	<ul style="list-style-type: none"> Very minor reduction in flows leading to a minor reduction in habitat availability. 	Negligible

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 Waterbody		Significance of Impact
Rhondda R – source to conf Afon Rhondda Fach (GB109057027200) Current status: Moderate (2018 interim)	<ul style="list-style-type: none"> There is a risk of short-term deterioration in status of the fish component due to the drought order. 	Major
Feature	Impact	Significance of Impact
Reach 1: Headwaters to new intake (Treherbert)		
Atlantic salmon	<ul style="list-style-type: none"> Delays and potential cessation of adult migration due to reduced flows and obstruction caused by sandbag weir. 	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. 	Negligible
Brown/sea trout	<ul style="list-style-type: none"> Delays and potential cessation of adult migration due to reduced flows and obstruction caused by sandbag weir. 	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. 	Negligible
Bullhead	<ul style="list-style-type: none"> Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow. 	Negligible
European eel	<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: New intake (Treherbert- Afon Rhondda Fach confluence)		
Atlantic salmon	<ul style="list-style-type: none"> Delays and potential cessation of adult migration due to reduced flows. 	Major (September) Minor (October - November)
	<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 (September) Minor (October - November)
Brown/sea trout	<ul style="list-style-type: none"> Delays and potential cessation of adult migrations due to reduced flows. 	Major (September) Minor (October - November)
	<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 (September) Minor (October - November)
Bullhead	<ul style="list-style-type: none"> Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow. 	Major (September)

		Minor (October - November)
European eel	• 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
Reach 3: Afon Rhondda Fawr / Afon Rhondda Fach confluence - River Taff confluence		
Atlantic salmon	Delays and potential cessation of adult migration due to reduced flows and obstruction caused by sandbag weir.	Negligible
	Reduced water quality.	Negligible
	Reduction in spawning and juvenile survival due to habitat loss.	Negligible
Brown/sea trout	Delays and potential cessation of adult and smolt migrations due to reduced flows and obstruction caused by sandbag weir.	Negligible
	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.	Negligible
European eel	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

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

Feature	Impact	Significance of Impact
Reach 1: Headwaters to new intake (Treherbert)		
Phytobenthos	<ul style="list-style-type: none"> Increase in nutrient levels 	Negligible
Reach 2 – New intake (Treherbert- Afon Rhondda Fach confluence)		
Phytobenthos	<ul style="list-style-type: none"> Reduction in wetted area and velocities, increase in nutrient levels. 	Moderate (September) Minor (October - November)
Reach 3- Afon Rhondda Fawr / Afon Rhondda Fach confluence- River Taff confluence		
Phytobenthos	<ul style="list-style-type: none"> Very low reduction in flows leading to a minor reduction in habitat availability. 	Negligible

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

Feature	Impact	Significance of Impact
Reach 1 Headwaters to new intake (Treherbert)		
White-clawed crayfish	<ul style="list-style-type: none"> Increased mortality as a result of deterioration to water quality. 	Minor
Reach 2 New intake (Treherbert-Afon Rhondda Fach confluence)		
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. 	<p>Major (September)</p> <p>Minor (October to November)</p>
Reach 3 Afon Rhondda Fawr / Afon Rhondda Fach confluence- River Taff confluence		
White-clawed crayfish	<ul style="list-style-type: none"> Small reductions in flows 	Negligible

5.3.4 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

Feature	Impact	Significance of Impact
Reach 2 New intake (Treherbert- Afon Rhondda Fach confluence)		
<i>Mimulus guttatus</i>	<ul style="list-style-type: none"> Implementation of the drought permit will do nothing to favour proliferation of this species. 	Negligible

5.3.5 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 & 3		
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 RHONDDA FAWR DROUGHT PERMIT – MITIGATION

The environmental assessment has identified some significant impacts, including major hydrological impacts, major aquatic ecology impacts including negligible to major impacts on fish and white clawed crayfish and moderate impacts on macrophytes, macroinvertebrates and phytobenthos.

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 Rhondda Fawr drought permit are given in **Table 9.1**. 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

No cumulative effects of implementing the Afon Rhondda Fawr 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 Rhondda Fawr.

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 Rhondda Fawr 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 RHONDDA FAWR 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 ENVIRONMENTAL MONITORING PLAN (EMP)

9.1 INTRODUCTION

The overall scope of the EMP for the Afon Rhondda Fawr 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 9.2.2.

9.2 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).

9.3 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 9.1**. and are illustrated on **Figure 9.1**.

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 as 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 9.1 Baseline, Pre, Onset, During and Post Drought Permit Monitoring and Mitigation Recommendations

Feature reach and	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 growth as a result of major impacts on water levels and flows.Changes to community composition due to changes to flow rates and habitat loss due to reduction in wetted widthIncrease in filamentous algae levels due to increased nutrients/water	<p>The macrophyte community in Reach 2 is reasonably well understood only. Control site to be established downstream in Reach 3 and monitoring in Reach 2 to improve temporal baseline.</p> <p>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">Reach 2 – NRW Site: At PentreReach 3 (Control) – Site location <i>TBC during walkover</i>	<p>Survey to be undertaken and macrophytes identified in September. Follow LEAFACS2 standard methodology ¹⁰.</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 order implementation occurs in 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 for soluble reactive phosphorus.</p>	<p>Consider measures to address identified point sources of nutrient loading.</p> <p>Consider scope for addressing any identified sources of nutrient loading from walkover survey, if this would help address water quality risks.</p>	<p>In the two years following drought order 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 actions:</p>	Welsh Water

¹⁰ Environment Agency (2011). Surveying freshwater macrophytes in rivers. Operational instruction 131_07. (Unpublished procedures manual)

Feature reach and	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)	
	temperature/decreased velocity	surveys outlined above.				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.	
Macroinvertebrates Reach 2	<ul style="list-style-type: none"> Reduction in species diversity and abundance as a result of reduced recruitment. 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. Deterioration to water quality directly and indirectly impacting community. 	<p>The macroinvertebrate community in the impacted reach is reasonably well understood as a result of monitoring carried out by NRW. Surveys to ideally be carried out to provide a three-year baseline dataset, then repeated every three years.</p> <p>Monitoring sites are located at the following sites:</p> <ul style="list-style-type: none"> Reach 2 – NRW Site: At Pentre Reach 3 (Control) - Site location TBC during walkover surveys outlined above. 	<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 order 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.</p> <p>Consider the removal of fine silt by manual raking of small areas.</p>	<p>In the two years following drought order 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 habitat quality, and flush sediment from benthic substrate.</p> <p>If sedimentation is deemed to be a risk to the community, consider the</p>	Welsh Water

Feature 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)	
						removal of fine silt by manual raking of any accessible shallow marginal areas. If recovery of the community does not occur within two years, consider the installation of fly boards at unimpacted sites during egg laying season, before transferring the boards to the impacted reach for eggs to hatch and re-populate.	
Fish (Atlantic salmon, brown/sea trout, bullhead, other fish species) Reach 1 & 2	<ul style="list-style-type: none"> Delays and potential cessation of a dult salmon/trout upstream migration due to reduced flows. Reduced water quality. Loss of spawning and juvenile habitat as a result of reduced river levels. Increased mortality (density dependant) as a result of increased predation and competition. 	<p>The fish community in the impacted reach is reasonably well understood as a result of monitoring carried out by NRW.</p> <p>Surveys to be repeated every three years. To complement any existing NRW monitoring, monitoring sites are located at:</p> <ul style="list-style-type: none"> Reach 1 – Redd counts to be carried out in Reach 1 to assess spawning Reach 2 – NRW Site: To13 or To13a (<i>TBC during walkover</i>) Reach 3 (Control) – NRW Site: To17a 	<p>Electric-fishing surveys to monitor fish populations at one site in Reach 2, redd counts in Reach 1 and a d/s control site on in Reach 3.</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 reaches:</p> <ul style="list-style-type: none"> Identification of key habitats which are at risk of low flow impacts. <p>Appropriate trigger values would be set for level and flow for spawning habitats based on local circumstances, timing, seasonality and expert opinion.</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> <p>Gravel washing of key spawning areas to be undertaken prior to salmonid spawning period (winter)</p> <p>Targeted installation of woody debris features to increase localised flow velocity/scour at impacted spawning gravels (to aid sediment</p>	<p>Two years of annual post-drought fish population surveys (including lamprey specific 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.</p>	Welsh Water

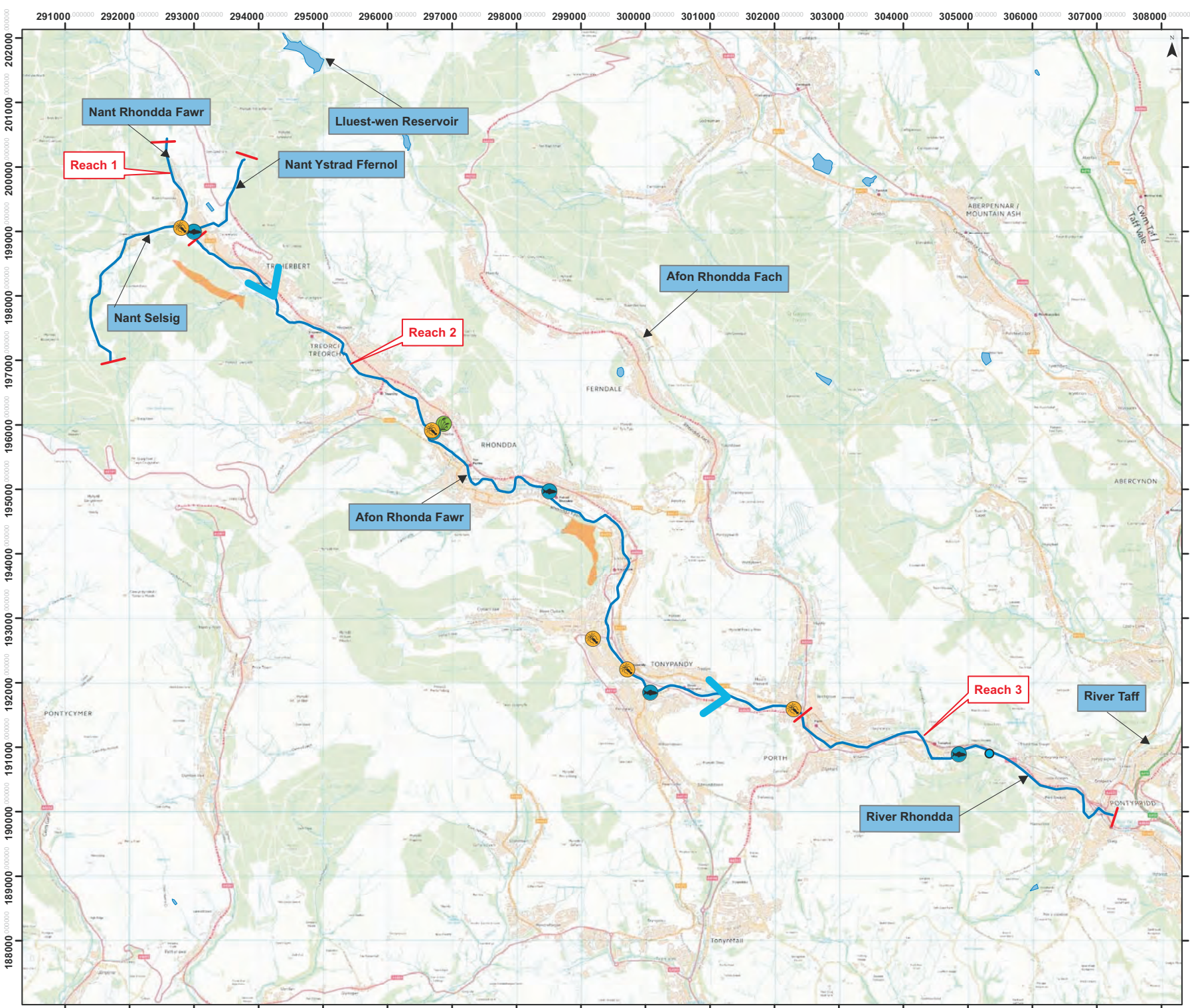
Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
					<p>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> <p>Deployment of aeration equipment in key reaches that have standing or slow flowing water with low oxygen levels.</p> <p>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> <p>Consider provision of physical deterrents to deter piscivorous birds at significant locations (e.g. scare crows) in consultation with NRW.</p> <p>In extreme cases (where environmental parameters such as dissolved oxygen and temperature allow),</p>	<p>Record extent of exposed marginal habitats, and composition of the bed substrate and estimates of overlaying 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 impacted 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	

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>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 upstream of the impacted reach (where environmental parameters such as dissolved oxygen and temperature allow).</p>	currently provided at a barrier, investigate appropriate methods of improving passage (e.g. fish passage design and installation).	

Feature 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)	
Phytoplankton Reach 2	<ul style="list-style-type: none"> Decrease in flow affecting phytoplankton community composition. High risk of deterioration to SRP affecting phytoplankton 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 2 and one site in Reach 3 (control). 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 crayfish 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. Reduction in availability of refuges Increased mortality (density dependant) as a result of increased 	<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 document¹¹.</p> <p>One survey to be undertaken per 500m survey stretch (survey stretches to be established during the initial baseline walkover). This will require:</p> <ul style="list-style-type: none"> X7 survey stretches in Reach 1 - X2 survey stretches in each of the three tributaries in Reach 	To be confirmed following baseline survey	To be confirmed following baseline survey	No additional measures specified.	To be confirmed following baseline survey	Welsh Water

¹¹ Peay S (2003). Monitoring the White-clawed Crayfish *Austropotamobius pallipes*. Conserving Natura 2000 Rivers Monitoring Series No. 1, English Nature, Peterborough

Feature 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>predation and competition</p> <ul style="list-style-type: none"> • 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. 	<p>1, and X1 survey stretch in the Rhondda Fawr in Reach 1</p> <ul style="list-style-type: none"> • X8 survey stretches in Reach 2 • X3 survey stretches in Reach 3 					



- Legend**
- Hydrological Reach
 - Flow Direction
 - Flow Gauge
 - Reservoir
 - Site of Special Scientific Interest
 - Fish Survey Site
 - Macroinvertebrate Survey Site
 - Macrophyte Survey Site



1:55,000
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: 8112-1
Afon Rhondda Fawr - Emergency abstraction
from the River Rhondda at Treherbert

Figure Number: Figure 10.1	Date: February 2019
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10 CONCLUSIONS

This EAR provides an assessment of the potential environmental impacts relating to the implementation of the Afon Rhondda Fawr drought permit. If granted and implemented, the drought permit would enable Welsh Water abstract up to 1Ml/d from a temporary intake at Treherbert on the Afon Rhondda Fawr, for transfer to the raw water storage reservoir at Tynywaun 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 Rhondda Fawr as a result of implementing the drought permit. Impacts on the Afon Rhondda Fawr from the confluence of the Afon Rhondda Fach to the confluence of the River Taff have been assessed as **negligible**. These hydrological impacts are assessed as leading to **minor** impacts on the physical environment of the river, including water quality and geomorphology.

An environmental assessment was therefore required and included for features where screening has identified a major or moderate impact. Screening identified WFD status and Community Assessment / Environment (Wales) Act Section 7 Species, invasive fauna, landscape and recreation as environmental features for which an environmental assessment was required. The assessment has concluded that during periods when abstractions from a temporary intake at Treherbert on the Afon Rhondda Fawr occur there are **major** impacts on fish, macrophytes and white-clawed crayfish and **moderate** impacts on macrophytes, macroinvertebrates and phytobenthos.

No cumulative effects of implementing the drought permit with 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 Rhondda Fawr.

The environmental assessment has identified significant impacts of implementation of a drought permit at the Afon Rhondda Fawr. 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 Rhondda Fawr, 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**.

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)

		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)

		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)

		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 – 8112-1 HYDROLOGY AND PHYSICAL ENVIRONMENT ASSESSMENT

B1 INTRODUCTION

This appendix assesses the potential impacts on the physical environment of the Afon Rhondda Fawr / River Rhondda catchment during implementation of the Afon Rhondda Fawr drought permit.

For the purposes of this assessment, the “without drought permit” baseline excludes any abstraction from the Afon Rhondda Fawr River, as there is currently no licence in place. The drought permit would involve abstraction of up to 1Ml/d from a temporary intake at Treherbert on the Afon Rhondda Fawr, for transfer to the raw water storage reservoir at Tynywaun WTW.

B.1.1 Welsh Water’s Existing Operations

Welsh Water have a number of licences to abstract water under the Water Resources Act 1991 which supply raw water to a raw water storage reservoir at Tynywaun water treatment works (WTW) on the outskirts of Treherbert:

- Llyn Fawr and Nant Garreg Lwyd (licence no. 21/57/24/0001).
- Nant Selsig (licence no. 21/57/24/0004).
- Nant Ystrad Ffernol (licence no. 21/57/24/0007).

No direct abstraction is currently made by Welsh Water from the Afon Rhondda Fawr to support raw water supply to the Tynywaun WTW. Water treated at Tynywaun WTW is put into local supply in the upper Rhondda Fawr valley, with any excess supplying the lower valley.

B.1.2 Welsh Water’s Proposed Drought Permit Operations

The drought permit involves a new, unsupported emergency river abstraction of 1Ml/d from the Afon Rhondda Fawr adjacent to Treherbert to support raw water supply to the raw water storage reservoir at Tynywaun WTW. To enable the abstraction, a low, temporary weir constructed of sandbags, would be required across the Afon Rhondda Fawr. 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 be implemented during the period from September to November inclusive. This is based on water resources modelling undertaken by Welsh Water. The drought permit would influence the Afon Rhondda Fawr for a short distance downstream during ongoing low flow conditions; and the Nant Selsig, Nant Ystrad Ffernol and Nant Rhondda Fawr Stream upstream of the temporary weir. The study area is shown on **Figure B1.1**.

The physical environment includes consideration of hydrology and hydrodynamics;

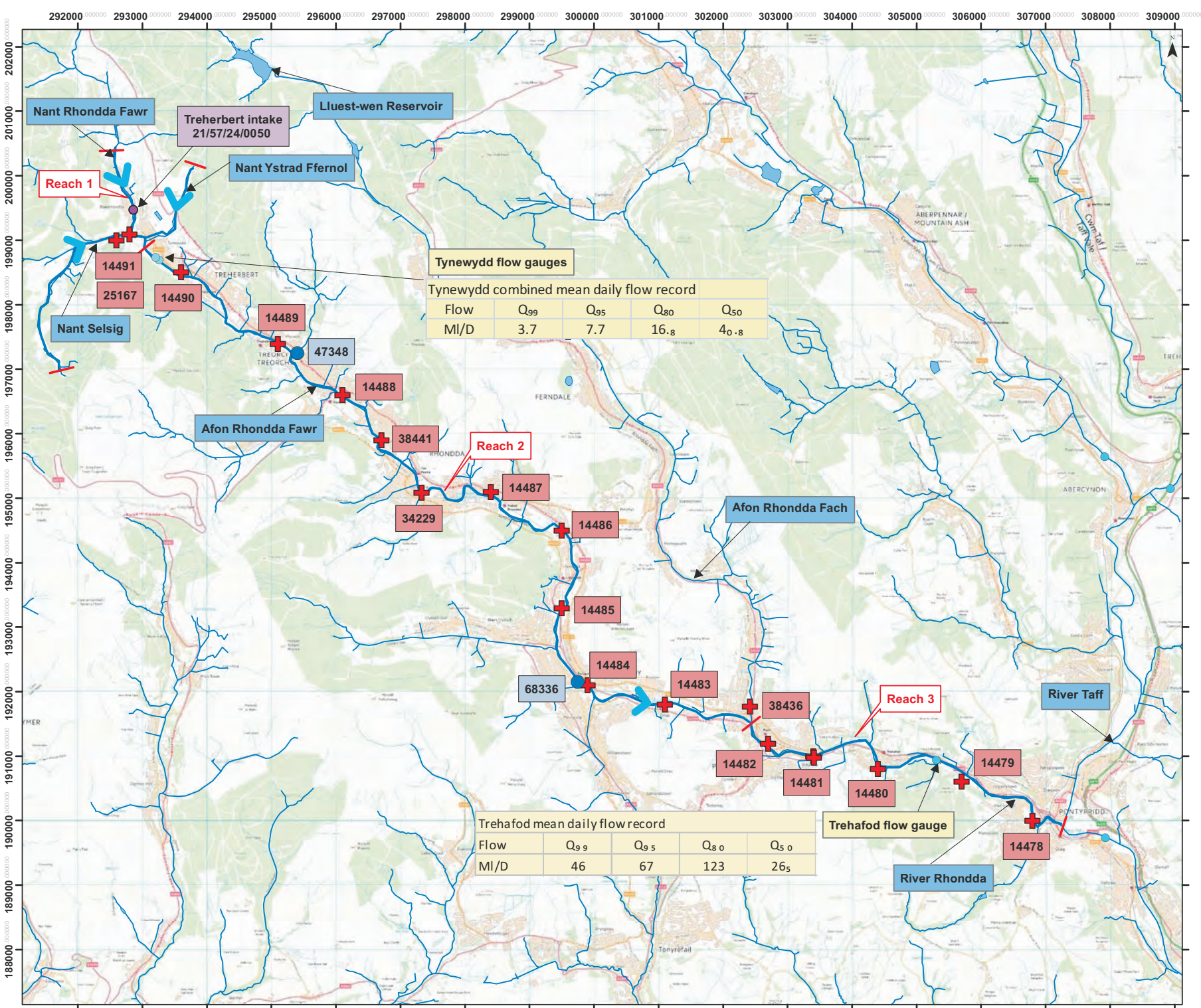
geomorphology; and water quality. The assessment has three key objectives:

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.
3. 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
- Reservoir
- Abstraction
- Flow Gauge
- Water Quality Monitoring Site
- RHS Site

1:55,000
Note: All locations are approximate
This drawing incorporates Ordnance Survey information
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Project Title: Welsh Water Drought Plan
Environmental Assessment

Hydrological Overview: 8112-1
Afon Rhondda Fawr - Emergency abstraction
from the River Rhondda at Treherbert

Figure Number:
Figure B1.1

Date:
February 2019

B2 HYDROLOGICAL IMPACT

B.2.1 Reference Conditions

B.2.1.1 Catchment Overview

The Afon Rhondda Fawr and Afon Rhondda Fach rise on the southern edge of the Brecon Beacons and cut through deep narrow valleys in their upper reaches before combining as the River Rhondda at Porth. At their confluence, the Afon Rhondda Fawr has a larger catchment area (65km²) than the Afon Rhondda Fach (30km²), with flow in both catchments affected by minewater discharges. The River Rhondda is a tributary of the River Taff, 5.9km downstream at Pontypridd. The River Taff then opens out onto broader meandering lowland plains and flows into Cardiff Bay.

Throughout the catchment there has been heavy industrial and urban development along the valley floors and the banks of the main rivers and their tributaries. The high altitude and close proximity to the sea creates a mild and wet climate. Following wet weather, river flows increase rapidly, but during prolonged dry periods, river flows become low and many small springs have a tendency to dry up due to the lack of long term groundwater storage².

Flow in the upper Afon Rhondda Fawr is unsupported and subject to abstractions from the Nant Garreg Lwyd, Selsig and Ystrad Ffernol stream intakes. A new surface water abstraction would result in the removal of a proportion of the downstream flow.

A review of the flows and physical habitat characteristics of the river network in the upper River Rhondda has identified the study area for this assessment (see **Figure B.1.1**). The study area includes the Afon Rhondda Fawr and its headwaters, and its continuation downstream of the Afon Rhondda Fach confluence, the River Rhondda; comprising three distinct hydrological reaches, as listed in **Table B.2.3** and identified on **Figure B.1.1**. Potential hydrological impacts associated with drought permit implementation have been reviewed for each of the three reaches, as discussed below.

B.2.1.2 Baseline Data Availability

Continuous monitoring of flow in the Afon Rhondda Fawr and downstream River Rhondda is undertaken by NRW. Available data include:

- Tynewydd flow gauges, Afon Rhondda Fawr; daily river flow 1989 to 2016
- Trehafod flow gauge, River Rhondda; daily river flow 1970 to 2014

B.2.1.3 Hydrology

Afon Rhondda Fawr at Tynewydd

Flow is measured in the Afon Rhondda Fawr at Tynewydd. The flow record for the current gauge, station number 057809 (NGR: SS9325998687), covers the period 17/4/2001 to date.

² Environment Agency Wales (2000) Local Environment Agency Plan, Taff Area Action Plan. April 2000. Environment Agency Wales

However, data from a previous nearby gauge, station number 057809A (NGR: SS9320398734), is also available for an earlier period from 10/2/1989 to 30/9/1998 and 11/2/2003 to 21/9/2004. The summer low flow statistics for the two gauges are very different; the values from the current record of summer $Q_{95}=12.4\text{Ml/d}$ and $Q_{99}=10.2\text{Ml/d}$ are significantly higher than the corresponding values from the earlier record (summer $Q_{95}=5.4\text{Ml/d}$ and $Q_{99}=2.0\text{Ml/d}$). This is likely to be due to a number of particularly dry years such as 1990 and 1995 in the earlier record, than to the slight difference in location. However, it was also noted that during the overlap period of 2003/04, daily flows from station number 057809A were consistently higher than corresponding flows from station number 057809.

In order to make use of the earlier data, therefore, we carried out a linear regression between the overlapping daily data record from 2003/04 to estimate the relationship between the two data sets; we then applied this as an adjustment to the “old” record from 1989 to 1998 and appended this at the start of the “new” record from 2001 to 2016.

Consideration was also given to adjusting the earlier data record for a previous drought permit which allowed abstraction of up to 2Ml/d from the Afon Rhondda Fawr headwaters during the period 23/8/1989 to 21/2/1990. However, data on actual abstractions was not available for this period, and a trial adjustment (flow naturalisation) based on the maximum abstraction of 2Ml/d during the period made no difference to the summer flow statistics, as these are mainly determined by the lowest flow period of 1995/96.

A summary of the available combined daily flow data record from 1989 to 2016 is given in **Table B2.1** below.

Table B2.1 Summary of Combined Mean Daily Flow Record in Afon Rhondda Fawr at Tynewydd (1989 – 2016)

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	1209.6	1313.3	1411.5	1418.2	1503.7	1019.5	813.9	800.1	933.1	1071.4	846.7	1330.6	1411.5
10% (high flow)	338.6	242.8	165.8	106.0	102.7	84.0	132.2	147.7	138.0	230.7	318.8	330.0	203.0
50%	102.2	57.1	46.3	30.9	26.6	22.4	24.8	27.2	26.9	63.6	81.0	77.0	40.8
80%	44.5	27.8	23.3	15.9	11.5	11.3	12.0	11.8	13.4	21.2	35.6	29.5	16.8
90%	30.2	15.8	17.6	13.0	7.5	7.6	7.7	7.6	9.2	11.6	24.6	18.4	11.0
95% (low flow)	22.7	10.9	12.2	11.1	5.3	5.4	6.2	4.8	6.7	9.4	18.6	14.6	7.7
99% (extreme low flow)	10.2	8.0	6.8	5.3	2.8	3.4	3.6	1.2	2.2	6.9	9.6	8.8	3.7
Minimum flow	8.4	5.9	6.1	4.4	2.4	2.5	2.5	1.1	1.0	5.9	6.9	7.4	1.0

The low flow statistics in Afon Rhondda Fawr at Tynewydd for the summer period (1 April to 30 September inclusive) are: Summer $Q_{95} = 6\text{Ml/d}$; Summer $Q_{99} = 2.5\text{Ml/d}$.

Figure B2.1 shows the typical pattern of flows at Tynewydd for part of the adjusted period from 1989 to 1995, and **Figure B2.2** from the current gauge from 2005 to 2006, and the combined flow duration curve is shown in **Figure B2.3**.

Figure B2.1 Afon Rhondda Fawr at Tynewydd Adjusted Flows (1989-1995)

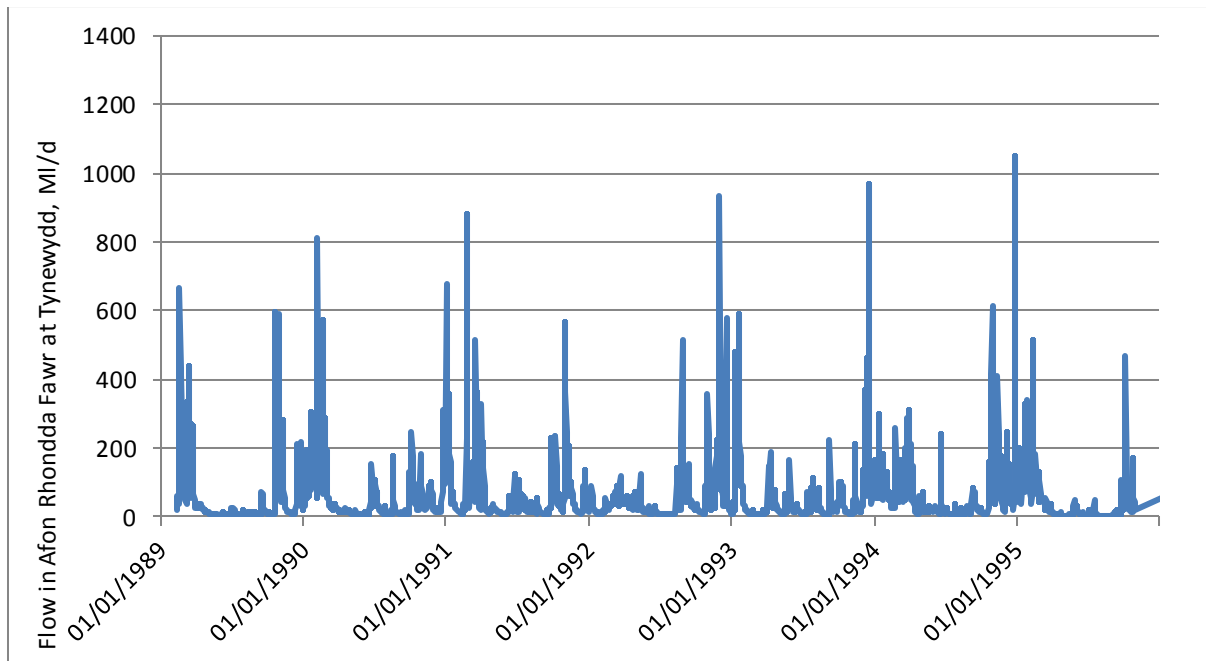


Figure B2.2 Afon Rhondda Fawr at Tynewydd Flows (2005 – 2006)

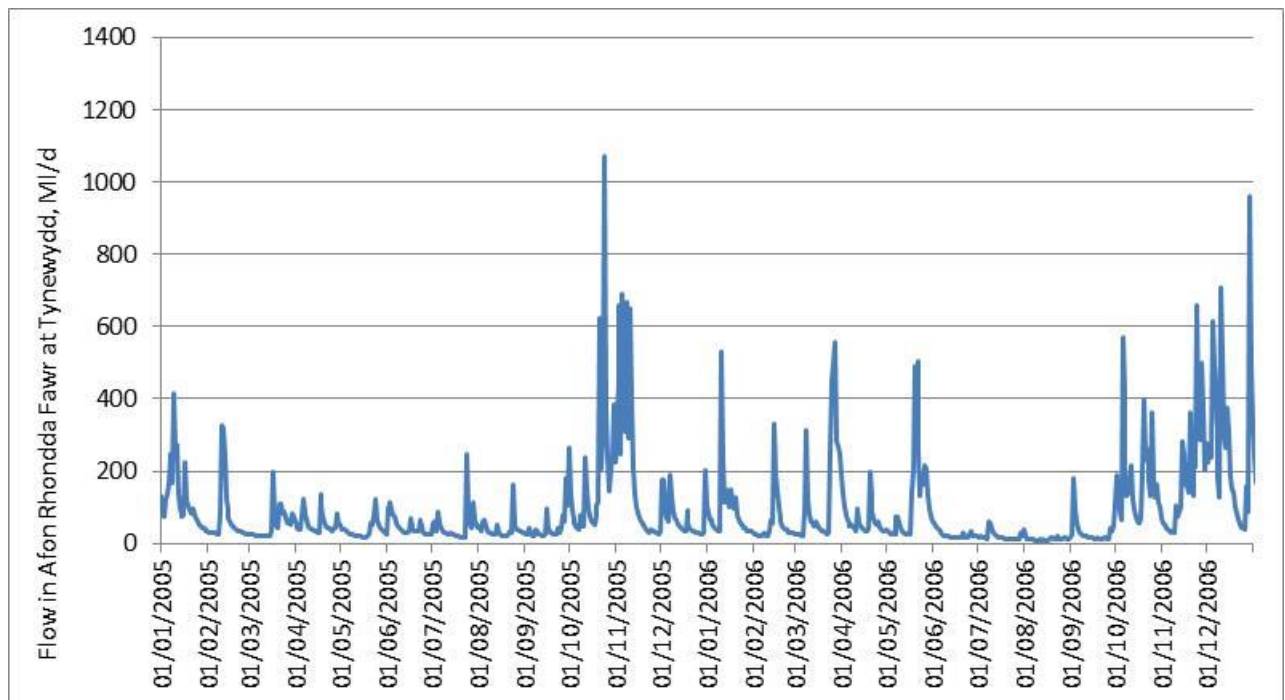
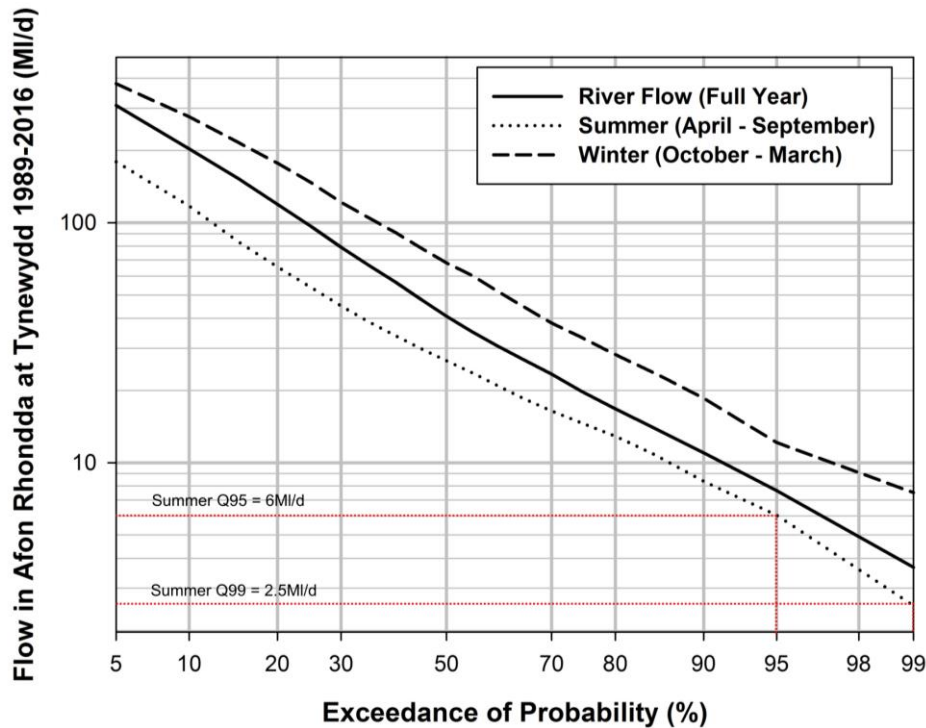


Figure B2.3 Afon Rhondda Fawr at Tynewydd Flow Summary (1989 – 2016)



River Rhondda at Trehafod

Flow is measured in the River Rhondda at Trehafod (NGR: ST0528390946). A summary of the available daily flow data from 1970 to 2014 is given in **Table B2.2** below.

Table B2.2 Summary of Recorded Mean Daily Flow in River Rhondda at Trehafod (1970 – 2014)

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	6134	7111	7604	2626	4067	4821	4337	4544	6437	7500	5718	8821	8821
10% (high flow)	1904	1497	1054	757	563	484	541	719	867	1411	1741	1943	1187
50%	566	379	298	218	170	145	132	167	187	366	524	496	265
80%	260	193	167	127	105	84	77	85	92	162	232	230	123
90%	184	154	133	102	88	61	63	61	70	105	173	164	88
95% (low flow)	148	131	101	89	70	51	53	54	57	72	140	137	67
99% (extreme low flow)	93	88	86	72	53	38	29	36	44	49	72	102	46
Minimum flow	76	73	70	61	44	32	26	31	30	42	56	90	26

The low flow statistics in the River Rhondda at Trehafod for the summer period (1 April to 30 September inclusive) are: Summer Q_{95} = 58Ml/d; Summer Q_{99} = 39Ml/d.

Figure B2.4 shows the typical pattern of flows at Trehafod from 2005 to 2006, and the flow duration curve is shown in **Figure B2.5**.

Figure B2.4 River Rhondda at Trehafod Flows (2005 – 2006)

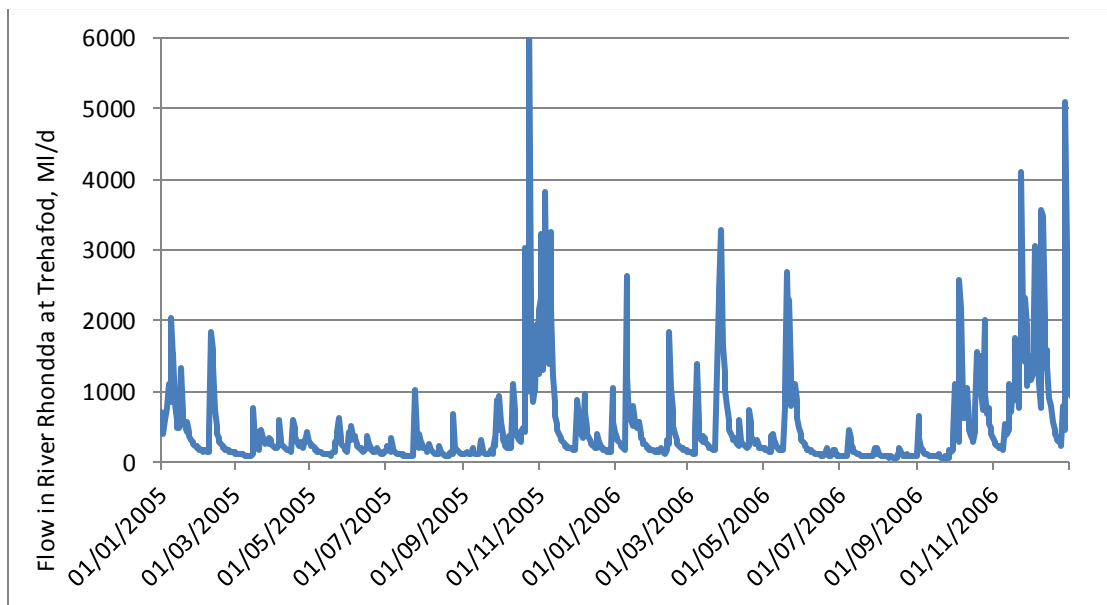
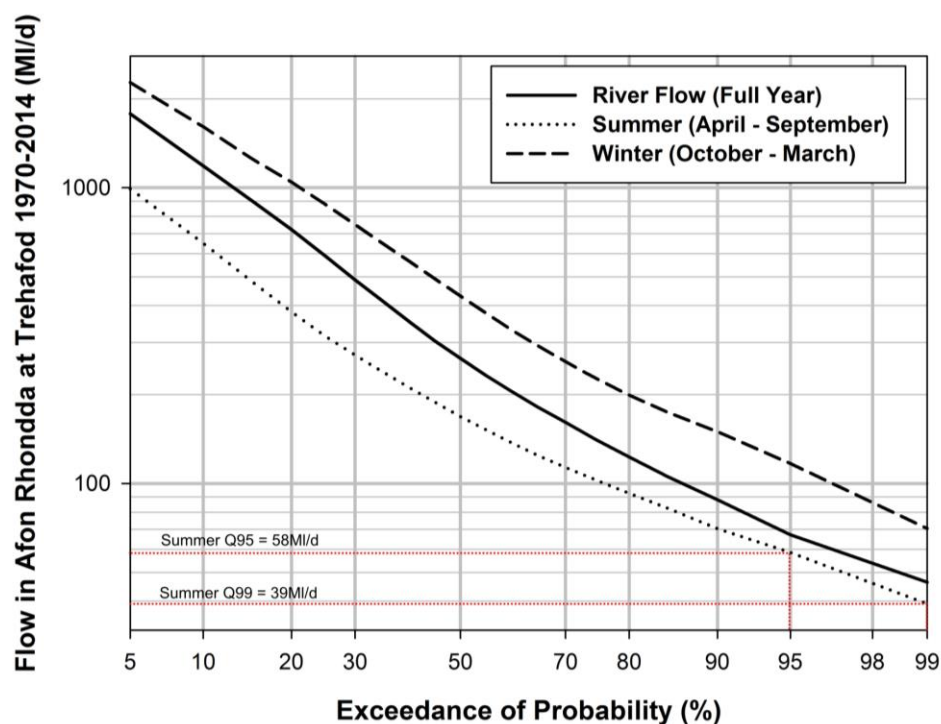


Figure B2.5 River Rhondda at Trehafod Flow Summary (1970 – 2014))



B.2.2 Hydrological Impact

B.2.2.1 Hydrological Zone of Influence

The study area includes the Afon Rhondda Fawr from the headwater streams (Nant Rhondda Fawr, Nant Ystrad Ffernol, Nant Selsig) down to the confluence with the Afon Rhondda Fach, and its continuation the River Rhondda downstream to the confluence with the River Taff,

comprising three distinct hydrological reaches as shown in **Figure B1.1**:

- Reach 1 is the headwater streams (Nant Rhondda Fawr, Nant Ystrad Ffernol, Nant Selsig) of the Afon Rhondda Fawr down to the proposed intake location at Treherbert.
- Reach 2 is the Afon Rhondda Fawr, from the proposed intake location at Treherbert down to the confluence with the Afon Rhondda Fach.
- Reach 3 is the River Rhondda, from the Afon Rhondda Fawr / Afon Rhondda Fach confluence down to the River Taff confluence near Pontypridd

Potential hydrological impacts of drought permit implementation have been assessed for each reach, as summarised in **Table B2.3** at the end of this section. Details of the assessment are presented below.

B.2.2.2 Hydrological Impact Assessment

A number of spot flow gauging results are available from the site of the previous Tynewydd gauge (station number 057809A) prior to the start of the continuous daily gauged record in 1989. The lowest values of 6.0Ml/d on 30/7/1984 and 7.1Ml/d on 24/8/1976 both correspond to values of approximately the summer Q_{99} or lower at the Trehafod gauge, observed on those dates. However, inspection of the data indicates that the lowest flows measured at Tynewydd during the summer of 1995 do not correspond with a period of extreme low flows at the Trehafod gauge, so as a precautionary approach we have used the lower values of Q_{99} and Q_{95} , based on the adjusted gauged record from 1995, for the assessment.

Reach 1 – Afon Rhondda Fawr headwater streams to the proposed intake at Treherbert

The three headwater streams of the Afon Rhondda Fawr – the Nant Selsig, Nant Ystrad Ffernol and the Nant Rhondda Fawr are steep mountain streams draining the valley sides and head. These streams comprise Reach 1. The flow regimes of the Nant Selsig and Nant Ystrad Ffernol are managed through Welsh Water abstractions. The Nant Garreg Lwyd is a small headwater tributary of the Nant Rhondda Fawr whose flow regime is also managed through Welsh Water abstractions. All three sub-catchments are dominated by commercial forestry, and the Nant Rhondda Fawr flows through former colliery areas and is culverted in sections. At the downstream end of Reach 1, below the confluences of the streams, is the Afon Rhondda Fawr.

The drought permit does not amend the flow regime of streams in Reach 1. 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 in a short stretch of river 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 to be **minor** during the period of implementation of the drought permit from September to November inclusive. In addition, there would be potential hydro-ecology impacts associated with the

physical barrier of the temporary weir across the river.

Reach 2 – Afon Rhondda Fawr, from the proposed intake at Treherbert to the confluence with the Afon Rhondda Fach

The Afon Rhondda Fawr in Reach 2, is an upland river of a predominantly cobble substrate with ripple flow. The channel is constrained by a steep-sided, heavily urbanised valley with a limited floodplain (typically less than 200m wide) and an extensively modified channel which is developed in alluvium. The channel is wide and shallow, varying greatly downstream, from 9m to 20m bankfull width and 0.1 to 0.45m bankfull depth. The land cover on the surrounding hillslopes comprises rough grazing, commercial forestry and grassland.

During a drought, river flows would be low and the drought permit will have an impact on the river, comprising a significant reduction in wetted width and wetted depth below those observed in the Afon Rhondda Fawr without the drought permit. In upper Reach 2, summer low and extreme low flow conditions are represented by the Q_{95} and Q_{99} summer (April to September inclusive) flow statistics of the combined Tynewydd daily flow record, which are 6Ml/d and 2.5Ml/d respectively. A flow reduction of 1Ml/d due to the drought permit abstraction is therefore a 17% reduction in the Q_{95} summer low flow, and a 40% reduction in the Q_{99} summer extreme low flow. The potential hydrological impact of drought permit implementation in Reach 2 is therefore considered to be **major** during the summer month of September. The impacts will lessen further downstream due to flow accretion, although at times of low flow the magnitude of the flow accretion is likely to be low.

During the winter, year round flow statistics in upper Reach 2 are estimated as 7.65Ml/d (Q_{95}) and 40.5Ml/d (Q_{50}). The flow reduction of 1Ml/d due to the drought permit abstraction therefore represents percentage reductions of 13.1% and 2.5% respectively. This would be assessed as a **minor** hydrological impact during the winter months of October to November inclusive.

Reach 3 – River Rhondda, from the Afon Rhondda Fawr / Afon Rhondda Fach confluence to the River Taff confluence

Summer flow statistics for Reach 3 are provided by the NRW flow gauge at Trehafod on the River Rhondda and are as follows: $Q_{95} = 58\text{Ml/d}$; $Q_{99} = 39\text{Ml/d}$. The emergency abstraction of 1Ml/d thus represents reductions of around 1.7% and 2.6% in the summer low and extreme low flows respectively. The hydrological impact of drought permit implementation on Reach 3 has therefore been assessed as **negligible** during the summer month of September.

The year round flow statistics at the Trehafod flow gauge are as follows: $Q_{95} = 67\text{Ml/d}$; $Q_{50} = 265\text{Ml/d}$. The temporary abstraction of 1Ml/d under this drought permit would therefore represent percentage reductions of 1.5% and 0.4% respectively in these flow values. This would therefore be assessed as a **negligible** hydrological impact during the winter months of October to November inclusive.

B.2.2.3 Hydrological Impact Summary

Three river reaches have been considered for which the assessed hydrological impacts range from **negligible** to **major** during the summer month of September, and from **negligible** to **minor** during the winter months of October to November. The impacted reaches are shown in **Table B2.3** and **Table B2.4** and establish the full in-channel zone of influence of the drought permit for environmental sensitivity screening (see **Figure B1.1**).

Table B2.3 Hydrological reaches and impacts identified in the study area – Summer impact (September)

Hydrological Reach		Reach boundary		Reach length	% flow reduction		Hydrological Impact (summer)	Clarification
		Upstream	Downstream		Summer Q ₉₅	Summer Q ₉₉		
1	Headwater streams	Headwaters	New intake (Treherbert)	5.9km	0%	0%	Minor	Local ponding effect of temporary weir.
2	Afon Rhondda Fawr	New intake (Treherbert)	Afon Rhondda Fach confluence	15.6km	17%	40%	Major	-
3	River Rhondda	Afon Rhondda Fawr / Afon Rhondda Fach confluence	River Taff confluence	5.9km	1.7%	2.6%	Negligible	-

Table B2.4 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)	Clarification
		Upstream	Downstream		Year round Q ₅₀	Year round Q ₉₅		
1	Headwater streams	Headwaters	New intake (Treherbert)	5.9km	0%	0%	Minor	Local ponding effect of temporary weir.
2	Afon Rhondda Fawr	New intake (Treherbert)	Afon Rhondda Fach confluence	15.6km	2.5%	13.1%	Minor	-
3	River Rhondda	Afon Rhondda Fawr / Afon Rhondda Fach confluence	River Taff confluence	5.9km	0.4%	1.5%	Negligible	-

B3 PHYSICAL ENVIRONMENT ASSESSMENT

B.3.1 Geomorphology

Geomorphological information for the Afon Rhondda Fawr was obtained from RHS surveys and previous assessments such as the 2007 SE11 Environmental Management Plan (EMP)³, and augmented where necessary by extant aerial imagery. RHS data are available for 18 sites; two in Reach 1 (survey IDs: 14491, 25167), 11 sites in Reach 2 (survey IDs: 14483- 14490, 34229, 38441, 38436) and five sites in Reach 3 (survey IDs: 14478 - 14482). Headwater streams delineate Reach 1, with Reach 2 beginning slightly downstream of the start of the river's main stem and Reach 3 delineated by the confluence with the Afon Rhondda Fach. The river is underlain by alluvium and glaciofluvial deposits, with glacial till deposits on valley sides.

Reach 1 - Afon Rhondda Fawr headwater streams to the proposed intake at Treherbert

The Afon Rhondda Fawr's three headwater streams – the Nant Selsig, Nant Ystrad Ffernol and the Nant Rhondda Fawr - are steep mountain streams draining the valley sides and head. All three sub-catchments are dominated by commercial forestry, and the Nant Rhondda Fawr flows through former colliery areas and is culverted in sections. Two RHS surveys (survey IDs: 14491, 25167) are located towards the downstream end of this reach. Right bank heights of 2.5 m were recorded in both surveys, whilst left bank height decreased from 3.5 to 2 m, width increased from 2.5 to 6.2 m and depth increased from 0.1 to 0.35 m, all in a downstream direction. Riparian tree cover is semi-continuous on both banks in the upstream RHS survey site (survey ID: 25167), decreasing to isolated or scattered in the downstream survey (survey ID: 14491). Urban land use increases markedly in the areas downstream of the RHS surveys and the valley is consistently narrow and steep-sided.

RHS data indicates some flow heterogeneity in this reach, and riffles and unvegetated point bars have also been observed, however both surveys also indicate a heavily modified river in the downstream section of the reach with habitat modification scores of 2565 (survey ID: 14491) and 3465 (survey ID: 25167). Bridges and outfall deflectors contribute to the modification, but the largest influences are bed and bank reinforcement and channel resectioning. Small amounts of in-channel vegetation were recorded.

Sedimentation effects from drought permit implementation are presumed to be minimal, however a temporary weir would be required for abstraction. This will have a local ponding effect, increasing wetted depth and width, whilst reducing flow velocity and potentially increasing fine sediment deposition in a short stretch of river behind the sandbags. This impact is assessed as negligible.

³ Cascade Consulting (2007). Provision of an Environmental Monitoring Plan. Environmental Monitoring Plan for River Rhondda adjacent to Treherbert (SE11). Final. 23rd May 2007. A report for DCWW by Cascade Consulting.

Reach 2 - Afon Rhondda Fawr, from the proposed intake at Treherbert to the confluence with the Afon Rhondda Fach

This reach varies in sinuosity, with straight sections and some large meanders. Flood walls have resulted in bank heights of up to 8m being recorded in RHS data, though in general left and right bank heights vary from 2-3.5m and 2-3.75m respectively. Width varies from 6-18m and depth from 0.1-0.45m. Riparian tree cover is largely semi-continuous along the length of the reach and bankside vegetation is mainly bare, with occasional simple vegetation structures. The channel is constrained by a steep-sided, heavily urbanised valley with a limited floodplain (typically less than 200m wide). Land cover on the surrounding hillslopes is composed of rough grazing, commercial forestry and grassland.

Channel substrate is composed predominantly of cobbles, with an increase in boulders in the substrate near the end of the reach. Flow patterns are dominantly rippled. RHS data indicate consistent presence of in-channel depositional features, with riffles recorded at all sites and unvegetated point bars at most sites. This reach is heavily modified, with HMS scores ranging from 2060 to 410 (mean HMS = 1217). Bridges are ubiquitous features. Bed and bank have had some reinforcement at all sites and nine RHS surveys indicate resectioning. Channel realignment has also been recorded on two adjacent surveys (IDs: 38441 and 34229) and impoundment in three surveys, all of which also have weirs. Low density in-channel vegetation was recorded in all RHS surveys.

Given the dominance of cobble substrate, it is presumed that fines are not prevalent in this reach. However, flow reductions associated with the drought permit will significantly reduce low flows and thus there is a risk of deposition of some of the fine sediment load due to wetted width and depth reductions and associated reductions in flow velocities, this is assessed as minor.

Reach 3 - Afon Rhondda Fawr/Afon Rhondda Fach confluence to the River Taff confluence

This reach varies in sinuosity, with straight and meandering sections flowing over a medium gradient. RHS data report left and right bank heights range from 2-5.5m and 2.5-6.5m, respectively, again indicating the presence of flood walls where bank heights are high. Width is highly variable, ranging from 8-20m and depth ranges from 0.15-0.5m. Riparian tree cover is largely semi-continuous on the left bank, whereas the right bank is characterised by more isolated or scattered trees. The floodplain is still highly constrained and largely urbanised. Land cover on adjacent hillslopes is rough grazing, forest or grassland.

Substrate information is not available for this reach, however superficial geology remains unchanged and thus it is assumed similar to Reach 2. All RHS surveys report the presence of riffles and pools, however this is a heavily modified river. HMS scores range from 2645 to 3240, with bridges present in all surveys, heavy bed and bank reinforcement, re-sectioning and channel realignment and over-deepening. Low to medium density in-channel vegetation was recorded at all RHS sites.

Abstraction under the drought permit represents reductions of <2.7% of extreme low flows and thus effects on wetted widths, depths and flow velocities are expected to be negligible. As such, increases to fine sediment deposition are also expected to be negligible.

B.3.2 Water Quality

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

To support the assessment of potentially sensitive environmental features (see **Appendix D**), a comprehensive analysis on the water quality of the river reaches impacted by the drought permit has been undertaken. Following WFD-UK technical advisory group (UKTAG) evidence⁴, the Environment Agency has set out⁵ Water Framework Directive (WFD) classification for pressures, including water quality pressures, to which each biological quality element is capable of responding to. For the purposes of assessment, supporting water quality parameters are set out as follows: dissolved oxygen saturation (DO) and total ammonia concentrations for fish and macroinvertebrates (where identified as sensitive features) and soluble reactive phosphorus (SRP) concentrations for macrophytes and algae (phytobenthos / diatoms) (where identified as sensitive features). 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 but if sufficient information is available on dissolved oxygen then a separate temperature assessment may not be necessary). Where data are lacking, the assessment has been undertaken using best professional judgement. Values at the limit of detection were halved in line with standard Environment Agency/NRW practice.

NRW routine monitoring data were reviewed to provide an overview of water quality in the zone of impact. In the Afon Rhondda Fawr catchment, within the extent of influence of the drought permit there are two NRW water quality sampling sites, as detailed in **Table B3.1** and **Figure B1.1**.

⁴ UK Technical Advisory Group on the Water Framework Directive (2008) Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive December 2007 (alien species list updated – Oct 2008 and Nov 2008). Appendix 1

⁵ Environment Agency (2011) Method statement for the classification of surface water bodies v2.0 (external release) Monitoring Strategy v2.0 July 2011 Table 2

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

Reach	Site Name	NRW Site Code	Grid reference
1	RHONDDA FAWR D/S CONFLUENCE WITH THE NANT ORKY	47348	SS9540097250
2	RHONDDA FAWR AT TONY PANDY RAILWAY STATION	68336	SS9975092154

Reach 1 - Headwater Streams - From Headwaters to new intake (Treherbert) (5.9km)

Water quality analysis for Reach 1 has been undertaken based on the data available at the Rhondda Fawr D/S confluence with the Nant Orky (47348) monitoring site. No data pertaining to total ammonia and SRP concentrations were available at this site. It is also worth noting that dissolved oxygen saturation data are very limited (2011 and 2012 only).

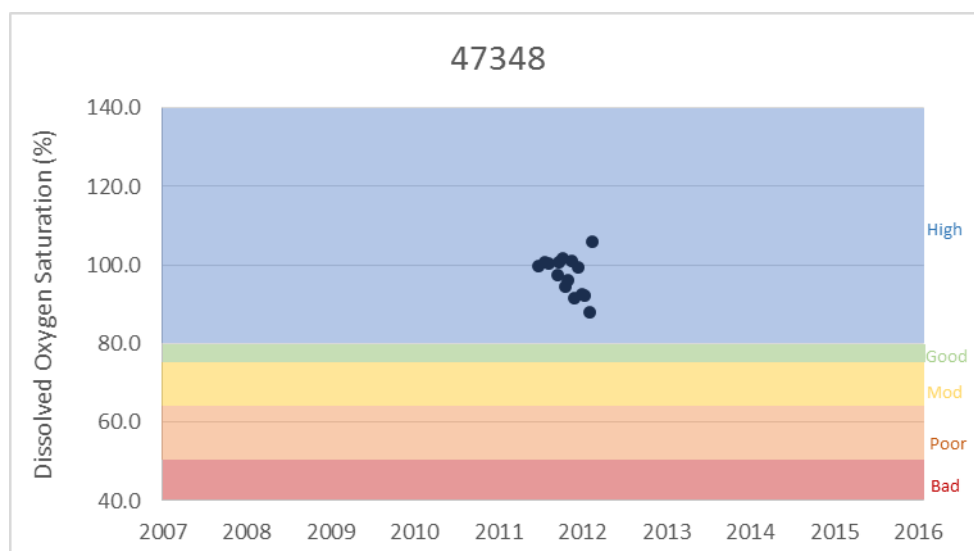
pH and Temperature

This site is characterised by an average pH of 7.8 and a maximum water temperature of 14.5°C.

Dissolved Oxygen Saturation

Dissolved oxygen saturation data from the Rhondda Fawr D/S confluence with the Nant Orky monitoring site were reviewed and presented in **Figure B3.2** against the relevant WFD standards for an upland low alkalinity river. Dissolved oxygen saturation measurements at this site exceed the WFD standard to support ‘good’ status (75% saturation) for fish and invertebrates for an upland low alkalinity river, and are indicative of a high water quality status.

Figure B3.2: Dissolved Oxygen Saturation at Rhondda Fawr D/S confluence with the Nant Orky, Incorporating Appropriate WFD Status Bands



Reach 2 - Afon Rhondda Fawr - From new intake (Treherbert) to Afon Rhondda Fach confluence (15.6km)

Water quality analysis for Reach 2 has been undertaken based on the data available at the Rhondda Fawr at Tonypany Railway Station (68336) monitoring site.

pH and Temperature

This site is characterised by an average pH of 7.8 and a maximum water temperature of 17.25°C.

Total Ammonia Concentrations

Total ammonia concentration data from Rhondda Fawr at Tonypany Railway Station were reviewed and presented in **Figure B3.3** against the relevant WFD standards for an upland low alkalinity river. Total ammonia concentrations at this site exceeded the WFD standard to support good status for fish and invertebrates (0.3mg/l), being thoroughly indicative of a high water quality status. An isolated instance in which total ammonia concentrations were indicative of a moderate status occurred in 2006, being associated with low flow (Q95 to Q80) conditions.

Figure B3.3: Total Ammonia concentrations at Rhondda Fawr at Tonypany Railway Station, Incorporating Appropriate WFD Status Bands

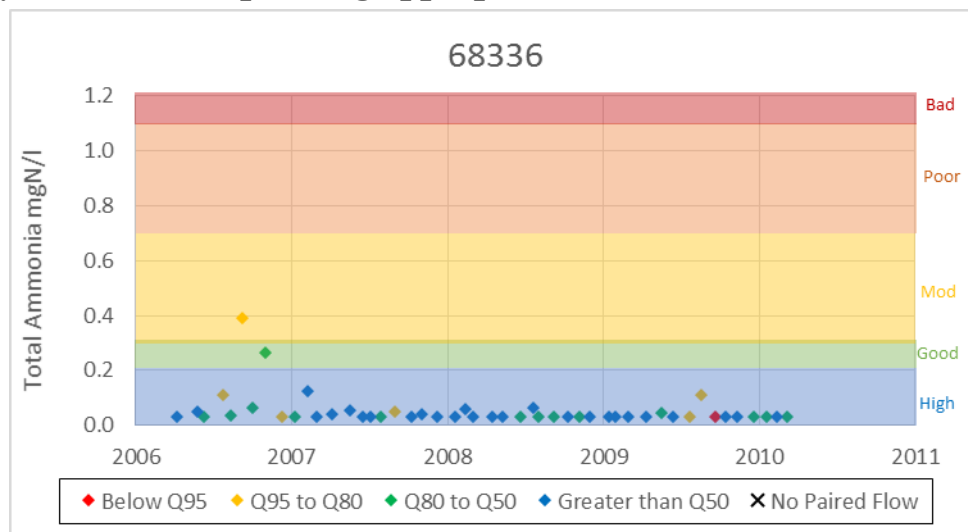
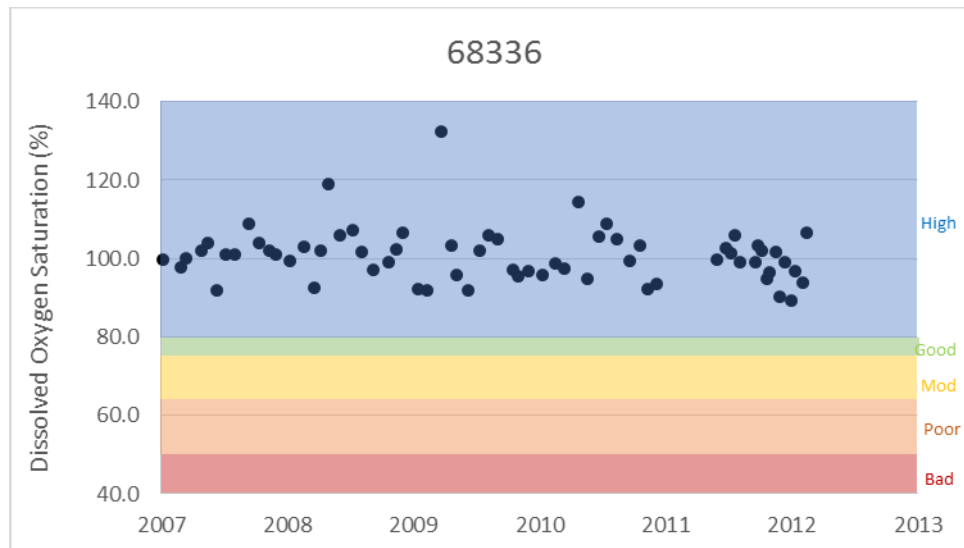


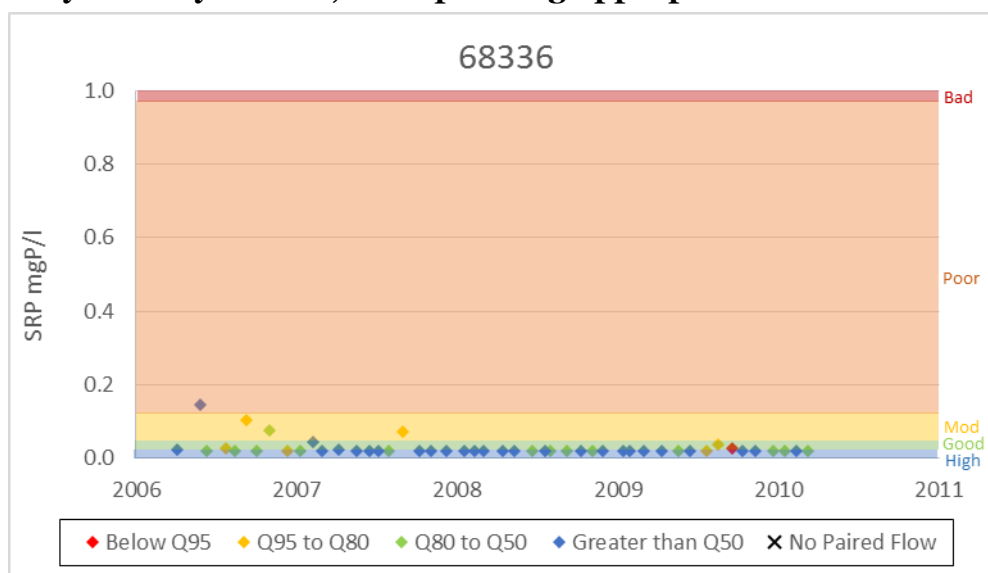
Figure B3.4: Dissolved Oxygen Saturation at Rhondda Fawr at Tonypandy Railway Station, Incorporating Appropriate WFD Status Bands



Soluble Reactive Phosphorus

SRP concentrations at Rhondda Fawr at Tonypandy Railway Station were reviewed and data are presented in **Figure B3.5** against the relevant WFD site specific standards provided by the Environment Agency⁶. Soluble reactive phosphorus concentrations at this site were mostly consistent with the WFD standard to support 'good' status (0.047 mgP/l) for fish and invertebrates for an upland low alkalinity river, occasionally falling short of this standard and crossing into the 'moderate' (three instances) and respectively 'poor' (one instance) status bands. No association with river flows is apparent at this location.

Figure B3.5: Soluble Reactive Phosphorus Concentrations at Rhondda Fawr at Tonypandy Railway Station, Incorporating Appropriate WFD Status Bands



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

Reach 3 – River Rhondda - From Afon Rhondda Fawr / Afon Rhondda Fach confluence to River Taff confluence (5.9km)

No water quality analysis has been conducted due to the negligible hydrological impact associated with the drought permit within this reach.

Water Quality Summary

Risks associated with water quality deterioration in Reach 3 due to Afon Rhondda Fawr drought permit implementation have been assessed considering water quality and hydrological impacts within Reaches 1 and 2. As hydrological impacts in Reach 3 are negligible, no assessment of water quality has been undertaken.

Throughout Reach 1, the limited dissolved oxygen saturation data are reflective of a high water quality status. The risk of water quality deterioration with respect to dissolved oxygen saturation was therefore assessed as **low**, due to the minor hydrological impact expected within this reach as well as the absolute compliance with the WFD ‘good’ standard observed at the site. No other parameters have been considered in this reach due to lack of data.

Throughout Reach 2, the water quality deterioration risk associated with total ammonia concentrations and dissolved oxygen saturations is assessed as **low**, despite the major hydrological impact predicted for this reach upon the implementation of the drought permit. This is justified by the excellent compliance with high WFD standards throughout the monitoring period as well as the lack of association between these water quality parameters and flow at this site. With regard to the risk of water quality deterioration associated with SRP concentrations, this is assessed as **high** due not only to the major hydrological impacts predicted for this reach but also to the history of occasional standard failure at this site.

B.3.3 Environmental Pressures

B.3.3.1 Flow Pressures

Surface Water Abstractions

There is one licensed surface water abstraction in the study area, located in Reach 1 (**Figure B1.1**). Licence 21/57/24/0050 held by the Upper Rhondda Angling Association is used to abstract water from the Nant Rhondda Fawr (NGR: SS928995) to support lake levels, year round, at a maximum daily rate of 1.97Ml/d and a maximum annual rate of 72Ml/d. The risk to the surface water abstractions is **minor** due to the effect of the drought permit on Reach 1.

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 final effluent from STWs. Discharges impacting the oxygen balance and ammonia concentration in the river reaches have been reviewed. Any 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).

There are 35 discharge permits (surface water outflows and surface sewer outflows) from various sources within the zone of influence of the Afon Rhondda Fawr drought permit (**Table B3.2**). Due to the size and location of these discharges, all are considered of **negligible** risk.

There are 19 discharge permits for CSOs (combined sewer overflows) from various sources within the zone of influence of the Afon Rhondda Fawr drought permit (**Table B3.3**). Due to the size and location of these discharges, all are considered of **negligible** risk.

Table B3.2 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 @ 105 C (mg/l)	Consideration of water quality pressure (during baseline low flow conditions)
A E2018401	Treherbert-Blaencwm Road/Tydraw Terrace SSo	SS9285099070	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A E2018402	Treherbert - Junction Bute St/Corbett St/David St	SS9420098180	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A E2018403	Treherbert - Rear Ynyswen Rd nr Ynysfeio Colliery	SS9475097560	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A E2018404	Treorchy - M/H at Side of Boys Club D/S Station Rd	SS9620096600	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A E2018405	Treorchy - Regent Street Pumping Station	SS9634096470	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A E2018407	Rees Street Pumping Station, Gelli, Rhondda Fawr	SS9775094960	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A E2018407	Rees Street Pumping Station, Gelli, Rhondda Fawr	SS9775094960	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A E2018409	Llwynypia Sewage Pumping Station	SS9964394004	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A E2018411	Dinas - Dinas Rd Station Road Sso	ST0067091840	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0050603	Area Adj. to Treorchy Pumping Station, Regent Street, Treorchy	SS9634096430	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0088001	Pentre - Volunteer Street PS	SS9653096130	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0106901	La ne to The Rear of School Street, Ton Pentre, Rhondda Fawr	SS9778095590	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0117901	Tylacelyn Road, Penygraig	SS9976091950	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0118301	Junction Nantgwyn Street and Hill Street, Penygraig	SS9967091910	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0118401	Glannant St/Dinas Rd, Cf401 Hn	ST0000291886	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0118601	Cymmer Road, Dinas, Porth, Rhondda	ST0241091350	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0122301	Gelli Crossing PS, Gelli, Pentre, Rct Cf417 Ud	SS9807395167	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0122501	Highway Adjacent to 18 River Street, Ystrad, Rhondda Fawr	SS9846095010	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0122601	Off Ynyscynon Road, Trealaw, Rhondda	SS9959093320	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0123601	Treherbert Pumping Station, Park Close, Treherbert, Rhondda	SS9390298358	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	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 @ 105 C (mg/l)	Consideration of water quality pressure (during baseline low flow conditions)
AN0123901	Rear of George Street, Treherbert	SS9434097900	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0124001	Opposite Side Railway Rear of Rheidol Close, Treherbert	SS9456097470	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0124201	Junction of Park Crescent and Sunny Bank, Cwmparc, Rhondda	SS9531096150	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0124301	Railway Terrace, Cwmparc	SS9474095770	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AE1016301	Glynfach Road, Porth, Rhondda	ST0280090990	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AE2018414	Trehafod County Primary School Pumping Station	ST0435991002	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0080001	Rear of 89 Trehafod Rd, Trehafod	ST0470090900	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0080101	Mill Street, Car Park Adjacent to Plas Carmel, Rhondda Road, Pontypridd	ST0704090100	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0118601	Cymmer Road, Dinas, Porth, Rhondda	ST0241091350	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0118701	Jenkins Street, Porth	ST0285091010	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0118801	Cadwgan Terrace Trehafod Rhondda Rct Cf37 2Pd	ST0431891018	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0249701	Sewage Pumping Station at The Rear Of Taff Street, Pontypridd	ST0733090150	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0339901	Eirw Rd SPS, Porth, Rhondda, Cf39 9Lt	ST0311791062	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
AN0374501	Trehafod Football Ground SPS EO	ST0411891237	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
EPR/JP3723XF	Colliery Street SPS, Trehafod, Pontypridd	ST0488490937	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible

Table B3.3 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 C (mg/l)	Consideration of water quality pressure (during baseline low flow conditions)
A E2018408	Gelligaleg Park CSO, Ystrad, Rhondda Fawr	SS9937794611	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0110901	Treorchy, Regent St Cso'S, Rhondda Fawr	SS9633296439	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0118001	Junction Dunraven St/Tylacelyn Rd Cso, Penygraig	SS9977892110	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0122201	Junction Ystrad/Church Road CSO, Ystrad, Ton Pentre	SS9723895421	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0122701	A CSO, Llwynypia Road - Tonypandy	SS9940092940	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0123001	A CSO, Tonypandy - Rear De Winton Street	SS9918092690	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A E2017703	High Level CSO, Ynysangharad Park, Pontypridd	ST0726589971	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0079801	A CSO, Pontypridd - Pellgwaun Cso Sheppard Street Garage	ST0659090360	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0156801	Pwllgwaun Road, Pwllgwaun, Pontypridd CSO	ST0675090290	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0157201	Maes-Y-Coed - Lanelay Crescent CSO	ST0679090040	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0241501	A CSO, Lower Mill St, Pontypridd	ST0712690024	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0316301	Pontypridd - Pwllgwaun CSO Millfield	ST0679090050	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0330401	A CSO, Taff St, Pontypridd	ST0730590065	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0332401	A CSO, Ynysangharad Park, Taff Street, Pontypridd Cf37 4Ss	ST0749889806	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0337101	A CSO, Crossbrook St, Pontypridd	ST0737390292	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0374601	Trehafod Football Ground CSO	ST0405991248	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
A N0374701	Gyfeillon Road CSO, Gyfeillon Road, Hopkinstown	ST0512591015	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible
NPSWQD005457	Brook Street CSO, Coedcae Rd, Rhondda Cynon Taff	ST0336490982	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	Negligible

B4 PHYSICAL ENVIRONMENT IMPACT SUMMARY

Potential impacts on the physical environment associated with the Afon Rhondda Fawr 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 Rhondda Fawr Drought Permit

Afon Rhondda Fawr Headwaters	
Flows in the Afon Rhondda Fawr headwater streams <i>Minor impacts during the period of implementation from September to November inclusive</i>	<ul style="list-style-type: none"> No reductions in flow, but minor localised impacts due to ponding effects immediately upstream of temporary weir.
Water quality in the Afon Rhondda Fawr <i>Low risk in period September to November inclusive</i>	<ul style="list-style-type: none"> Low risk of water quality deterioration for DO No data for other parameters available
Consented discharges <i>Negligible risk</i>	<ul style="list-style-type: none"> Negligible risk due to the size and nature of discharges
CSOs <i>Negligible risk</i>	<ul style="list-style-type: none"> Negligible risk due to the size and nature of discharges
Afon Rhondda Fawr	
Flows in the Afon Rhondda Fawr <i>Major impacts in summer (September); minor impacts in winter period (October to November inclusive)</i>	<ul style="list-style-type: none"> Reductions of up to 40% (September) or 13% (October to November) in flow in Reach 2.
Water quality in the Afon Rhondda Fawr <i>Low to High risk in period September to November inclusive</i>	<ul style="list-style-type: none"> Low risk of water quality deterioration associated with total ammonia concentrations and DO High risk associated with SRP
Geomorphology <i>Minor impacts in period September to November inclusive</i>	<ul style="list-style-type: none"> Minor risk to wetted width and sediment.
Consented discharges <i>Negligible risk</i>	<ul style="list-style-type: none"> Negligible risk due to the size and nature of discharges
CSOs <i>Negligible risk</i>	<ul style="list-style-type: none"> Negligible risk due to the size and nature of discharges
River Rhondda	
Flows in the River Rhondda <i>Negligible impacts during the period of implementation from September to November inclusive</i>	<ul style="list-style-type: none"> Reductions of up to 2.6% (September) or 1.5% (October to November) in flow in Reach 3.

B5 CUMULATIVE IMPACTS

The focus of this Environmental Assessment Report (EAR) is the Afon Rhondda Fawr 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**). 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 Rhondda Fawr Drought Permit with other Drought Options

Organisation	Potential In-combination Impacts	Further Consideration Required (Yes/No)
Welsh Water - other drought options in the SEWCUS Rhondda WRZ / River Rhondda / River Taff catchments	<u>8109-1 (Reduce compensation water releases from Llwynon Reservoir)</u> - This option combined with reduced compensation flows from both Llwynon and Pontsticill Reservoirs would involve a flow reduction of up to 19.2Ml/d in the River Taff below the River Rhondda confluence; this represents reductions of 6.5% and 8.8% in the summer Q ₉₅ and Q ₉₉ flows respectively (measured at Pontypridd), and 2% and 5.9% in the year round Q ₅₀ and Q ₉₅ respectively. The cumulative impact of the three drought options together on the River Taff below the River Rhondda confluence is therefore negligible.	No
	<u>8119-1 (Compensation Water Reduction of 50% at Pontsticill Reservoir)</u> - This option combined with reduced compensation flows from both Llwynon and Pontsticill Reservoirs would involve a flow reduction of up to 19.2Ml/d in the River Taff below the River Rhondda confluence; this represents reductions of 6.5% and 8.8% in the summer Q ₉₅ and Q ₉₉ flows respectively (measured at Pontypridd), and 2% and 5.9% in the year round Q ₅₀ and Q ₉₅ respectively. The cumulative impact of the three drought options together on the River Taff below the River Rhondda confluence is therefore negligible.	No
Natural Resources Wales - Drought options in the River Rhondda 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 *High* or *Good*, the potential impact is to be investigated. This investigation is specific to the risk of deterioration below the *Good* status band to the *Moderate* status band.

Definition of Impacts

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.

- **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

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.

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:

- 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
			Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
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.	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– 8112-1 ENVIRONMENTAL FEATURES ASSESSMENT

D1 INTRODUCTION

This appendix presents information regarding environmental features associated with the Afon Rhondda Fawr drought permit. Baseline data and impact assessments are presented for environmental features that form part of the scope of the assessment, as established by the screening exercise described in Appendix B. The features assessment is presented in full below. Points of interest referred to throughout the text 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 presented in full in **Appendix B**. In summary, hydrological impacts in Reach 1 are assessed as minor in September to November (caused by the installation of the temporary weir associated with the proposed intake), major in September and minor in October to November in Reach 2, and negligible in September to November in Reach 3.

The ecological assessment has been undertaken recognising the Institute of Environmental Management and Assessment (IEMA^{1,2}) and the Chartered Institute of Ecology and Environmental Management (CIEEM) study guidelines³. 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, where applicable, in order to determine the magnitude of impact in the relevant lake and river reaches for the Afon Rhondda Fawr 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.

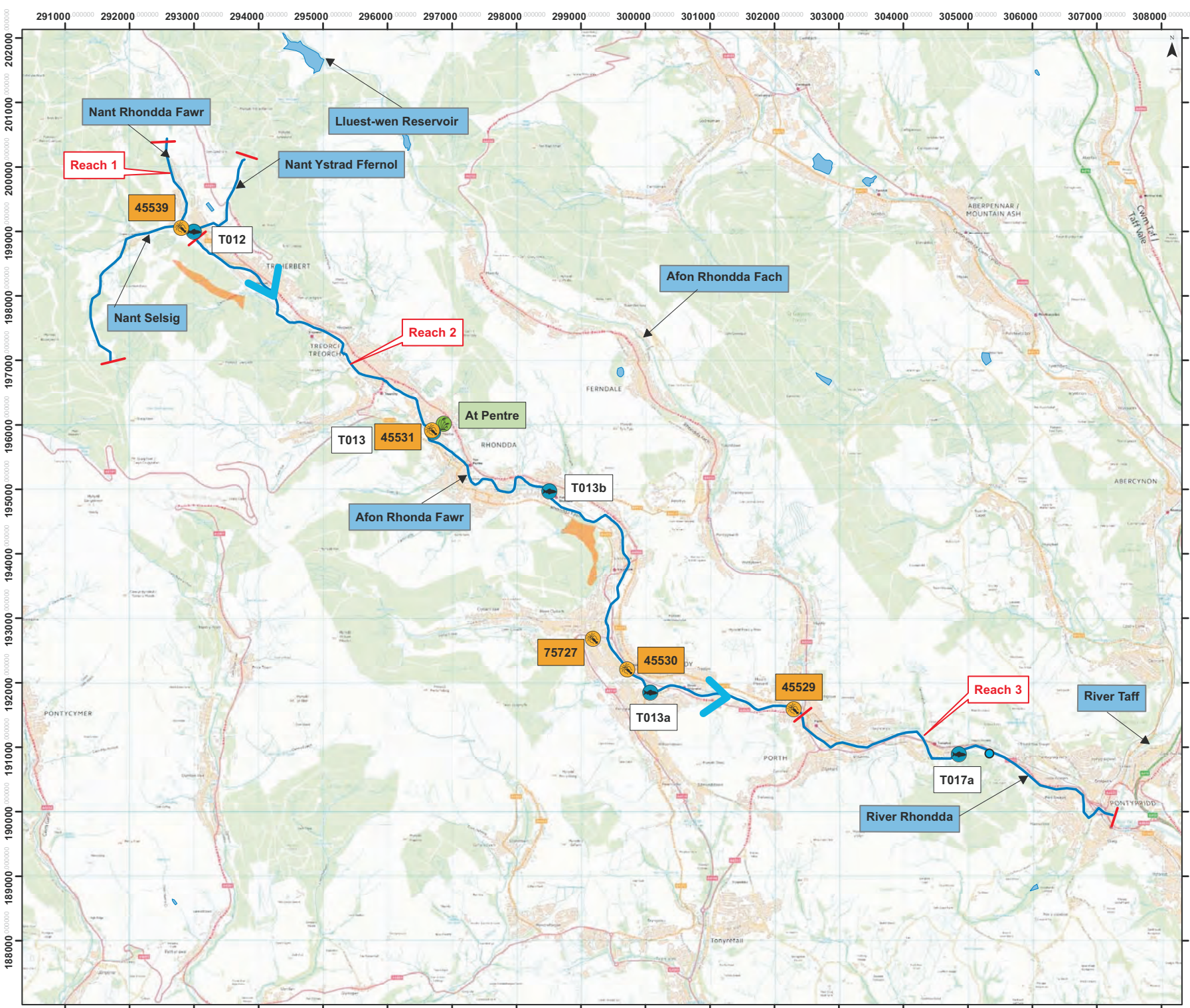
This appendix is set out in the following sections:

- Section D.2 WFD Status and Community Assessment / Notable Species
- Section D.3 Invasive Flora and Fauna
- Section D.4 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 (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland.



- Legend**
- Hydrological Reach
 - Flow Direction
 - Flow Gauge
 - Reservoir
 - Site of Special Scientific Interest
 - Fish Survey Site
 - Macroinvertebrate Survey Site
 - Macrophyte Survey Site



1:55,000
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: 8112-1
Afon Rhondda Fawr - Emergency abstraction
from the River Rhondda at Treherbert

Figure Number: Figure D1.1	Date: February 2019
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D2 WFD STATUS AND COMMUNITY ASSESSMENT / NOTABLE SPECIES

D.2.1 Macrophytes

D.2.1.1 Baseline

Baseline macrophyte monitoring information, received from Natural Resources Wales (NRW), within the reaches subject to hydrological impact consisted of three surveys (2005-2007) at one site in Reach 2; At Pentre (see **Figure D1.1**).

Considering the limited spatial and temporal constraints on the baseline information, care must be taken in data interpretation and should be seen as indicative only.

Macrophyte results were provided by (NRW) using the standard LEAFPACS methodology⁴ 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 LEAFPACS2 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) Number of macrophyte taxa which are truly aquatic, i.e. hydrophytes (NTAXA);
- (iii) Number of functional groups of macrophyte taxa which are hydrophytes (NFG): an assessment of the structural diversity of the plant community; and
- (iv) Percentage cover of all green filamentous algal taxa over the whole of the surveyed river sections (ALG).

In addition to the above scores, River Macrophyte Hydraulic Index (RMHI), observed Mean Trophic Rank (MTR), and Macrophyte Flow Ranking (MFR) scores were also provided for sampling taken. **Table D2.1** provides a summary of RMNI, RMHI, MTR and MFR scores recorded at sites within the study reach. **Table D2.2** and **Table D2.3** identify the interpretation of MFR and MTR scores.

Table D2.1 LEAFPAC summary indices for the At Pentre, Afon Rhondda Fawr, Reach 2

Site	Grid Reference	Sample Date	MTR	MFR	RMNI	RMHI	NTAXA	NFG
AT PENTRE	SS9669295916	15-Jul-05	45	2.58	6.31	6.28	10	6
		30-Jun-06	55.2	2.94	5.47	5.75	13	6
		01-Aug-07	48.8	2.73	5.83	5.95	13	7

⁴ WFD-UKTAG(2014) UKTAG river assessment method – macrophytes and phyto benthos (River LEAFPACS2).

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.

Table D2.2 Interpretation of MFR scores used for this Assessment

MFR Score	Interpretation of Score
1	Community preferring slow flow velocity
2	Community preferring slow to moderate flow velocity
3	Community preferring moderate flow velocity
4	Community preferring moderate to fast flow velocity
5	Community preferring fast flow velocity

Table D2.3 Interpretation of MTR scores (from Holmes *et al.*, 1999⁵)

MTR Score	Interpretation of Score
< 25	Site is badly damaged by eutrophication, organic pollution, toxicity or is physically damaged.
25 - 65	Site is likely to be either eutrophic or at risk of becoming eutrophic
> 65	Site is unlikely to be eutrophic

The RMNI scores from the At Pentre site varied from 5.47 to 6.31 which is indicative of a macrophyte community associated with moderate levels of eutrophication. MTR scores from the site from 45 to 55.2 also indicate mesotrophic to eutrophic conditions. RMHI scores varied from 5.75 to 6.28 which is indicative of a macrophyte community associated with moderate flow velocities. MFR scores from the site corroborate these findings with scores ranging from 2.58 to 2.94 indicating moderate flow velocity preference.

The species present include bryophytes (*Amblystegium fluviatile*, *Amblystegium riparium*, *Calliergon cuspidatum*, *Chiloscyphus polyanthos*, *Fontinalis antipyretica*, *Pellia* spp.), marginal species (*Oenanthe crocata*, *Mentha* sp., *Rorippa nasturtium-aquaticum*) and in

⁵ Holmes, N T H, Newman, J R, Chadd, S, Rouen, K J, Saint, L and Dawson, F H (1999) *Mean Trophic Rank: A Users Manual*. R&D Technical Report E38, Environment Agency, Bristol.

channel species (*Ranunculus* spp.). In addition, algae species such as *Voucheria* sp. and *Cladophora* sp. are present but at a low percentage cover (<0.1%), indicating that no acute nutrient enrichment had taken place around the survey period. The river has not been classified for macrophytes under the WFD.

Notable Species

No notable macrophyte species were recorded in the available data for this study area.

D.2.1.2 Assessment

Reach 1 will not have a reduction in flow, however a localised area upstream of the temporary weir may become impounded leading to reduced velocities. 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 *Mentha aquatica*. These species may outcompete species which require higher velocities. Due to the steepness of the upper catchment, the area impacted by the ponded reach is predicted to be small.

The risk of water quality deterioration associated with soluble reactive phosphorus (SRP) in Reach 1 has not been assessed due to a lack of data, although as a precautionary approach the risk is assumed to be low considering the hydrological impact in this reach. 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. As the risk of SRP deterioration is assumed to be low, the magnitude of this impact is classified as low, short term, temporary and reversible. Overall, the impacts of the drought permit on the macrophyte communities of Reach 1 are expected to be **negligible**.

Reach 2 is where the largest flow reductions would occur, particularly in September. Significant reductions in the wetted width and depth of the river would be expected under baseline drought conditions, exposing many macrophyte species such as bryophytes. Bryophytes are generally well adapted to tolerate desiccation and rewetting, and communities can take a long time to react to changes in environmental conditions⁶. The bryophyte community present within the study area of this drought permit is composed of species which are tolerant of being above the water line, and as such are unlikely to be significantly impaired by reductions to wetted width and depth. Provided there is sufficient soil moisture, marginal species such as *Mentha aquatica* are likely to spread out into the channel to occupy this new habitat. This may bring additional benefits such as the narrowing of the river flow. Given the limited duration of the most severe hydrological impacts of the drought permit (limited to September), it is expected that any effects on the macrophyte community would be reversed

⁶ 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*

following a return to the normal hydrological regime.

The risk of water quality deterioration associated with SRP in Reach 2 has been assessed as high. As the macrophyte community in the reach is expected to be consistent with moderate levels of eutrophication, an increase in the available nutrients of this magnitude may significantly alter the composition of the community in the reach. Overall, the impacts of the drought permit on the macrophyte communities of Reach 2 are expected to be **moderate adverse**, short term, temporary and reversible for September, and **minor adverse**, short term, temporary and reversible for October to November.

Reach 3 has negligible flow reductions between September and November, and risk to water quality deterioration is not anticipated, therefore the impact on the macrophyte community in Reach 3 is classified as **negligible**.

D.2.1.3 Summary

The potential impacts of the Afon Rhondda Fawr drought permit on the macrophyte community are summarised in **Table D2.4**. 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 D2.4** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D2.4 Summary of Impacts on Macrophyte Community

Feature	Impact	Significance of Impact
Reach 1 - Headwaters to new intake (Treherbert)		
Macrophytes	<ul style="list-style-type: none"> Increased water depth, siltation and growth of marginal plants. Risk of soluble reactive phosphorus deterioration 	Negligible
Reach 2 – New intake (Treherbert- Afon Rhondda Fach confluence)		
Macrophytes	<ul style="list-style-type: none"> Reduction in wetted area and velocities. Desiccation of some species such as bryophytes Increase in marginal species. Risk of soluble reactive phosphorus deterioration 	Moderate (September) Minor (October-November)
Reach 3 - Afon Rhondda Fawr / Afon Rhondda Fach confluence - River Taff confluence		
Macrophytes	<ul style="list-style-type: none"> Very minor reduction in flows leading to a minor reduction in habitat availability. 	Negligible

There is a risk of short-term deterioration in status of the macrophyte component of the Rhondda R - source to conf Afon Rhondda Fach waterbody (GB109057027200) due to the drought permit. The waterbody has not been assessed for macrophytes under the WFD. Impacts of the 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 **moderate** risk of short-term deterioration.

D.2.2 Macroinvertebrates

D.2.2.1 Baseline

Baseline data has been provided by NRW for the WFD waterbody within which the impacted reaches for this drought order are located, Rhondda R - source to conf Afon Rhondda Fach waterbody (GB109057027200). Waterbody GB109057027200 provides five NRW macroinvertebrate sampling locations which are located within the zone of influence of this drought permit. One site is located within Reach 1 and four sites are located within Reach 2. Data are available for these sites between 1990 and 2015, although only more recent data from 2005 considered within this assessment.

Table D2.5 Macroinvertebrate monitoring sites

Hydrological Reach	Site ID	Location	NGR
1	45539	At Tynewydd	SS9 280299057
2	45531	At Pentre	SS9 669295916
	75727	Near Tonypandy	SS9 919092686
	45530	At Tonypandy	SS9 971892207
	45529	At Porth	ST02 30191595

Sampling was conducted by following the standard NRW protocol involving a three minute kick / sweep sample encompassing all the available instream habitats in proportion to their occurrence. Data collected from the five sites were analysed to a mixture of both family and mixed taxon level resolution. These datasets were 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 (NTAXA).

BMWP is primarily used to monitor the impact of organic water quality but also responds to other pressures such as habitat reduction, siltation and toxic pollutants. High BMWPs are associated with good water and habitat quality. Comparisons between sites with BMWP scores must be used with caution as change to river type can have considerable influence over BMWP score. ASPT is derived from BMWP and provides the average BMWP sensitivity score of all the taxa found in the sample's macroinvertebrate assemblage. This index provides a more reliable means of comparing macroinvertebrate community quality between sites whilst also reducing the influence of sampling artefacts such as variable sampling effort. As such ASPT is used as the primary means of assessing macroinvertebrate response to water quality in this assessment. As a guide ASPT scores above 5 represent macroinvertebrate communities living in good water quality. Scores below 5 indicate water quality stress on the macroinvertebrate community. Data for LIFE and ASPT are graphically presented in **Figures D3.1 and D3.2**.

Overall, the macroinvertebrate community in both reaches shows moderate levels of diversity, with taxa dominated by EPT (Ephemeroptera, Plecoptera and Tricoptera) river fly species as would be expected for this type of upland river.

The ASPT scores obtained from Reach 1 site At Tynewydd range from 6.43 to 6.81 from data

collected in 2006 and 2009. This reflects a macroinvertebrate community which is expected to be composed of a high proportion of taxa which are sensitive to water quality pressures. LIFE scores from the same site range from 7.87 to 8.2 in the same monitoring period, this reflects a community which is adapted for high energy flows and as such is considered to be highly sensitive to any reduction in flow velocity.

In Reach 2 ASPT scores obtained from the four monitoring sites range from 5.2 to 7 across the monitoring period 2005 to 2015. This reflects a community that does not appear to have been significantly impacted by water quality pressures and is expected to be composed of a good to high proportion of taxa which are sensitive to water quality pressures. The LIFE scores indicate the presence of invertebrate families that favour predominately moderate to fast velocity habitats with a community that has high sensitivity to reductions in flow velocity.

Figure D3.1 Observed Family LIFE score sites on the Afon Rhondda Fawr

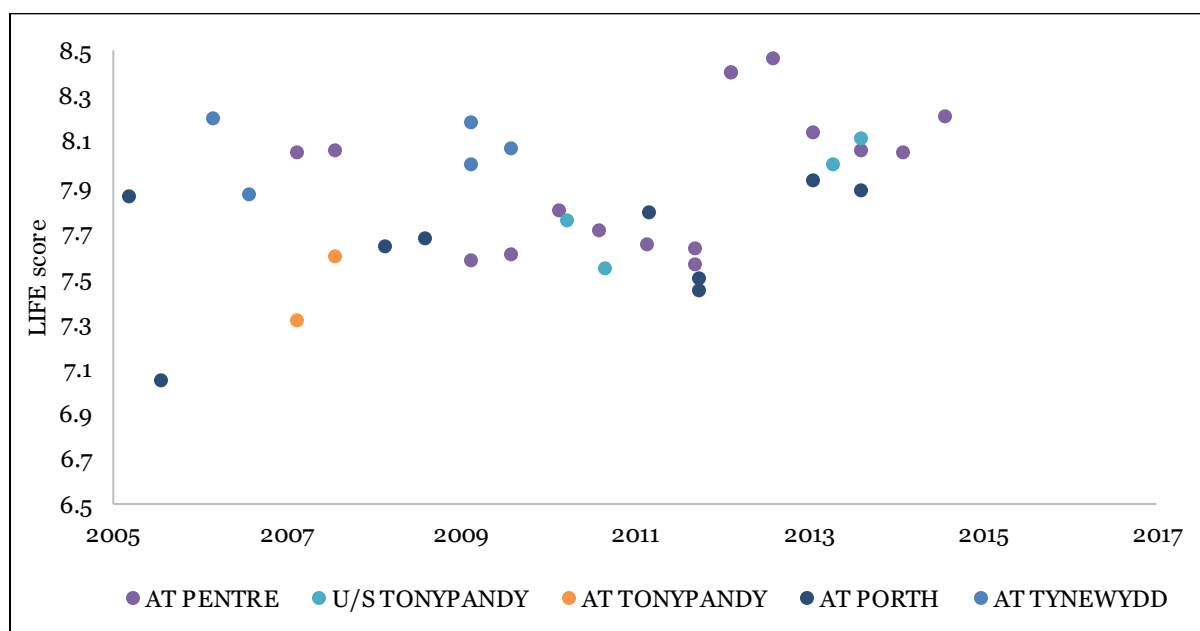
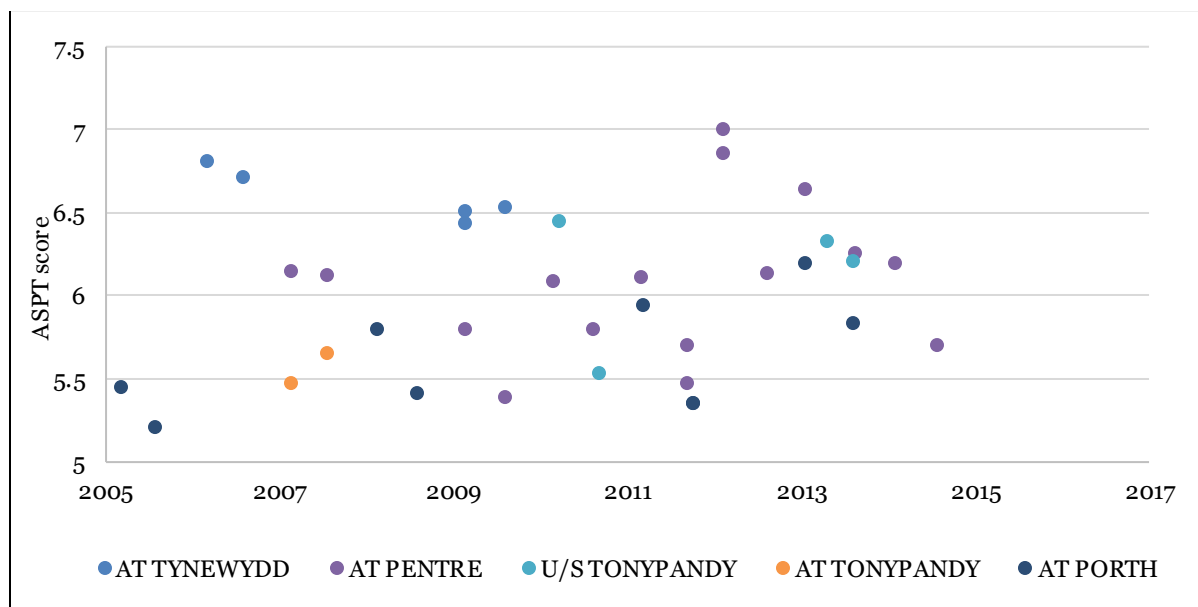


Figure D3.2 Observed Family ASPT score for Afon Rhondda Fawr



Notable Species

The small grey sedge *Glossosoma intermedium* is one of Britain's rarest caddisflies. It is classified as Rare (Red Listing based on pre 1994 IUCN guidelines) and is an England NERC act Section 41 species, but is not listed as an Environment (Wales) Act Section 7 species. Given the rarity of *G. intermedium* and previous inclusion on the UK Biodiversity Action Plan priority species list, it is considered to be a notable species. There are definite records from only four streams in the English Lake District, but there are several other unconfirmed records⁷. Two counts of the species were recorded at the At Pentre site on the Afon Rhondda Fawr in 2010, although it has not been recorded since.

Fresh water pearl mussels *Margaritifera margaritifera* are not present on the Afon Rhondda Fawr.

D.2.2.2 Assessment

Reach 1 is upstream of the drought permit abstraction location, as a result the drought permit will 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 ponding effect will primarily affect macroinvertebrates which prefer faster flow conditions. The macroinvertebrate community in Reach 1 is adapted to high energy flows and therefore will be susceptible to any reduction in flow velocity associated with the ponding behind the temporary

⁷ BugLife (2011) *Glossosoma intermedium*.

<https://www.buglife.org.uk/sites/default/files/Glossosoma%20intermedium%20species%20dossier.pdf> [accessed July 2016]

weir. 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. Dissolved oxygen has been assessed as being of low risk of deterioration in the impacted section of Reach 1, ammonia has not been assessed to a lack of data although as a precautionary approach risk is also assumed to be low. A modest decline in water quality is likely to impact only the taxa most sensitive to pollution, notably taxa within the stonefly, mayfly and caddisfly orders. Overall, deterioration of community composition will be localised and temporary, with a rapid return to baseline community composition once the temporary weir is removed.

Reach 2 is where the largest hydrological impact would occur. During a drought, river flows would naturally be low, causing a significant reduction in wetted width and wetted depth. The drought permit abstraction will result in a 17% reduction in the Q95 summer low flow, and a 40% reduction in the Q99 summer extreme low flow. The effect of this is a further reduction in wetted habitat and a reduction in velocities.

This effect will mostly affect flow sensitive taxa such as stonefly, mayfly, and caddisfly taxa such as Chloroperlidae, Heptageniidae, Rhyacophilidae, and Goeridae. 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.

This impact may be mitigated by the in-channel macrophytes which may encroach as river levels drop, which may narrow the river channel and maintain flow velocity. Marginal habitats are the most sensitive to flow reduction, with many slow-flow favouring macroinvertebrate 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 addition to effects on velocity and habitat availability, the drought permit has been assessed as having a low impact on ammonia and dissolved oxygen in Reach 2, which has the potential to affect macroinvertebrate communities during drought permit implementation. This may manifest as a small reduction in pollution sensitive taxa in this reach. Taxa that require high dissolved oxygen levels will be most susceptible. BMWP and ASPT scores from a communities impacted by this pressure will likely be slightly reduced. A number of crustacean taxa such as the freshwater shrimps (Gammaridae) are particularly sensitive to ammonia. Consequently, there is potential that in the short-term this impact will modify the macroinvertebrate community across the reach with a reduction in abundance of ammonia sensitive species.

Potential impacts on SRP levels in Reach 1 are assessed as moderate for summer and minor during winter. SRP is not expected to have a direct impact on the macroinvertebrate community, although proliferation of algal communities in response to elevated nutrients may have indirect effects, for example fluctuations in diurnal dissolved oxygen saturation in response to increased primary production, having a deleterious effect on sensitive taxa.

The impact on Reach 3 is likely to be **negligible** based on the small flow reductions in comparison to natural drought.

Overall, considering the composition of the baseline macroinvertebrate community, the short-term, temporary and reversible hydrological impacts of the drought permit and the effective recolonisation strategies of macroinvertebrate species, impacts are on the macroinvertebrate community are assessed as **moderate adverse**, short term, temporary and reversible for Reach 2 in September, **minor adverse**, short term, temporary and reversible for Reach 2 in October to November, and **negligible** for Reach 1 and 3.

D.2.2.3 Summary

The potential impacts of the Afon Rhondda Fawr drought permit on the macroinvertebrate community are summarised in **Table D2.6**. 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 macroinvertebrate community. The impacts presented in **Table D2.6** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D2.6 Summary of Impacts on Macroinvertebrate Community

Feature	Impact	Significance of Impact
Reach 1 - Headwaters to new intake (Treherbert)		
Macroinvertebrates	<ul style="list-style-type: none"> Increased depth directly upstream of the temporary weir, potentially leading to increased siltation. 	Negligible
Reach 2 – New intake (Treherbert- Afon Rhondda Fach confluence)		
Macroinvertebrates	<ul style="list-style-type: none"> Reduction in wetted area and velocities. Deterioration to ammonia and dissolved oxygen. 	Moderate (September) Minor (October to November)
Reach 3- Afon Rhondda Fawr / Afon Rhondda Fach confluence- River Taff confluence		
Macroinvertebrates	<ul style="list-style-type: none"> Very minor reduction in flows leading to a minor reduction in habitat availability. 	Negligible

There is a risk of short-term deterioration in status of the macroinvertebrate component of the Rhondda R - source to conf Afon Rhondda Fach waterbody (GB109057027200) due to the drought permit. The waterbody has been classified as High for macroinvertebrates. Impacts of drought permit have been summarised as negligible to moderate adverse, short-term, temporary and reversible. Consequently, the macroinvertebrate component of this waterbody is considered to be at **minor** risk of short-term deterioration.

D.2.3 Fish

D.2.3.1 Baseline

Fisheries monitoring data within the hydrological zone of influence on the Afon Rhondda Fawr and Afon Rhondda is limited to semi-quantitative and timed fish surveys undertaken by NRW (and previously Environment Agency Wales, EAW) at five sites between 2005 and 2012. The

available data are sufficient to provide a general understanding of the fish population in the hydrological zone of influence only and do not allow a detailed or robust assessment of the impact of a drought permit over and above a natural drought.

Existing data

Semi-quantitative and timed fish survey data from five sites were made available (see **Table D2.7** below) and have been analysed as part of this assessment. The data consists of juvenile salmonid (brown trout *Salmo trutta* and Atlantic salmon *Salmo salar*) densities from semi-quantitative surveys, and counts only for all other surveys and species.

Table D2.7 NRW fish survey locations on Afon Rhondda Fawr and Afon Rhondda

Reach	NRW site code	NGR	Sampling years
1	To12	SS 93000 99000	2005 – 2007, 2012
2	To13	SS 96707 95893	2005, 2007, 2012
	To13a	ST 00074 91853	2005 – 2007, 2012
	To13b	SS 98511 94973	2005 - 2007
3	To17a	ST 04861 90895	2005 – 2007, 2012

A fisheries monitoring programme was recommended as part of the 2007 Welsh Water Environmental Monitoring Plan process⁸, however, no additional monitoring has been undertaken with the exception of the routine NRW fish surveys discussed above.

The Rhondda R - source to conf. Afon Rhondda Fach waterbody (GB109057027200) was assessed as being at Good status for fish in 2015, and Moderate in the interim 2018 cycle 2 classification. Salmon were assessed as the species driving this failure in the 2018 interim classification.

Species composition

Eight fish species have been recorded within the study area, including Atlantic salmon, brown / sea trout, bullhead *Cottus gobio*, European eel *Anguilla anguilla*, minnow *Phoxinus phoxinus*, rainbow trout *Oncorhynchus mykiss*, stone loach *Barbatula barbatula* and three-spined stickleback *Gasterosteus aculeatus*.

The available data suggest that between 2005 and 2012, juvenile brown/sea trout densities were generally very good (Grades A to D⁹) at site To12 (Reach 1) but juvenile Atlantic salmon were absent or present in only very low densities (Grades E or F). Over the same period, brown/sea trout densities were generally below average at sites To13a (Reach 2) and To17a

⁸ Cascade Consulting (2007). Provision of an Environmental Monitoring Plan. Environmental Monitoring Plan for River Rhondda adjacent to Treherbert (SE11). Final. 23rd May 2007. A report for DCWW by Cascade Consulting in association with APEM.

⁹ 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).

(Reach 3) with National Fisheries Classification (NFC) Grades of C to F. Atlantic salmon were absent from Reach 2 and largely absent from Reach 3, with one record from 2005 noting low densities at site TO17a where (Grade E). The data confirms that Atlantic salmon spawning does occur in the Afon Rhondda Fawr and the Afon Rhondda, however, juvenile densities suggest that recruitment is very limited.

No area (m²) data was made available for the surveys, so it is not possible to investigate the density of the other species recorded in NRW surveys.

Bullhead have been recorded at sites in Reaches 1 to 3, but counts suggest low densities only.

While European eel have been recorded in the Afon Rhondda in Reach 3, there are no records within the Afon Rhondda Fawr (Reaches 1 and 2). It is unusual for European eel to be absent from a river like the Afon Rhondda Fawr given that fish passage into the lower reaches is not compromised. However, there are no records of the species in any fisheries survey (even as far back as 1991) and it appears that eel are absent from this part of the catchment.

There are no records of lamprey in any fisheries data for the hydrological zone of influence. This is likely to be a result of historical pollution.

The available data do not allow any further investigation into the status of fish populations within the hydrological zone of influence.

Data limitations

The available data are not sufficient to adequately describe the fisheries baseline. There is uncertainty surrounding the status of fish populations present, including protected species (e.g. Atlantic salmon and bullhead). Further monitoring would be required in order to assess the potential impacts of a drought permit over and above those of a natural drought.

The precautionary principle has therefore been used in the following assessment, which assumes that significant populations of protected species exist in Reaches 1 and 2.

In order to obtain a suitable baseline, a suite of electric fishing surveys in one year with adequate coverage of the hydrological reach would be required as a minimum.

Ecological value of fisheries receptors

Atlantic salmon and bullhead (both NERC Act Section 41 and Habitats Directive Annex II species), brown/sea trout (NERC Act Section 41 species) and European eel (NERC Act Section 41 and IUCN Red List 'Critically Endangered' species) are considered to be of national importance. Minnow, stone loach and three-spined stickleback are considered to be of local importance only. Rainbow trout are a non-native species stocked for angling purposes and are not considered further.

D.2.3.2 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 (for example 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 wetted area and volume, with 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)^{10,11}, reduced water quality and reduced reproductive success, growth and condition¹². In this instance, the temporary sandbag dam also would have 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 on fish relate to habitat loss, water quality and migration. These are discussed for key fish species in the sections that follow with particular focus on those aspects of fish ecology (e.g. migrations and juvenile life-stages) most susceptible during the likely impact period (the drought permit is likely to occur between summer and autumn but may occur year-round).

Reach 2 (Afon Rhondda Fawr, from the proposed intake at Treherbert to the confluence with the Afon Rhondda Fach) is predicted to undergo a reduction in flow of 17% at Q_{95} and up to 40% at Q_{99} during drought permit implementation for September only. While 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

Reaches 2 and 3 are likely to constitute a migratory pathway for Atlantic salmon (both upstream-migrating adults and out-migrating smolt). The majority of Atlantic salmon migration into the Afon Rhondda and Rhondda Fawr is likely to occur from October to December, and a drought permit may affect part of this migration. 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 and smolt-stage Atlantic salmon migrations are linked to flow increases and river flow

¹⁰ 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

¹¹ 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.

¹² 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.

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. Due to the risk of the temporary weir potentially limiting the free movement of upstream migrating salmon into Reach 1, the impact on adult Atlantic salmon migration in Reach 1 is considered to be **major adverse**, short term, temporary and reversible in September to November. The impact on adult Atlantic salmon migration in Reach 2 is considered to be of high magnitude, short-term, temporary and reversible for September, and low magnitude, short-term, temporary and reversible for October to November. The impact on adult Atlantic salmon migration in Reach 2 is considered to be **major adverse**, short term, temporary and reversible in September and **minor adverse**, short term, temporary and reversible in October to November. The impact on adult Atlantic salmon migration in Reach 3 is considered to be **negligible**.

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 and particularly dissolved oxygen and water temperature. These specific water quality impacts have been assessed as low risk in Reaches 1 and 2 and negligible in Reach 3, and the impact on Atlantic salmon is therefore considered to be of low magnitude, short-term, temporary and reversible. The impact on Atlantic salmon is therefore considered to be **minor adverse**, short term, temporary and reversible in Reach 1 and 2 and **negligible** in Reach 3 due to a potential reduction in water quality.

Juvenile Atlantic salmon

There is potential for reduced flow to result in a decrease in river levels and wetted width, causing loss or degradation of juvenile habitat and 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. 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 unlikely to be affected, however, fry and parr populations are likely to be impacted. The impact on juvenile salmon is therefore considered to be **negligible** in Reach 1 and Reach 3. Due to the major hydrological impacts associated with the drought permit in September, the impact on juvenile salmon is assessed as **major adverse**, short term, temporary and reversible in Reach 2 for September only, and **minor adverse**, short-term, temporary and reversible in Reach 2 for October to November.

Brown/sea trout

Sea trout migration

Reaches 2 and 3 are likely to be a migratory pathway for sea trout (both upstream-migrating

adults and out-migrating smolt). The majority of upstream adult sea trout migration into the Afon Rhondda and Afon Rhondda Fawr is likely to occur from July to November, therefore a drought permit has the potential to have a significant impact on this migration. 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 and smolt-stage 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.

Due to the risk of the temporary weir potentially limiting the free movement of upstream migrating salmon into Reach 1, the impact on adult Atlantic salmon migration in Reach 1 is considered to be **major adverse**, short term, temporary and reversible in September to November. The impact on adult sea trout migration in Reach 2 is considered to be of high magnitude, short-term, temporary and reversible for September, and low magnitude, short-term, temporary and reversible for October to November. The impact on adult sea trout migration in Reach 2 is considered to be **major adverse**, short term, temporary and reversible in September and **minor adverse**, short term, temporary and reversible in October to November. The impact on adult sea trout migration in Reach 3 is considered to be **negligible**.

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 and particularly dissolved oxygen and water temperature. The effects of reduced water quality are likely to particularly impact sensitive juvenile life-stages. These specific water quality impacts have been assessed as low risk in Reaches 1 and 2 and negligible in Reach 3, and the impact is therefore considered to be of low magnitude, short-term, temporary and reversible. The impact on brown/sea trout is therefore considered to be **minor adverse** in Reach 1 and 2 and **negligible** in Reach 3 due to a potential reduction in water quality.

Juvenile brown/sea trout

There is potential for reduced flow to result in a decrease in river levels and wetted width, causing loss or degradation of juvenile habitat and gravel spawning habitat. Provided minimum low flows are available, juvenile 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 unlikely to be affected, however, fry and parr populations are likely to be impacted. The impact on juvenile trout is therefore considered to be **negligible** in Reach 1 and Reach 3. Due to the major hydrological impacts associated with the drought permit in September, the impact on juvenile trout is assessed as **major adverse**, short term, temporary

and reversible in Reach 2 for September only, and **minor adverse**, short-term, temporary and reversible in Reach 2 for October to November.

Bullhead

Bullhead are thought to be present in low densities throughout Reaches 1 to 3. 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 2. The impact in Reach 2 is therefore considered to be of high magnitude, short-term, temporary and reversible. The impact on bullhead is therefore considered to be **negligible** in Reach 1 and 3, and **major adverse**, short term, temporary and reversible in Reach 2 for September and **minor adverse**, short term, temporary and reversible for Reach 2 in October to November.

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) eel tends to occur between September and December in most rivers, however, European eel have only been recorded in Reach 3 and therefore impacts are not expected to be significant. Due to the limited hydrological impacts associated with the implementation of the drought permit in Reach 3, the impact on European eel is considered to be **negligible** in Reaches 1 to 3.

Other Fish Species

Minnow, stone loach and three-spined stickleback may be affected by drought permit implementation. Sensitive life-stages of these species are susceptible to impacts associated with low flows, whilst minnow require good water quality in which to thrive. The impact in Reach 2 is therefore considered to be of high magnitude, short-term, temporary and reversible. The impact on other fish species is therefore considered to be **negligible** in Reach 1 and 3, **moderate adverse**, short term, temporary and reversible in Reach 2 for September, and **minor adverse**, short term, temporary and reversible in Reach 2 for September.

D.2.3.3 Summary

The potential impacts of the Afon Rhondda Fawr drought permit on the fish community are summarised in **Table D2.8**. 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 D2.8** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D2.8 Summary of Impacts on Fish Community

Feature	Impact	Significance of Impact
Reach 1 - Headwaters to new intake (Treherbert)		
Atlantic salmon	• Delays and potential cessation of adult migration due to reduced flows and obstruction caused by sandbag weir.	Major
	• Reduced water quality.	Minor
	• Reduction in spawning and juvenile survival due to habitat loss.	Negligible
Brown/sea trout	• Delays and potential cessation of adult migrations due to reduced flows and obstruction caused by sandbag weir.	Major
	• Reduced water quality.	Minor
	• 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.	Negligible
European eel	• 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 - New intake (Treherbert - Afon Rhondda Fach confluence)		
Atlantic salmon	• Delays and potential cessation of adult migration due to reduced flows.	Major (September) Minor (October - November)
	• Reduced water quality.	Minor
	• Reduction in spawning and juvenile survival due to habitat loss.	Major (September) Minor (October - November)
Brown/sea trout	• Delays and potential cessation of adult migrations due to reduced flows.	Major (September) Minor (October - November)
	• Reduced water quality.	Minor
	• Reduction in spawning and juvenile survival due to habitat loss.	Major (September) Minor (October - November)
Bullhead	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow.	Major (September) Minor (October - November)
European eel	• 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.	Moderate
Reach 3 - Afon Rhondda Fawr / Afon Rhondda Fach confluence - River Taff confluence		
Atlantic salmon	Delays and potential cessation of adult migration due to reduced flows and obstruction caused by sandbag weir.	Negligible
	Reduced water quality.	Negligible
	Reduction in spawning and juvenile survival due to habitat loss.	Negligible
Brown/sea trout	Delays and potential cessation of adult migration due to reduced flows and obstruction caused by sandbag weir.	Negligible
	Reduced water quality.	Negligible
	Reduction in spawning and juvenile survival due to habitat loss.	Negligible

Feature	Impact	Significance of Impact
Reach 1 - Headwaters to new intake (Treherbert)		
Bullhead	Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow.	Negligible
European eel	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

There is a risk of short-term deterioration in status of the fish component of the Rhondda R - source to conf. Afon Rhondda Fach waterbody (GB109057027200) due to the drought permit. The waterbody has been classified as Good for fish in 2015, and Moderate in 2018 (cycle 2 interim classification). Impacts of drought permit implementation have been summarised as negligible to major adverse, short-term, temporary and reversible, with the greatest impacts assessed as affecting salmon populations (a species assessed as driving the failure to achieve Good status for the fish element). Consequently, the fish component of these waterbodies is considered to be at **major** risk of short-term deterioration.

D.2.4 Phytobenthos

D.2.4.1 Baseline

No baseline monitoring information for phytobenthos was received from NRW for the study area.

D.2.4.2 Assessment

Impacts on phytobenthos assemblages of the Afon Rhondda 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 drought permit implementation in Reach 2 are likely to result in changes to the phytobenthos communities present within the time-frame of the drought permit.

WFD Ecological Quality Ratio (EQR) metrics for phytobenthos (TDI4 in DARLEQ)¹³ 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). 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, resulting in a potential decrease in WFD ecological status in respect to phytobenthos.

¹³ WFD-UKTAG (2014) Phytobenthos: Phytobenthos for Assessing River and Lake Ecological Quality (River DARLEQ2)

Implementation of the drought permit in Reaches 1 and 2 is expected to result in low and high risk to water quality deterioration associated with SRP 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. Therefore, impacts associated with the drought permit implementation on WFD phytobenthos status is likely to be **negligible** for Reach 1, **moderate adverse**, short term, temporary and reversible for Reach 2 in September, and **minor adverse**, short term, temporary and reversible for Reach 2 in October to November. However, monitoring of phytobenthos communities within the affected reach would be required to fully assess the effects of the proposed drought permit. Reach 3 has negligible flow reductions between September and November, and risk to water quality deterioration is not anticipated, therefore the impact on the phytobenthos community in Reach 3 is classified as **negligible**.

D.2.4.3 Summary

The potential impacts of the Afon Rhondda Fawr drought permit on the diatom community are summarised in **Table D2.9**. 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 diatom community. The impacts presented in **Table D2.9** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D2.9 Summary of Impacts on Diatom Community

Feature	Impact	Significance of Impact
Reach 1 - Headwaters to new intake (Treherbert)		
Phytobenthos	<ul style="list-style-type: none"> Increase in nutrient levels. 	Negligible
Reach 2 – New intake (Treherbert- Afon Rhondda Fach confluence)		
Phytobenthos	<ul style="list-style-type: none"> Reduction in wetted area and velocities, increase in nutrient levels. 	Moderate (September) Minor (October to November)
Reach 3 - Afon Rhondda Fawr / Afon Rhondda Fach confluence – Afon Taf confluence		
Phytobenthos	<ul style="list-style-type: none"> Very low reduction in flows leading to a minor reduction in habitat availability. 	Negligible

There is a risk of short-term deterioration in status of the phytobenthos component of the Rhondda R - source to conf. Afon Rhondda Fach waterbody (GB109057027200) due to the drought permit. However, the waterbody has not been classified for phytobenthos under the WFD. Impacts of drought permit implementation have been summarised as moderate to

negligible adverse, short-term, temporary and reversible. Consequently, the phytobenthos component of these waterbodies is considered to be at **minor** risk of short-term deterioration.

D.2.5 Crustacea: White-clawed Crayfish

D.2.5.1 Baseline

White-clawed crayfish are designated as a species of principal importance in Wales under Section 7 of Environment (Wales) Act. There are no records of white-clawed crayfish within the Afon Rhondda Fawr but they have been recorded elsewhere in the catchment. As a precautionary approach in this assessment, it is assumed that white-clawed crayfish are present in Reaches 1, 2 and 3.

D.2.5.2 Assessment

In Reach 1, hydrological impacts will manifest as an impoundment of water being the temporary weir located at Treherbert. 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 is anticipated). The species is tolerant of reduced flow velocity and is adapted to both fast flowing and lacustrine habitats, so increased water depth within the impoundment is not expected to exclude white-clawed crayfish. 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 influence of impacts in the reach. Considering the ecological value of the species, the significance of impact in Reach 1 is assessed as being **minor adverse**, short term, temporary and reversible.

In Reach 2, 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 decline¹⁴. 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. Furthermore, with loss of shelter the white-clawed crayfish population is particularly susceptible to predation¹⁵. Finally, individuals could also become stranded in refuges, particularly within the river banks, if water levels were to fall rapidly, potentially causing mortality to those individuals which become stranded out of the water. In Reach 2, water quality impacts comprise a low risk to ammonia and medium risk to dissolved oxygen deterioration. Considering the ecological value of the species and the impacts identified above, the significance of impact in Reach 2 is assessed as **major adverse**, short term, temporary and reversible in September and **minor**

¹⁴ 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.

¹⁵ 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.

adverse, short term, temporary and reversible in October to November.

Reach 3 only has very limited flow reductions and no expected risk to water quality deterioration, therefore the impact on the white-clawed crayfish is assessed as **negligible**.

D.2.5.3 Summary

The potential impacts of the Afon Rhondda Fawr drought permit on the white clawed crayfish are summarised in **Table D2.10**. 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 white clawed crayfish. The impacts presented in **Table D2.10** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D2.10 Impacts on Notable Crustacea Species

Feature	Impact	Significance of Impact
Reach 1 - Headwaters to new intake (Treherbert)		
White-clawed crayfish	<ul style="list-style-type: none"> Increased mortality as a result of deterioration to water quality. 	Minor
Reach 2 - New intake (Treherbert - Afon Rhondda Fach confluence)		
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. 	<p>Major (September)</p> <p>Minor (October to November)</p>
Reach 3 - Afon Rhondda Fawr / Afon Rhondda Fach confluence- River Taff confluence		
White-clawed crayfish	<ul style="list-style-type: none"> Small reductions in flows 	Negligible

D3 INVASIVE FLORA AND FAUNA

D.3.1 Invasive Non-native Plant (*Mimulus guttatus*)

D.3.1.1 Baseline

Mimulus guttatus was recorded in the macrophyte surveys carried out at the site At Pentre, located in Reach 2. The species is a perennial invasive non-native plant which is often found on the banks of rivers and standing waters. The species spreads primarily via seed dispersal with high flow events in rivers being associated with increases in range, fragments of the plant may also regenerate into new plants providing another pathway for introduction to new areas.¹⁶

D.3.1.2 Assessment

Implementation of the drought permit will lead to reductions in wetted width, depth and flow velocities. Such changes are not expected to increase the distribution of *Mimulus guttatus*, as seed dispersal and fragmentation pathways are unlikely to benefit from reductions in flow. SRP is assessed as being of high risk of deterioration in Reach 2. The species is associated with mesotrophic waters with an RMNI score of 5.79, as such increases in SRP concentration will not favour the species. Overall the risk of increasing the distribution of *Mimulus guttatus* due to implementation of the Afon Rhondda Fawr drought permit is assessed as **negligible**.

D.3.1.3 Summary

The potential impacts of the Afon Rhondda Fawr drought permit on the invasive species are summarised in **Table D3.1**. 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 invasive species. The impacts presented in **Table D3.1** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.1 Summary of Impacts on Invasive Species

Feature	Impact	Significance of Impact
Reach 2 - New intake (Treherbert- Afon Rhondda Fach confluence)		
<i>Mimulus guttatus</i>	<ul style="list-style-type: none"> Implementation of the drought permit will do nothing to favour proliferation of this species. 	Negligible

¹⁶ Non-Native Species Secretariat (2015) Rapid Risk Assessment Summary Sheet for Monkey Flower *Mimulus Guttatus*, Accessed 17/11/2016.

D4 LANDSCAPE, RECREATION AND ARCHAEOLOGY

D.4.1 Landscape

D.4.1.1 Baseline

The Afon Rhondda Fawr rises on the southern edge of the Brecon Beacons National Park. From here it flows through a deep narrow valley linking the scenic, unspoilt landscapes of the Brecon Beacons to the urban and industrial areas of Treherbert, Treorchy, Tonypany and Porth. These towns form an almost continuous urbanised area along the Afon Rhondda Fawr within the study area. There are no evident footpaths in proximity or adjacent to the Afon Rhondda Fawr.

D.4.1.2 Assessment

Hydrological implications of implementing the Afon Rhondda Fawr drought permit include significant reductions in wetted width and wetted depth. The scheme would also involve construction of a low, temporary sandbag weir across the Afon Rhondda Fawr and submersible pumps to enable abstraction. The temporary weir would have visual amenity impacts in Treherbert, in the less urbanised, upper part of the study area. The visual amenity impacts resulting from the reduction in wetted width would be visible from river crossings and bankside access in the urban areas through which the Afon Rhondda Fawr flows. 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**.

D.4.2 Recreation

D.4.2.1 Baseline

The proximity of the Brecon Beacons National Park presents a range of recreational activities to the population within the study area such as walking and cycling, although for the majority of the study area this is somewhat limited. Fish stocking with brown trout is conducted regularly, on stretches such as that between Treorchy and Trehafod, downstream of Porth, and there are healthy populations of brown trout along the river.

D.4.2.2 Assessment

Any reduction in wetted width and depth may influence the angling resource on the Afon Rhondda Fawr 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 Rhondda Fawr drought permit on landscape and recreation are summarised in **Table D4.1**. The impacts presented in **Table D4.1** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused

by a natural drought.

Table D4.1 Summary of Impacts on Landscape and Recreation

Feature	Impact	Significance of Impact
Reach 1, 2 & 3		
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