Dŵr Cymru Welsh Water

Environmental Assessment of Cefni Reservoir Drought Permit (8001-5)

Final

March 2019

Client:	**Dŵr Cymru Welsh Water**
Title:	**Environmental Assessment of Cefni Reservoir Drought Permit (8001-5)**
Project No:	**ED10929**
Date of Issue:	**March 2019**
Status:	**Final**
Version No:	**1.1**

Produced By

.....
Dr Anne Fairhead
Principal Environmental Scientist

Authorised for Release By

.....
John Sanders
Technical Director

*As part of a share purchase agreement in August 2015, Cascade Consulting (Environment & Planning) Ltd transferred its business to Ricardo plc. All employees transferred to Ricardo Energy & Environment, a trading name of Ricardo-AEA Ltd which is a wholly owned subsidiary of Ricardo plc. The work described in this report spanned the pre-acquisition and post-acquisition period and throughout this time the consultants involved maintained a continuity of service both as employees of Cascade Consulting and then subsequently as employees of Ricardo Energy & Environment.

CONTACT DETAILS:

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

Tel: +44 (0)1235 753000

ISO 9001 REGISTERED FIRM

ISO 14001 REGISTERED FIRM

iema EIA

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 / order options.

A drought permit or order 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 Cefni Reservoir, over and above those arising due to natural effects of drought and those which would occur under "normal" abstraction licence conditions.

Cefni Reservoir is located in Welsh Water's North Eryri Ynys Môn Water Resource Zone (WRZ) – this area includes the mainland adjacent to the Menai Straits (North Eryri) and Ynys Môn (Anglesey). Water is supplied from five impounding reservoirs; on the mainland Ffynnon Llugwy, Llyn Cwellyn and Llyn Marchlyn Bach and on Ynys Mon, Llyn Alaw and Llyn Cefni. The resources are operated conjunctively with the ability to feed water from the mainland to parts of the island from the gravity resources of Llyn Cwellyn, Ffynnon Llugwy and Llyn Marchlyn Bach when storage allows. As storage declines, the area of Ynys Môn supported from the mainland is reduced and the area supported by Llyn Alaw and Llyn Cefni increases. The Afon Cefni is a component of the Malltraeth Marsh / Cors Ddyga Sites of Special Scientific Interest (SSSI) therefore consideration has been given to the potential impacts of drought permit implementation on the features and species of these designated sites.

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

This report is a 'shelf-copy' report which would be updated to support an application to Natural Resource Wales (NRW) for a drought permit at Cefni, 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 North Eryri Ynys Môn WRZ in the event of a future severe drought, Welsh Water would make an application

to NRW for a drought permit to vary the conditions of abstraction from Cefni reservoir.

If granted, the drought permit involves a proposed reduction in the statutory compensation release from Cefni Reservoir to the Afon Cefni of 0.9Ml/d, from 1.8Ml/d to 0.9Ml/d. The drought permit is most likely to occur during the summer and autumn months period, to conserve the longevity of reservoir storage for use in direct supply during a drought. This is based on modelling of Cefni Reservoir's performance under normal operating conditions in dry summers. The drought permit scheme will influence the downstream Afon Cefni from the outflow at Cefni Reservoir to the tidal limit.

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

The revised abstraction arrangements would legally be authorised for 6 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 Cefni. 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 **major** impact on flows in the Afon Cefni as a result of implementing the drought permit. These hydrological impacts are assessed as leading to moderate impacts on the physical environment of the river, including minor beneficial impact on 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 / Habitats Directive designated habitats and species, SSSI designated features and Environment (Wales) Act Section 7 species, invasive species and recreation as environmental features for which an environmental assessment was required.

The assessment has concluded that during periods when release from Cefni Reservoir is restricted to compensation flow only there are **major** impacts on fish, and **moderate** impacts on macroinvertebrates and macrophytes and minor impacts on phytobenthos. The impacts on Malltraeth Marsh / Cors Ddyga SSSI are assessed as minor and as major on the Dingle / Nant y Pandy Local Nature Reserve.

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 Cefni Reservoir.

MITIGATION AND MONITORING

The environmental assessment has identified significant impacts of implementation of a drought permit at Cefni Reservoir. 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 Cefni Reservoir during July to December 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.**

Contents

1 Introduction 1
1.1 Purpose of the Environmental Assessment 1
1.2 Supporting Studies 2
1.3 Consultation 3
1.4 Structure and Content of the Report 3
2 Background to the Drought Permit 4
2.1 Welsh Water's Supply System 4
2.2 Description of Existing Arrangements at Cefni Reservoir 5
2.3 Welsh Water's Drought Planning Process 7
2.4 Statement of the Need for Drought Permit 7
2.5 Drought Permit– Regulatory Arrangements 7
2.6 Review of Alternative Options 8
2.7 Proposed Drought Permit Details 8
2.8 Drought Permit Programme 9
2.9 Drought Permit Baseline 9
3 Approach 10
3.1 Introduction 10
3.2 Approach to Screening and Scoping 11
3.3 Approach to Assessing Impacts, Mitigation and Monitoring 15
3.4 Limitations of the Assessment and Uncertainties 18
4 Cefni Drought Permit - Hydrology and the Physical Environment 19
4.1 Introduction 19
4.2 Summary of Stage 1 Screening 19
4.3 Summary of Potential Effects on the Physical Environment 20
5 Cefni Reservoir Drought Permit Environmental Features Assessment 22
5.1 Introduction 22
5.2 Summary of Stage 2 Screening and Scoping 22
5.3 Features Assessment 25
6 Cefni Reservoir Drought Permit – Mitigation 34
7 Cumulative Impacts 36
8 Cefni Reservoir Drought Permit - Summary of Residual Impacts 38
9 Environmental Monitoring Plan (EMP) 39
9.1 Introduction 39
9.2 Basis of the EMP 39
9.3 Monitoring Recommendations 41
10 Conclusions 51

Appendix A – Hydrology and Hydrogeological Methodology
Appendix B – Hydrology and Physical Environment Assessment
Appendix C – Environmental Features Assessment Methodologies
Appendix D – Environmental Features Assessment

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 reduce the statutory compensation release from Cefni Reservoir to the Afon Cefni by 0.9Ml/d. Water stored at Cefni Reservoir is used to provide public water supplies to Welsh Water's North Eryri Ynys Mon (NEYM) 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 Natural Resources Wales (NRW) for a drought permit at Cefni Reservoir. 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 July to December 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 Cefni Reservoir drought permit, covers the following waterbodies:

- Afon Cefni - Ceint to Cefni reservoir (GB110102058770)

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 the Welsh Government / NRW Drought Plan Guideline[1] (DPG); specifically Section 5 and Appendices I and J, and Welsh Government / Defra / NRW / Environment Agency guidance on drought permits and drought order[2].

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 or drought order 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 order /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 order /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 orders / permits where there is certainty that there are no such impacted sensitive features.

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

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

[1] Natural Resources Wales (2017) *Water Company Drought Plan Technical Guideline*. Available at https://cdn.naturalresources.wales/media/684414/final-wc-drought-plan-guidance-2017.pdf?mode=pad&rnd=131656713580000000, Accessed 04 February 2019.
[2] Welsh Government / Defra / Natural Resources Wales / Environment Agency (2015) *Apply for a drought order or emergency drought order*, https://www.gov.uk/government/collections/apply-for-a-drought-permit-drought-order-or-emergency-drought-order Accessed 21 December 2018.

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 at Cefni Reservoir, 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

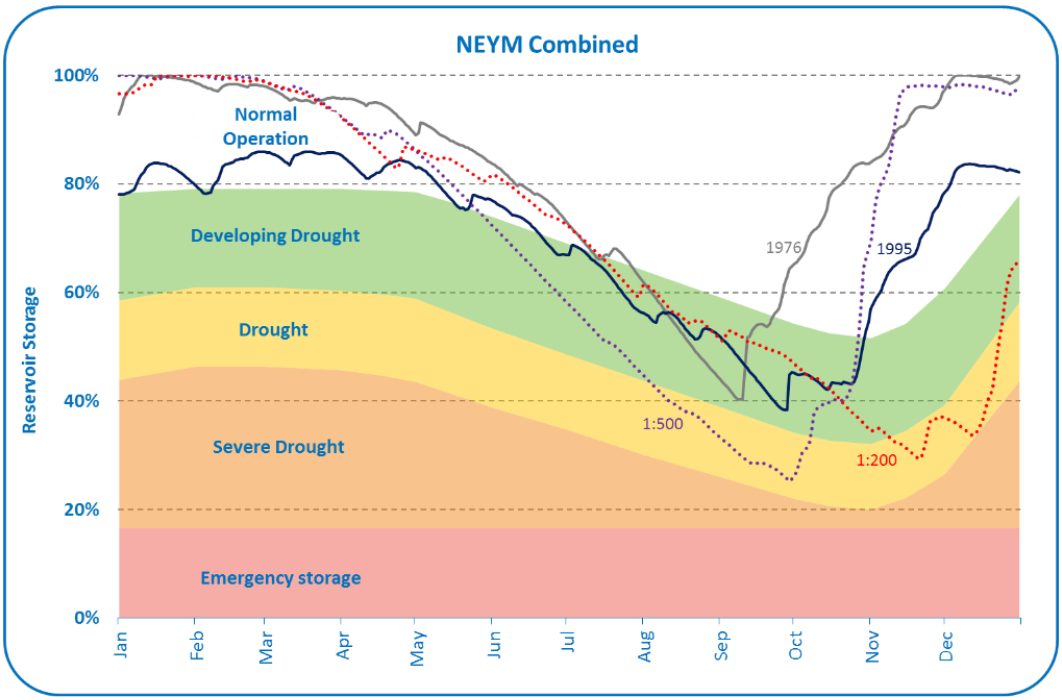
Welsh Water supplies water to more than 3 million people. The Welsh Water supply area covers the majority of Wales and a small part of England. It is split into 24 WRZ's (see **Figure 2.1**).

Figure 2.1 Welsh Water Water Resource Zones

The North Eryri Ynys Môn Water Resource Zone (WRZ) includes the mainland adjacent to the Menai Straits (North Eryri) and Ynys Môn (Anglesey). Water is supplied from five impounding reservoirs; on the mainland Ffynnon Llugwy, Llyn Cwellyn and Llyn Marchlyn Bach and on Ynys Mon, Llyn Alaw and Llyn Cefni. The resources are operated conjunctively with the ability to feed water from the mainland to parts of the island from the gravity resources of Llyn Cwellyn, Ffynnon Llugwy and Llyn Marchlyn Bach when storage allows. As storage declines, the area of Ynys Môn supported from the mainland is reduced and the area supported by Llyn Alaw and Llyn Cefni increases.

The trigger levels for applying for a drought permit at Cefni Reservoir are based on combined storage 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 NEYM WRZ Drought Action Zones and Historic Droughts



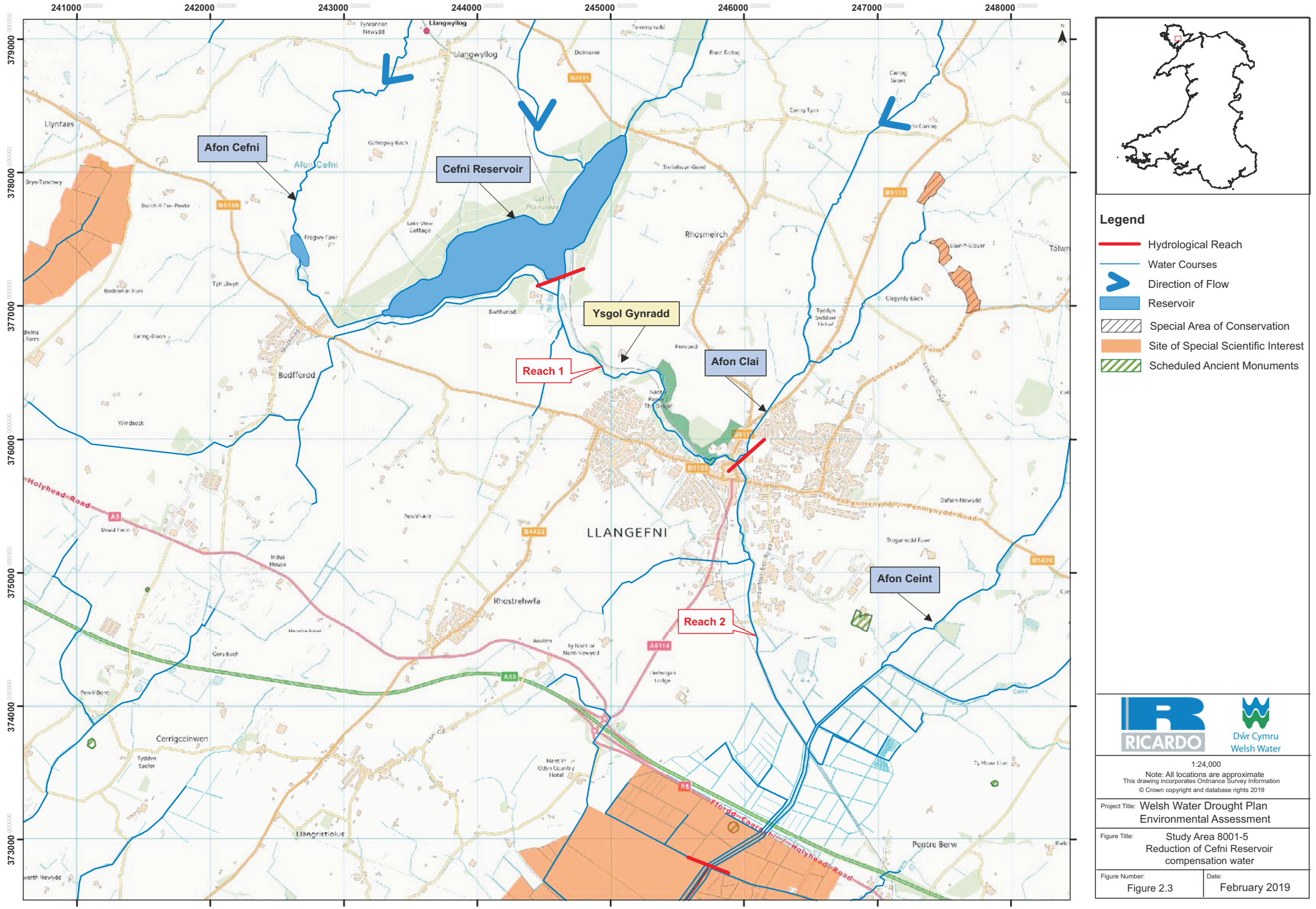
2.2 DESCRIPTION OF EXISTING ARRANGEMENTS AT CEFNI RESERVOIR

Welsh Water owns and operates Cefni Reservoir. The company's licence (number 23/102/2/007) to abstract water under the Water Resources Act at Cefni Reservoir includes the following licence conditions:

- 5,475 million litres (Ml) authorised to be abstracted per annum
- At an abstraction rate not exceeding 15.0Ml/d
- Subject to the Anglesey County Council Water Act 1944, which requires the discharge of compensation water (equivalent to a continuous daily release) of 1.8Ml/d to the Afon Cefni.

The abstraction for potable supply is made directly from Cefni Reservoir, treated at Cefni Water Treatment Works (WTW) from where it is put into supply.

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



Legend

- Hydrological Reach
- Water Courses
- Direction of Flow
- Reservoir
- Special Area of Conservation
- Site of Special Scientific Interest
- Scheduled Ancient Monuments

RICARDO

Dŵr Cymru Welsh Water

1:24,000

Note: All locations are approximate

Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Study Area 8001-5 Reduction of Cefni Reservoir compensation water

Figure Number: Figure 2.3

Date: February 2019

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 permits; emergency drought permits.

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 permits 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 permits grant the same powers as a drought permit, 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 order/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 North Eryri Ynys Môn WRZ in the event of a future severe drought, Welsh Water may need to make an application to NRW for a drought permit to vary the conditions of its abstraction licence from Cefni Reservoir.

If granted, the drought permit involves a proposed reduction in the statutory compensation release from Cefni Reservoir to the Afon Cefni of 0.9Ml/d, from 1.8Ml/d to 0.9Ml/d. The drought permit is most likely to occur during the summer and autumn months period, to conserve the longevity of reservoir storage for use in direct supply during a drought. This is based on modelling of Cefni Reservoir's performance under normal operating conditions in dry summers. The drought permit scheme will influence the downstream Afon Cefni from the outflow at Cefni Reservoir to the tidal limit at Pentre Berw.

Details of the existing and proposed drought permit abstraction at Cefni Reservoir are presented in **Table 2.1**.

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

Table 2.1 Cefni Reservoir Existing and Proposed Drought Permit Abstraction

Abstraction Water Source	NGR	Normal Abstraction	Proposed Drought Permit Abstraction	Benefit Ml/d
Cefni Reservoir	SH 44468 77496	Welsh Water's licence (number 23/102/2/007) to abstract water under the Water Resources Act at Cefni Reservoir includes the following licence conditions: • 5,475 million litres (Ml) authorised to be abstracted per annum • At an abstraction rate not exceeding 15.0Ml/d • Subject to the Anglesey County Council Water Act 1944, which requires the discharge of compensation water (equivalent to a continuous daily release) of 1.8Ml/d to the Afon Cefni.	The drought permit involves a proposed reduction in the statutory compensation release from Cefni Reservoir to the Afon Cefni of 0.9Ml/d, from 1.8Ml/d to 0.9 Ml/d.	0.9Ml/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. The period of implementation for this drought permit is restricted to July to December, 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 includes the continuation of abstraction from Cefni Reservoir and in accordance with the abstraction licence conditions, including the continuation of a daily compensation release of 1.8Ml/d from Cefni Reservoir whenever regulation releases are not occurring. The assessed drought permit involves a reduction of 0.9Ml/d in the total flow release (either compensation or regulation) from Cefni Reservoir to the Afon Cefni.

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 / 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, Natural Resource Wales Drought Plans
- National Policy Statements for Wastewater and Renewable Energy Infrastructure.

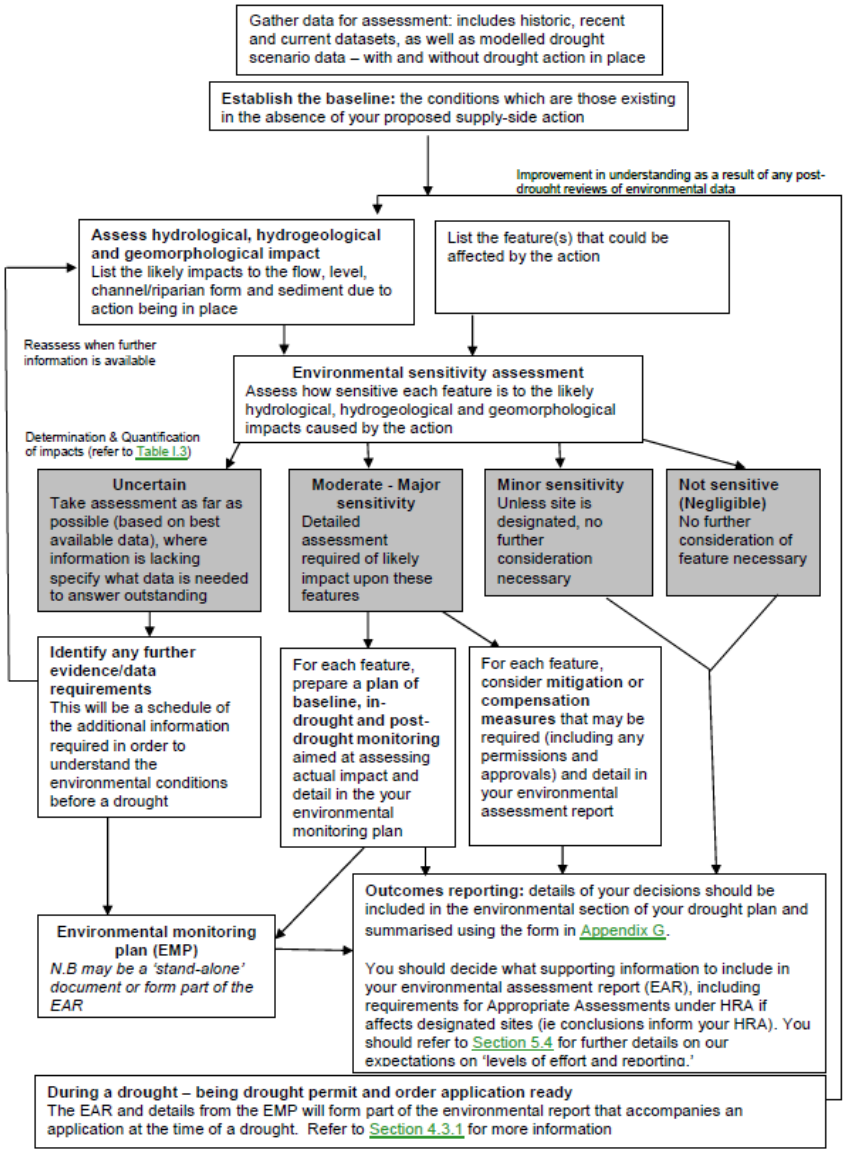
This is discussed further in Section 7.

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 permit.
- **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 Cefni Reservoir.

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 Cefni Reservoir 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 Ireland[3]
- 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

[3] 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[4,5] and the CIEEM study guidelines[6]. 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.

[4] IEMA (2004) Guidelines for Environmental Impact Assessment.
[5] IEMA (2011) Special Report – The State of Environmental Impact Assessment Practice in the UK
[6] 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 CEFNI RESERVOIR 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 Cefni Reservoir 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**) is identified as the Afon Cefni from the Cefni Reservoir to the tidal limit.

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:

- Change in river flows downstream of Cefni Reservoir.

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 to winter period, considered to not extend outside the period July to December.

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

Afon Cefni (Reach 1)	
Flows in the Afon Cefni *Major impacts during the period July to December*	Reductions of up to 50% in river flows with corresponding reductions in wetted depths/wetted widths (potential marginal habitats), during the period July to December
Water quality in the Afon Cefni *Moderate risk during the summer/autumn period*	Minor risk to dissolved oxygen and ammonia in Reach 1. Moderate risk to soluble reactive phosphorous in Reach 1.
Afon Cefni (Reach 2)	
Flows in the Afon Cefni *Minor impacts during the period July to September; negligible impacts during the period October to December*	Reductions of up to 11.2% in river flows with corresponding reductions in wetted depths/wetted widths (potential marginal habitats), during the summer period of July to September (flow reductions of up to 8.6% during the period October to December).
Water quality in the Afon Cefni *Moderate risk during the summer/autumn period*	Negligible risk to dissolved oxygen and ammonia in Reach 2. Moderate risk to soluble reactive phosphorous in Reach 2.

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 CEFNI 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 tht 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 Cefni Reservoir 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)
Malltraeth Marsh/Cors Ddyga SSSI	Minor	The site is designated for biological interest; including its' breeding bird community of lowland damp grassland, habitat of wet meadows, and for the botanical interest of its ditches and watercourses. It also contains some locally notable aquatic macroinvertebrates.	Moderate	Yes
Cefni Reservoir KWS	Minor beneficial (Cefni Reservoir)	Cefni Reservoir is sheltered by coniferous forests and lies 1.5 miles north of Llangefni. Red admirals, ringlet and other butterflies frequent the forest rides. The surrounding woods resonate to the sound of warblers in summer. Crossbills and siskins are present all year round and migrant hawker and golden ringed dragonflies are regulars. Bird hides provide close views of whooper swan, tufted duck, pochard, grebe and ruddy duck in winter.	Negligible	No
Nant Y Pandy (The Dingle) LNR	Major (Reach 1)	The Dingle / Nanty Pandy Local Nature reserve is a 10 hectare (25 acre) wooded valley, rich in wildlife and history. Parts of the woodland are dominated by sessile oak, ash and wild cherry, with a spectacular show of blue bells in spring. The site hosts amphibian, bird, fish and mammal life. In particular Llyn Pwmp, an old pump lake is known to contain trout, roach, perch and eel.	Moderate	Yes
Environment (Wales) Act Section 7 Species – Fish Atlantic salmon *Salmo salar* River lamprey *Lampetra fluviatilis* Sea lamprey *Petromyzon marinus* Brown and sea trout *Salmo trutta* European eel *Anguilla anguilla*	Major (Reach 1) Minor (Reach 2)	A number of Habitats Directive and/or Section 7 species are noted in the reach. 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 short term and are not anticipated to significantly alter habitat and availability for the resident fish community.	Major	Yes
Habitats Directive Annex 2 - non-priority Fish species Bullhead *Cottus gobio* Brook lamprey *Lampetra planeri*	Major (Reach 1) Minor (Reach 2)	Two Habitats Directive Annex 2 - non-priority Fish species are noted in the reach. 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 short term and are not anticipated to significantly alter habitat and availability for the resident fish community.	Major	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)
Environment (Wales) Act Section 7 – Mammals Otter *Lutra lutra* Water vole *Arvicola terrestris*	Major (Reach 1) Minor (Reach 2)	Otter and water vole have been recorded in the area. Otter are water-dependent, foraging in, over or adjacent to water for fish and aquatic invertebrates. However this species is not expected to be significantly impacted by the drought permit implementation, as habitat availability and quality for otter is not anticipated to be significantly altered. Water voles are typically associated with watercourses and waterbodies with well-vegetated banks. They use water to avoid predation and associated wetland vegetation for feeding. although in Great Britain they can survive for short periods of time in dry /terrestrial environments. Therefore, as the hydrological impacts are minor in Reach 2 where water voles may be present, they are not anticipated to be significantly affected by the drought permit.	Negligible	No
Macrophytes	Major (Reach 1) Minor (Reach 2)	Reduction in flows and level as a result of the drought permit could temporarily reduce the overall extent and / or quality of habitat availability for freshwater macrophytes in the study area.	Moderate	Yes
Benthic freshwater Macroinvertebrates	Major (Reach 1) Minor (Reach 2)	Reduction in flows and level as a result of the drought permit could temporarily reduce the overall extent of and quality habitat availability for freshwater macroinvertebrates in the study area.	Moderate	Yes
Invasive flora and fauna: Shrimp *Crangonyx pseudogracilis* New Zealand mud snail *Potamopyrgus antipodarum*	Major (Reach 1) Minor (Reach 2)	*Crangonyx pseudogracilis* and *Potamopyrgus antipodarum* are present within the impacted reaches. Both species are widespread and naturalised across Wales, as such changes to the hydrological regime are unlikely to increase the distribution.	Moderate	No
Recreation	Major (Reach 1) Minor (Reach 2)	The Afon Cefni provides recreational opportunities, especially for walkers, bikers, fishers and boaters. The area also includes a sustrans cycle route important for leisure and recreation in the area.	Minor	Yes
Archaeology	Major (Reach 1) Minor (Reach 2)	The search includes one Scheduled Ancient Monument sites; Mynwent y Llwyn a prehistoric mound. The site contains no water dependant features so is not susceptible to changes in the hydraulic regime.	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	Cefni – Ceint to Cefni reservoir (GB110102058770)	
Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Major	
Heavily Modified Waterbody (Y/N)	No	
RBMP Cycle	RBMP2 (2015)[7]	2018 C2 Interim[8]
Overall Biological	Moderate	Moderate
Fish	High	High
Macrophytes & Phytoplankton combined	Moderate	Moderate
Macrophytes	High	High
Phytoplankton	Moderate	Not assessed
Phytobenthos	Not assessed	Moderate
Macro-invertebrates	Good	Good
Total P/ Phosphate	High	High
Ammonia	High	High
Dissolved Oxygen	High	High
pH	High	High
Sensitivity (Uncertain, Moderate/ Major, Minor, Not sensitive)	Major	
Further Consideration Required (Y/N)	Yes	

5.3 FEATURES ASSESSMENT

5.3.1 Basis of Features Assessment

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

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

[7] NRW (2017) https://drive.google.com/file/d/0B2hsDbbdxz1tZHItRU9lNkg1YWs/view
[8] NRW (2018) https://drive.google.com/file/d/14w17jL05sNuToVELqMCK_yc6DdHU7STb/view

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

5.3.2 Summary of Features Assessment

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

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

Month		J	F	M	A	M	J	J	A	S	O	N	D
Malltraeth Marsh / Cors Ddyga SSSI		N/A	N/A	N/A	N/A	N/A	N/A				N	N	N
Afon Cefni (Reach 1)													
Macrophytes		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						
Risk to WFD waterbody macroinvertebrate status		N/A	N/A	N/A	N/A	N/A	N/A						
River lamprey	Spawning and juveniles	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	N	N	N	N	N
	Upstream migration	N/A	N/A	N/A	N/A	N/A	N/A						N
Sea Lamprey	Spawning and juveniles	N/A	N/A	N/A	N/A	N/A	N/A						N
	Migration	N/A	N/A	N/A	N/A	N/A	N/A				N	N	N
	Water quality	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N	N	N
Atlantic salmon	Spawning, egg survival, and juveniles	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	N	N			N
	Smolt migration	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N			N
	Water quality	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	N				N
	Juveniles (habitat loss)	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						
European eel		N/A	N/A	N/A	N/A	N/A	N/A	N	N				N
Other fish species- Grayling, minnow, three spined stickleback and stoneloach		N/A	N/A	N/A	N/A	N/A	N/A						
Risk to WFD waterbody fish status		N/A	N/A	N/A	N/A	N/A	N/A						
Phytobenthos		N/A	N/A	N/A	N/A	N/A	N/A						
Invasive Species		N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N	N	N
Recreation		N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N	N	N
Afon Cefni (Reach 2)													
Macrophytes		N/A	N/A	N/A	N/A	N/A	N/A				N	N	N
Notable macrophyte species – *Pilularia globulifera* communities		N/A	N/A	N/A	N/A	N/A	N/A				N	N	N
Macroinvertebrates		N/A	N/A	N/A	N/A	N/A	N/A						
River lamprey	Spawning and juveniles	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	N	N	N	N	N
	Upstream migration	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N	N	N
Sea Lamprey	Spawning and juveniles	N/A	N/A	N/A	N/A	N/A	N/A						
	Migration	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N	N	N
	Water quality	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N	N	N
Atlantic salmon	Spawning, egg survival, and juveniles	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	N	N			N
	Smolt migration	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N			N
	Water quality	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N	N	N
Brown / sea trout	Adult migration	N/A	N/A	N/A	N/A	N/A	N/A	N	N				N
	Juveniles (habitat loss)	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	N	N	N	N	N

Month	J	F	M	A	M	J	J	A	S	O	N	D
European eel	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N	N
Other fish species - Grayling, minnow, three spined stickleback and stoneloach	N/A	N/A	N/A	N/A	N/A	N/A						
Risk to WFD waterbody fish status	N/A	N/A	N/A	N/A	N/A	N/A						
Phytobenthos	N/A	N/A	N/A	N/A	N/A	N/A						
Invasive Species	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N	N	N
Recreation	N/A	N/A	N/A	N/A	N/A	N/A	N	N	N	N	N	N

Key to Environmental Effects:

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

5.3.3 Designated Sites

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

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

Feature	Impact	Significance of Impact
Reach 1 – Afon Cefni		
The Dingle / Nanty Pandy Local Nature Reserve	• The impacts on the fish community as a feature of the LNR are expected to be major adverse within Reach 1 during summer / autumn.	**Major** (summer / autumn)
Reach 2 – Afon Cefni		
Malltraeth Marsh / Cors Ddyga SSSI	• The impacts on pillwort Pilularia globulifera and the macrophyte community, as a feature of the SSSI are expected to be minor adverse within Reach 2 during summer/autumn and negligible in winter. • No impacts on the breeding, migrating or wintering birds are anticipated as a result of the drought permit due to the timing and minor hydrological impacts in Reach 2.	**Minor** (summer / autumn) **Negligible** (winter / spring)

5.3.4 WFD and Community Assessment

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

WFD Definitions

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

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

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

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

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

Bad ecological status - waters showing evidence of severe alterations to the values of the biological quality elements for the surface water body type and in which large portions of the relevant biological communities normally associated with the surface water body type are absent, shall be classified as bad.

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

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

The Environment Agency[9] 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

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

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**.

Macrophytes

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

Table 5.5 Summary of Impacts of Drought Permit Implementation on Macrophytes

WFD Status/ Community	Impact	Significance of Impact
Cefni - Ceint to Cefni reservoir (GB110102058770) Current Status: High	• There is a moderate to minor risk of short term deterioration to in the status of the macrophyte subcomponent of the water body.	**Moderate to Minor**
Feature	**Impact**	**Significance of Impact**
Reach 1 – Afon Cefni		
Macrophytes	• 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 width. • Increase in filamentous algae levels due to increased nutrients or water temperature and decreased velocity.	**Moderate** (July-September) **Minor** (October-December)
Reach 2 – Afon Cefni		
Macrophytes	• Reduction in growth as a result of minor impacts on water levels and flows. • Changes to community composition due to changes to flow rates and habitat loss due to reduction in wetted width.	**Moderate** (July-September) **Minor** (October-December)
Pilularia globulifera	• Increased in competition from macrophytes due to increased nutrients or altered hydrological regime.	**Minor**

Macroinvertebrates

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

Table 5.6 Summary of Impacts of Drought Permit Implementation on Macroinvertebrates

WFD Status/ Community	Impact	Significance of Impact
Cefni - Ceint to Cefni reservoir (GB110102058770) Current status: Good	• There is a moderate to minor risk of short term deterioration to the WFD status macroinvertebrate component of the Cefni - Ceint to Cefni reservoir water body	**Moderate to Minor**
• **Reach 1 – Afon Cefni**		
Macroinvertebrates	• 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 • Reduction in species diversity and abundance as a result of reduced recruitment. • Reduction is species abundance and/or diversity due to water quality deterioration.	**Moderate**
• **Reach 1 – Afon Cefni**		
Macroinvertebrates	• Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats • Reduction in species diversity and abundance as a result of reduced recruitment.	**Minor**

Fish

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

Table 5.7 Summary of Impacts of Drought Permit Implementation on Fish

WFD Status/ Community		Impact	Significance of Impact
Cefni - Ceint to Cefni reservoir (GB110102058770) Current status: Good		• There is a major risk of short-term deterioration in status of the fish component of the waterbody due to the minor to major adverse, short-term, temporary and reversible impacts associated with the drought permit	**Major**
Feature		**Impact**	**Significance of Impact**
Reach 1 – Afon Cefni			
Environment (Wales) Act Section 7 Species	Brook, river and sea lamprey	• Migration of river adults and transformers affected or halted by a reduction in flow.	**Minor (Jul-Nov)**
		• Migration of sea lamprey adults and transformers affected or halted by a reduction in flow.	**Minor (Jul-Sep)**
		• Loss of spawning and juvenile habitat as a result of reduced river levels.	**Major**
		• Reduced water quality	**Negligible**
	Atlantic salmon	• Delays and potential cessation of adult and smolt migrations due to reduced flows.	**Major (Oct- Nov)**
		• Reduced water quality	**Minor**
		• Reduction in spawning and juvenile survival due to habitat loss.	**Major**
	Brown/sea trout	• Delays and potential cessation of adult and smolt migrations due to reduced flows.	**Major (Sep-Nov)**
		• Reduced water quality	**Minor**
		• Reduction in spawning and juvenile survival due to habitat loss.	**Major**
	European eel	• Delays and potential cessation of silver eel migration due to reduced flows.	**Moderate (Sep-Nov)**
		• 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 2 – Eastern Cefni			
Environment (Wales) Act		• Migration of river adults and transformers affected or halted by a reduction in flow.	**Minor (Jul-Oct)**

WFD Status/ Community		Impact	Significance of Impact
Section 7 Species	Brook, sea and river lamprey	• Migration of sea lamprey adults and transformers affected or halted by a reduction in flow.	**Minor (Jul-Sep)**
		• Loss of spawning and juvenile habitat as a result of reduced river levels.	**Major**
		• Reduced water quality	**Negligible**
	Atlantic salmon	• Delays and potential cessation of adult and smolt migrations due to reduced flows.	**Minor (Oct- Nov)**
		• Reduced water quality	**Negligible**
		• Reduction in spawning and juvenile survival due to habitat loss.	**Minor**
	Brown / sea trout	• Delays and potential cessation of adult and smolt migrations due to reduced flows.	**Minor (Sep-Nov)**
		• Reduced water quality	**Minor**
		• Reduction in spawning and juvenile survival due to habitat loss.	**Minor**
	European eel	• Delays and potential cessation of silver eel migration due to reduced flows.	**Negligible**
		• 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.	**Minor**

Phytobenthos

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

Table 5.8 Summary of Impacts of Drought Permit Implementation on Phytobenthos

WFD Status/ Community	Impact	Significance of Impact
Cefni - Ceint to Cefni reservoir (GB110102058770) Current status: Moderate	• There is a moderate to minor risk of short term deterioration to the WFD status macrophyte sub-component of the Cefni - Ceint to Cefni reservoir water body	**Minor to moderate**
Feature	**Impact**	**Significance of Impact**
Reaches 1 and 2 – Afon Cefni		
Diatoms	• Changes to community composition due to changes in velocity and water quality	**Minor**

5.3.5 Invasive Flora and Fauna

Table 5.9 presents a summary of the potential impacts of the drought permit identified from the assessment of invasive flora and fauna.

Table 5.9 Summary of Impacts of Drought Permit Implementation on Invasive Flora and Fauna

Feature	Impact	Significance of Impact
Reach 1		
Crangonyx pseudogracilis New Zealand mud snail	Changes to community composition due to changes in velocity and water quality	**Negligible**

5.3.6 Recreation

Table 5.10 presents a summary of the potential impacts of the drought permit identified from the assessment of recreation.

Table 5.10 Summary of Impacts of Drought Permit Implementation on Recreation

Feature	Impact	Significance of Impact
Reach 1 and 2 : Afon Cefni		
Recreation	• Impacts on recreation activities (e.g. angling, canoeing, walking) are not anticipated over those from the natural drought conditions	**Negligible**

6 CEFNI RESERVOIR DROUGHT PERMIT – MITIGATION

The environmental assessment has identified some significant impacts, including major hydrological impacts, major aquatic ecology impacts including on fish; moderate impacts on macrophytes and macroinvertebrates; and minor impacts on Malltraeth Marsh SSSI.

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:

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 Order/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 order/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 order/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 order/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 order/permit
Provision of alternative water supplies	If there is a risk of derogation of other abstractors from the drought order/permit, it may be possible for Welsh Water to provide alternative water supplies or lower pumps in boreholes. Provision is otherwise provided in legislation[10] 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 Cefni Reservoir 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.

[10] 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 order / 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 / orders

No cumulative effects of implementing the Cefni Reservoir drought permit with drought order / permit schemes have been identified. However, this should be

reviewed at the time of any future application for a drought permit at Cefni Reservoir.

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 Cefni Reservoir 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 CEFNI RESERVOIR 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 Cefni Reservoir 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 9.2. Monitoring recommendations are set out in Section 9.3.

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 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/order application. Control sites will need to be identified at the time of application following a review of where drought permit/orders 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 and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	**Monitoring and trigger setting**	**Trigger and monitoring to inform mitigation action**	**Mitigation actions triggered by monitoring**	**Monitoring and post-drought mitigation (where applicable)**	
N/A		Walkover survey during low flow conditions - Mapping of sensitive habitats, communities and species.	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 **Reaches 1-2**	• Reduction in abundance and distribution of flow sensitive taxa. • Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats. • Increase in filamentous	Surveys to be carried out to provide a three-year baseline dataset, then repeated every three years. Follow LEAFPACS2 standard methodology, with particular attention to *Pilularia globulifera* in Reach 2. Reach 2 site to be located within Maelltrath Marsh SSSI. To be carried out annually during	Survey to be undertaken and macrophytes identified (if drought permit likely to be implemented in the plant growing seasonr). Follow LEAFPACS2 standard methodology [11]. Walkover survey to identify any key sources of nutrient loading.	Walkover of key sections known to be susceptible to lower flows, informed by pre-drought survey. If drought permit implementation occurs in the plant growing season r, carry out macrophyte surveys at baseline sites. Follow LEAFPACS2 standard	Mitigating impacts to the macrophyte community as a result of lowered flow and water level is not feasible during drought permit implementation. Mitigating this impact should be triggered by post drought macrophyte community assessments to implement post drought mitigation measures.	In the two years following drought permit implementation and in June to September monitoring period carry out LEAFPACS2 macrophyte surveys at the baseline monitoring sites. To be extended if recovery has not occurred in two years. Significant alteration to macrophyte community composition (as informed by expert judgement, based on baseline data and	Welsh Water

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

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
	algae levels due to increased nutrients or water temperature and decreased velocity	June-September. To complement any existing NRW monitoring, in discussion with NRW. Existing monitoring site located at: • Reach 1 - Ysgol Gynradd	Carry out water quality sampling at the baseline sites including samples for soluble reactive phosphorus.	methodology for assessing macrophyte communities. Carry out water quality sampling at the baseline sites including samples for soluble reactive phosphorus.	Consider measures to address identified point sources of nutrient loading. Consider scope for addressing any identified sources of nutrient loading from walkover survey, if this would help address water quality risks. Consider possible in-stream measures or adjustments to improve habitat conditions.	multivariate statistical analyses) triggers post drought mitigation actions: If existing macrophyte community has significantly deteriorated, consider reseeding /replanting where possible to promote recovery. Replanting of macrophyte community composition to be informed by pre-drought community. Consider the removal of fine silt by manual raking of small areas to improve habitat quality.	
Macroinvertebrates **Reaches 1-2**	• Reduction in species diversity as a result of the loss of flow-sensitive taxa • Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats • Alteration to community composition as a	The macro-invertebrate community in the impacted reaches is 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. Two sites per impacted reach. Reach 2 sites to be located within Maelltrath Marsh	Seasonal monitoring of macroinvertebrates at the baseline survey sites (spring and autumn). Samples to be collected and identified to species level. Carry out water quality surveys at same time. In severe drought conditions, no in	Seasonal monitoring of macroinvertebrates at the baseline survey sites (spring and autumn). Samples to be collected and identified to species level. Carry out water quality surveys at same time. In severe drought conditions, no in stream monitoring	Mitigating impacts to the macroinvertebrate community as a result of lowered flow and water level is not feasible during drought permit implementation. Mitigating this impact should be triggered by post drought macroinvertebrate community assessments to implement post drought mitigation measures.	In the two years following drought permit implementation, 3-minute kick sampling and mixed taxon level analysis at the five routine monitoring sites. To be extended if recovery has not occurred in two years. Significant alteration to macroinvertebrate community composition (as informed by expert judgement and based on baseline data) triggers post drought mitigation actions:	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)	
	result of water quality deterioration.	SSSI. To complement any existing NRW monitoring, in discussion with NRW. Monitoring sites are located at: • Reach 1 - D/S Cefni Reservoir and U/S livestock • Reach 2 - U/S Ceint	stream monitoring is advised during environmental drought to prevent further harm to the invertebrate community through kick/ sweep sampling.	is advised during environmental drought to prevent further harm to the invertebrate community through kick/ sweep sampling.	Consider possible in-stream measures or adjustments to improve habitat conditions. Consider the removal of fine silt by manual raking of small areas.	• Targeted habitat alteration/improvements can enhance natural recovery. Habitat restoration techniques can be utilised to improve habitat quality, and flush sediment from benthic substrate. • Consider the removal of fine silt by manual raking of small areas.	
Fish (including salmon, brown trout, eel) **Reaches 1-2**	Decreased growth, alteration to feeding and migration Loss of important habitats (spawning gravels, nursery habitat, resting pools) Increased mortality (density dependant) as a result of increased predation and competition Stranding of individuals as a result of a	Fish populations are not well understood as a result of a lack of recent monitoring. Limited data is available from NRW. Electric-fishing surveys to monitor fish populations at one site in each of the impacted reaches. Reach 2 site to be located within Maelltrath Marsh SSSI. Surveys to be repeated every three years. To complement any existing NRW	Electric-fishing surveys to monitor fish populations at one site in each of the impacted reaches. One site in each of the impacted reaches. In severe drought conditions, no fish population surveys are advised during drought as this may cause further stress. Walkover of key	No fish population surveys are advised during drought as this may cause further stress. Additional walkovers, if situation is expected to deteriorate in stream sections known to contain to contain high fish densities, spawning, nursery and cover habitats. Record extent of exposed marginal habitats, spawning habitats, bed	Targeted installation of woody debris features to provide fish with the habitat required to support feeding and development (growth). If the results of the walkovers deem spawning gravels to be at risk to siltation, the following mitigation action/s may be undertaken: • Gravel washing of key spawning areas to be undertaken prior to salmonid spawning period (winter)[12]	Two years of annual post-drought fish population surveys at baseline monitoring sites (corresponding with a control and impact site/s) to determine any changes in population dynamics both temporally and spatially. 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. Walkover of key spawning	Welsh Water

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

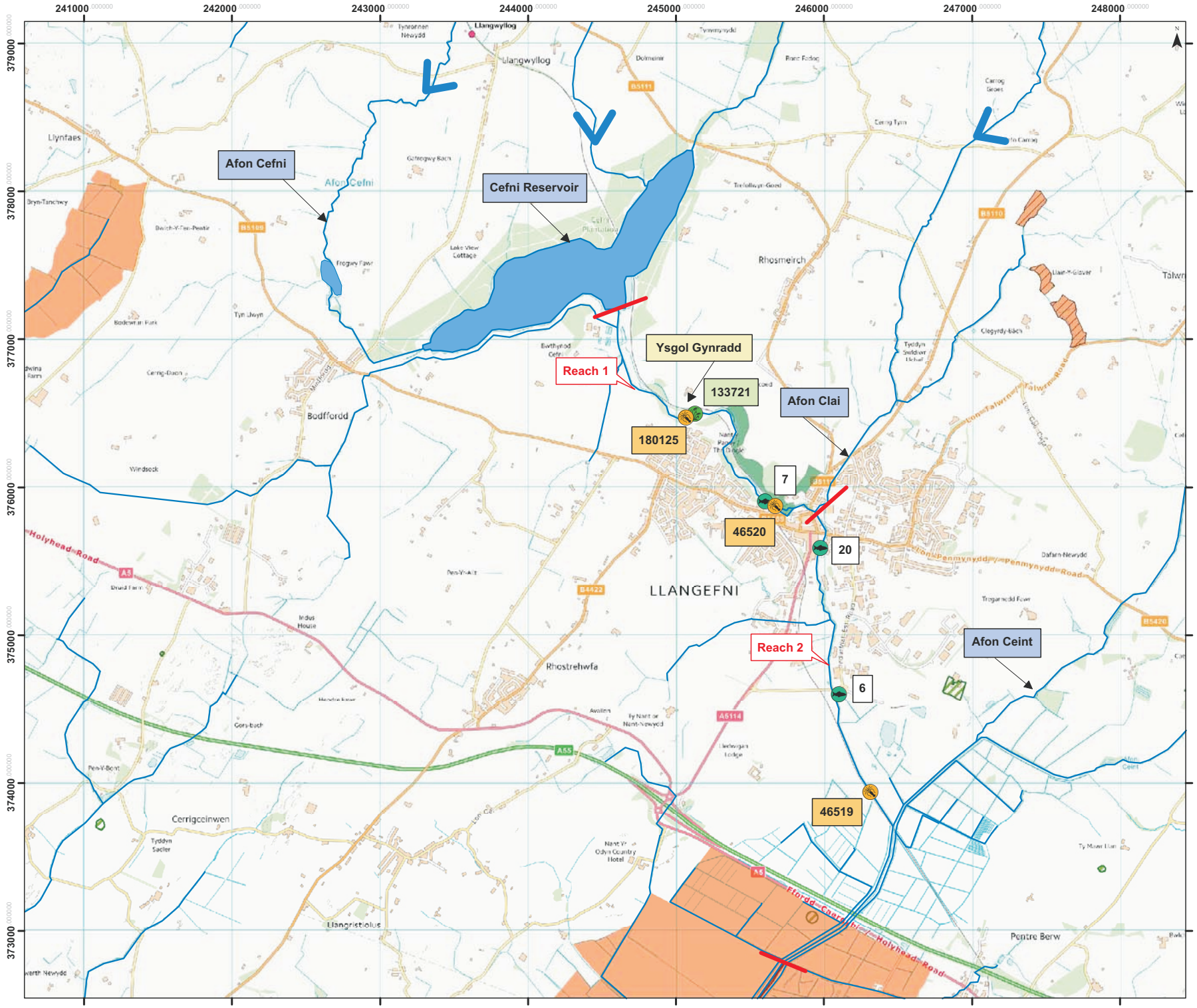
Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
	reduction in velocity Changes in flows and water levels may delay or prevent passage over barriers to migration Mortality as a result of water quality deterioration (oxygen stress, gill clogging) Alteration to species distribution and abundance as a result of water quality deterioration.	monitoring, in discussion with NRW. Monitoring sites are located at: • Reach 1 - Site 7 • Reach 2 - Site 6 • Reach 2 - Site 20	sections known to be susceptible to lower flows: • Identification of key habitats which are at risk of fragmentation. • Identification of key structures which may provide a barrier at lower flows. • Identification of key spawning locations recording the number of redds potentially affected, undertaken during the salmonid winter spawning period (depending on permit being implemented	substrates and estimates of overlaying silt cover. 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. 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 juvenile eel migration (spring/summer).	• Targeted installation of woody debris features to increase localised flow velocity/scour at impacted spawning gravels (to aid sediment transport and increase water depth for spawning depth) 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: • Targeted installation of woody debris features to increase flow heterogeneity/scour and marginal cover in shallow areas of the channel[13] • Deployment of aeration equipment in key reaches that	locations recording the number of redds potentially affected, undertaken during the winter spawning period. Record extent of exposed marginal habitats, spawning habitats, composition of the bed substrate and estimates of overlaying silt cover. If the results of the walkovers deem spawning gravels to have suffered from siltation, the following mitigation action/s may be undertaken: Gravel washing of key spawning areas to be undertaken prior to salmonid spawning period (winter)[14] Targeted installation of woody debris features to: • increase flow heterogeneity/scour and marginal cover in shallow areas of the channel[15] • increase localised	

[13] Wild Trout Trust Chalkstream Habitat Manual – Use of Large Woody Debris http://www.wildtrout.org/sites/default/files/library/Large_Woody_Debris.pdf
[14] Wild Trout Trust Habitat Management Sheet – Gravel Cleaning http://www.wildtrout.org/sites/default/files/library/Gravel_Cleaning_Apr2012_WEB.pdf
[15] Wild Trout Trust Chalkstream Habitat Manual – Use of Large Woody Debris http://www.wildtrout.org/sites/default/files/library/Large_Woody_Debris.pdf

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
			during the salmonid winter spawning period). Record extent of exposed marginal habitats, spawning habitats, composition of the bed substrate and estimates of overlaying silt cover. Approximation of the number of each fish species (e.g. 10s, 100s) in each ponded reach, where safe and practical to do so. Measure dissolved oxygen, conductivity and temperature in the field using calibrated handheld equipment. Appropriate trigger values	Frequency of fish passage assessments to be determined based on the on-set of environmental drought walkover and expert judgement of the resolution required to monitor the impacts of the drought. Measure dissolved oxygen, conductivity and temperature in the field using calibrated handheld equipment. Deployment of automated water quality equipment that continuously monitors for dissolved oxygen.	have standing or slow flowing water with low oxygen levels. • Targeted installation of woody debris features to provide submerged and overhead cover from predation where significant abundances of fish have been identified by walkover surveys. Consider provision of physical deterrents to deter piscivorous birds at significant locations (e.g. scare crows) in consultation with NRW. In extreme cases (where environmental parameters such as dissolved oxygen and temperature allow), consider removal of concentrated abundances of fish deemed to be stranded/at risk, relocating fish to suitable locations outside of the impacted reach within more suitable catchment, but	flow velocity/scour at impacted spawning gravels (to aide sediment transport and increase water depth for spawning depth) 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: • 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 juvenile eel migration (spring/summer). • 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	

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)	
			would be set for level and flow for spawning habitats based on local circumstances, timing, seasonality and expert opinion.		would need to be discussed with NRW to ensure compliance with the Keeping and Introduction of Fish Regulations 2014. 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). 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). Alternatively, mitigation should seek to protect any populations 'trapped' as a result of the barrier/s until flows increase for example by	passage). Where fish passage is not currently provided at a barrier, investigate appropriate methods of improving passage (e.g. fish passage design and installation).	

Feature and reach	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period		Post Drought Permit	Responsibility
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring	Monitoring and post-drought mitigation (where applicable)	
					using aeration (if dissolved oxygen levels are low) or preventing predation (see Increased Mortality impact mitigation actions outlined above). Deployment of aeration equipment in key reaches that have standing or slow flowing water with low oxygen levels.		



Legend

- Hydrological Reach
- Water Courses
- Direction of Flow
- Reservoir
- Macroinvertebrate Survey
- Macrophyte Survey
- Fish Survey
- Special Area of Conservation
- Site of Special Scientific Interest
- Scheduled Ancient Monuments

RICARDO

Dŵr Cymru Welsh Water

1:24,000

Note: All locations are approximate

Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Environmental Monitoring: 8001-5 Reduction of Cefni Reservoir compensation water

Figure Number: Figure 10.1

Date: February 2019

10 CONCLUSIONS

This EAR provides an assessment of the potential environmental impacts relating to the implementation of the Cefni Reservoir drought permit. If granted and implemented, the drought permit would enable Welsh Water to reduce the total flow release to the Afon Cefni by 0.9Ml/d, conserving storage in the reservoir.

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 **major** impact on flows in the Afon Cefni as a result of implementing the drought permit. These hydrological impacts are assessed as leading to **moderate** impacts on the physical environment of the river, including water quality.

An environmental assessment was therefore required and included for features where screening has identified a major or moderate impact. Screening identified WFD status and Community Assessment / Environment (Wales) Act Section 7 Species, Habitats Directive Annex 2 Species, Malltreath Marsh/Cors Ddtga SSSI and Nant y Pandy LNR and recreation as environmental features for which an environmental assessment was required. The assessment has concluded that there are **major** impacts on fish, and **moderate** impacts on macroinvertebrates and macrophytes and minor impacts on phytobenthos. The impacts on Malltraeth Marsh / Cors Ddyga SSSI are assessed as minor and as major on the Dingle / Nant y Pandy LNR

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 Cefni Reservoir.

The environmental assessment has identified significant impacts of implementation of a drought permit at Cefni Reservoir. Consequently, in line with the DPG, mitigation measures have been proposed and further discussion with NRW is required in order 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 Cefni Reservoir, 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 DPG[1]) 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 approach[2] 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 upland[3]. 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		
	% reduction in flow	<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		
	% reduction in flow	<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 Q_{95}, summer[4]) and very high sensitivity to changes in extreme low flow (represented by Q_{99}, 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 Q_{95}), but similarly sensitive to reductions in extreme summer low flows (summer Q_{99}).

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		
	% reduction in flow	<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 – 8001-5 HYDROLOGY AND PHYSICAL ENVIRONMENT ASSESSMENT

B1 INTRODUCTION

This appendix assesses the potential impacts on the physical environment of Cefni Reservoir and the Afon Cefni river catchment during the period of implementation of the drought permit and subsequent reservoir level recovery.

For the purposes of this assessment, the "without drought permit" baseline includes the continuation of abstraction and statutory rate of compensation release (1.8Ml/d) under the existing abstraction licence from Cefni Reservoir. This represents normal operating arrangements during a typical summer/autumn period. The assessed drought permit assumes a temporary reduction in the compensation rate of 50% to 0.9Ml/d, to conserve storage in Cefni Reservoir.

B.1.1 Welsh Water's Existing Operations

Welsh Water's licence (number 23/102/2/007) to abstract water under the Water Resources Act at Cefni Reservoir includes the following licence conditions:

• 5,475 million litres (Ml) authorised to be abstracted per annum

• At an abstraction rate not exceeding 15.0Ml/d

• Subject to the Anglesey County Council Water Act 1944, which requires the discharge of compensation water (equivalent to a continuous daily release) of 1.8Ml/d to the Afon Cefni.

The abstraction for potable supply is made directly from Cefni Reservoir, treated at Cefni Water Treatment Works (WTW) from where it is put into supply.

B.1.2 Welsh Water's Proposed Drought Permit Operations

The drought permit involves a proposed reduction in the statutory compensation release from Cefni Reservoir to the Afon Cefni of 0.9Ml/d, from 1.8Ml/d to 0.9Ml/d. The drought permit conditions are most likely to be implemented during the period July to December inclusive, based on water resources modelling carried out by Welsh Water. The reduced compensation flow would help to conserve the longevity of reservoir storage for use in direct supply during a drought. The drought permit scheme will influence the downstream Afon Cefni from the outflow at Cefni Reservoir to the tidal limit.

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 principle objectives:

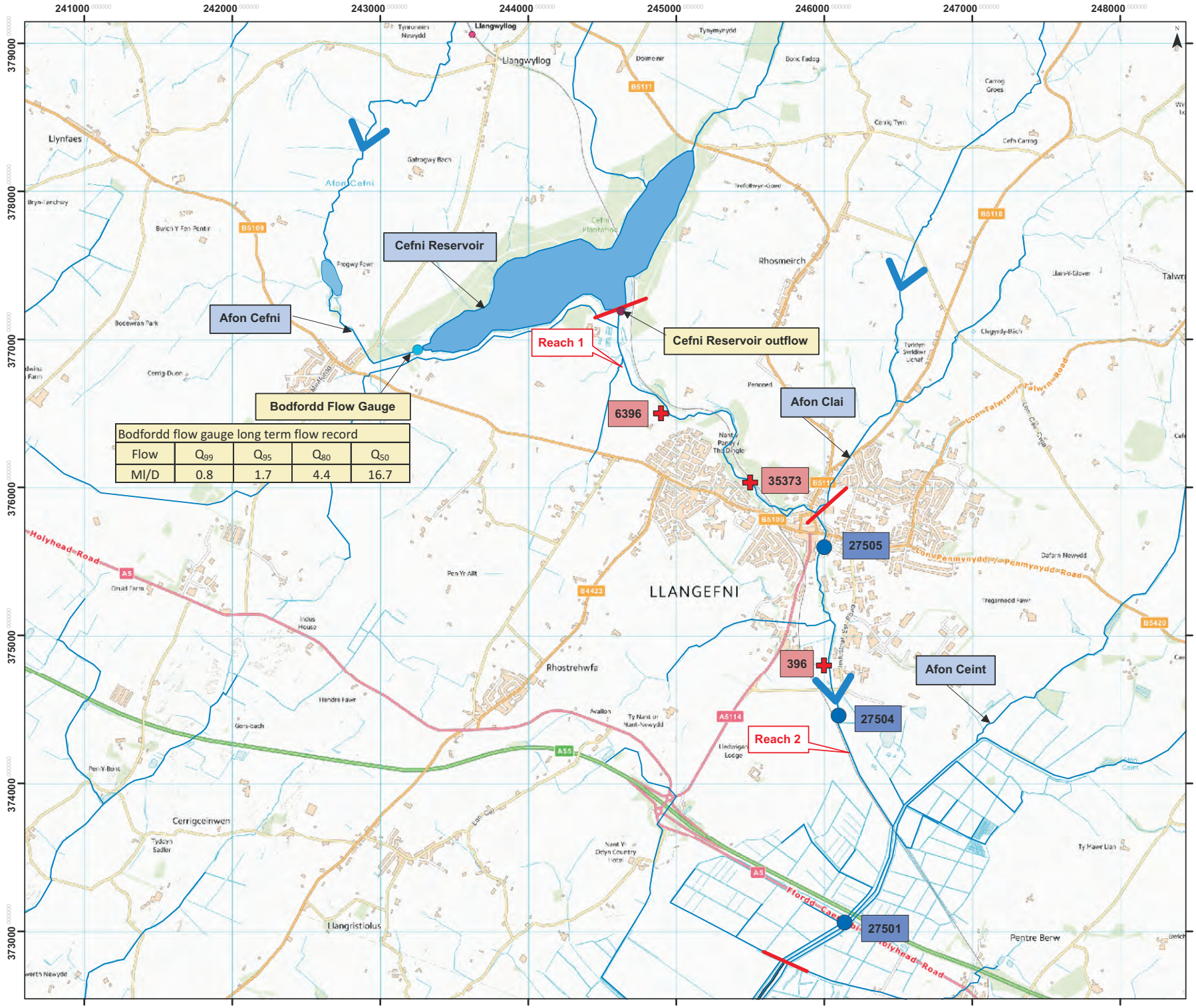
1. To "list the likely impacts to the flow, level, channel/riparian form and sediment due to

action being in place" as required by the DPG[1] 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.
3. Where sensitive features are the physical environment itself, it provides supporting technical information for their screening and assessment.

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.



Bodfordd flow gauge long term flow record				
Flow	Q_{99}	Q_{95}	Q_{80}	Q_{50}
Ml/D	0.8	1.7	4.4	16.7

Legend

- Abstraction
- Flow Gauge
- WQ Site
- RHS Site
- Hydrological reach
- Water Courses
- Direction of Flow
- Reservoir

RICARDO

Dŵr Cymru Welsh Water

1:24,000

Note: All locations are approximate

Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Hydrological Overview: 8001-5 Reduction of Cefni Reservoir compensation water

Figure Number: Figure B1.1

Date: February 2019

B2 HYDROLOGICAL IMPACT

B.2.1 Reference Conditions

B.2.1.1 Catchment Overview

Cefni Reservoir is situated in the centre of the Isle of Anglesey at an altitude of around 35m. The reservoir holds a maximum usable storage volume of 1,549Ml with a surface area of about 0.7km^2 at top water level. The 41km^2 catchment, draining into the reservoir, has significantly lower rainfall than that on mainland Gwynedd, falling on improved pasture with mixed livestock. A further 40km^2 of catchment feeds the downstream Afon Cefni. Additional flows are provided by Llangefni WwTW. Approximately 500m of the Afon Cefni upstream of the tidal limit falls within the extensive flood plain area designated as a SSSI (Malltraeth Marsh).

Cefni Reservoir has been recognised as an important habitat for waterfowl and wading birds and is a key wetland site in the Anglesey Wetland Strategy. Cefni Reservoir is also noted as an important game fishery in Anglesey and is operated by the Cefni Angling Association.

A review of the flows and physical habitat characteristics of the river network downstream on Cefni Reservoir has identified the study area for this assessment (see **Figure B1.1**). The study area includes a length of the Afon Cefni from the Cefni Reservoir outfall to the tidal limit at Pentre Berw; comprising two distinct hydrological reaches, as listed in **Table B2.5** and **Table B2.6** and identified on **Figure B1.1.** The two reaches are also based on differing water quality which is related to various discharges in the Llangefni area (see Section B3.3).

The potential hydrological impact of the drought permit has been reviewed separately for the hydrological reaches and are discussed below.

B.2.1.2 Baseline Data Availability

Continuous monitoring is undertaken by Welsh Water to monitor its operations at Cefni Reservoir, including:

- Weekly Cefni Reservoir water level data, 1983 – 1987 and daily levels from 1989 to present
- Daily Cefni Reservoir compensation flow data, 1998 to present
- Daily Cefni Reservoir abstraction flows, 2005 to present

There is no continuous measurement of the Afon Cefni river flow downstream of the Cefni Reservoir, and overflows which occur when reservoir storage is at top water level, are not measured.

Continuous monitoring of river level is undertaken by NRW at the Bodffordd flow gauge on the upper Afon Cefni. This part of the river catchment is upstream of the reservoir impoundment and is the only natural flow gauge on the Isle of Anglesey.

Available flow data includes:

- NRW Bodffordd river flow gauge on the Afon Cefni, daily river flow from 1988 to 2014.

The reference conditions of Cefni Reservoir and the Afon Cefni river catchment are summarised below, based on the available hydrological data as set out above.

B.2.1.3 Hydrology

Cefni Reservoir

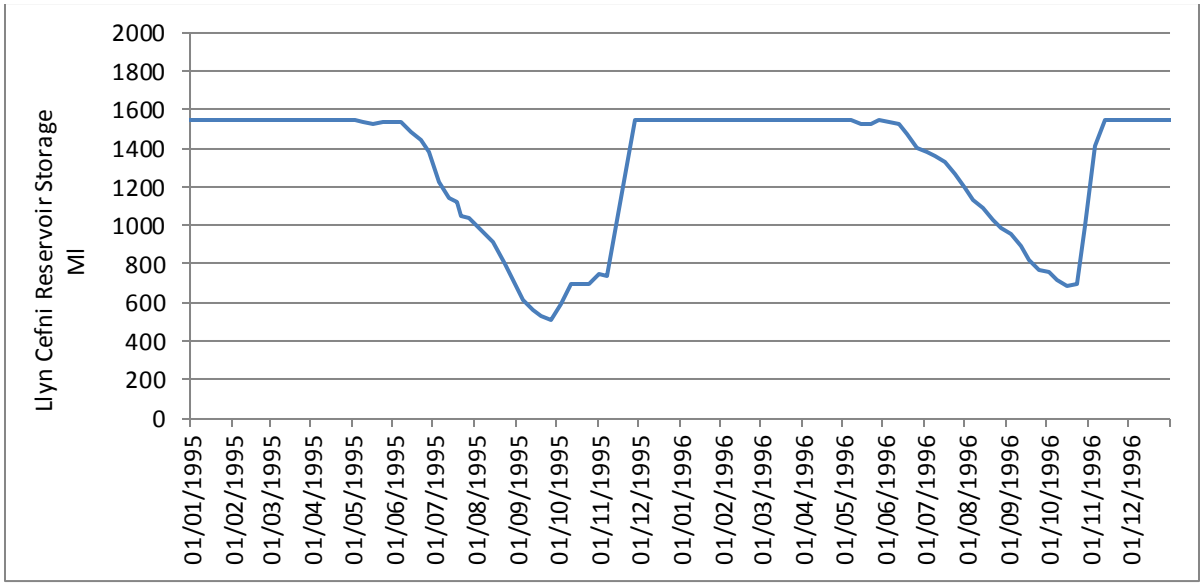
Typically, reservoir levels range from about 3m to about 5m above datum (1983 – 2015, excluding 1988) in Cefni Reservoir. The minimum level of 2.7m was recorded in September 1984. The top water level is at 5m above datum and when the reservoir is at full capacity, any overflows pass down the spillway channel into Afon Cefni. A summary of reservoir levels is given in **Table B2.1** below.

Table B2.1 Summary of Recorded Mean Daily Reservoir Level in Cefni Reservoir (1983 – 2015)

Percentage of timelake level equalled or exceeded	Mean daily reservoir level, metres, per month														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year	Summer	Winter
Maximum reservoir level	5.2	5.2	5.1	5.2	5.2	5.1	5.1	5.1	5.2	5.2	5.2	5.2	5.2		
10% (high level)	5.1	5.1	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.1	5.1	5.1	5.1		
50%	5.0	5.0	5.0	5.0	5.0	4.9	4.8	4.7	4.8	5.0	5.0	5.0	5.0		
80%	5.0	5.0	5.0	5.0	5.0	4.8	4.6	4.4	4.4	4.8	5.0	5.0	4.9		
90%	5.0	5.0	5.0	5.0	4.9	4.7	4.4	4.3	4.3	4.4	5.0	5.0	4.6	4.5	5.0
95%	5.0	5.0	5.0	5.0	4.9	4.6	4.4	3.8	3.5	3.5	5.0	5.0	4.4	4.3	4.9
99% (low level)	5.0	5.0	5.0	5.0	4.8	4.4	4.0	3.6	3.1	3.1	4.3	5.0	3.5	3.5	3.6
Minimum reservoir level	5.0	5.0	4.9	4.7	4.7	4.3	3.8	3.2	2.7	3.0	3.6	5.0	2.7		

Abstractions from the reservoir, to supply Cefni WTW, have typically been in the range 5 – 10Ml/d between 2005 – 2015. However, there was a relatively dry period between 1995-1996 and drawdown patterns in Cefni Reservoir are illustrated in **Figure B2.1**.

Figure B2.1 Cefni Reservoir Storage (1995-96)



Afon Cefni

The Afon Cefni is about 19km long, with a catchment area of 81.3km^2 at its tidal limit. At the Cefni reservoir spillway weir, the catchment area is 40.7km^2. The compensation release from the reservoir is measured, however overflows which occur when the reservoir is at full capacity are not measured.

The statutory compensation requirement is for a daily release of 1.8Ml/d. Recorded flows are generally in the range 1.9 – 2.2Ml/d.

Other than the compensation flow record, there is limited measured flow data available for the Afon Cefni downstream of Cefni Reservoir; this consists of occasional spot flow gauging results for around 6 locations over the period 1991 - 2003.

Flow is measured in the Afon Cefni upstream of the Cefni Reservoir impoundment at Bodffordd. A summary of the available daily flow data from 1988 onwards is given in **Table B2.2** below.

Table B2.2 Summary of Recorded Mean Daily Flow in Afon Cefni at Bodffordd (1988 – 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	Summer	Winter
Maximum flow	1002.2	413.9	533.1	366.3	303.3	227.2	166.8	232.4	772.4	1192.3	1088.6	570.2	1192.3		
10% (high flow)	131.3	104.3	72.4	49.4	22.9	18.0	13.0	14.8	39.6	97.5	148.7	149.9	85.4	27.8	119.4
50%	53.0	38.9	22.8	15.6	8.7	4.5	3.4	3.5	5.4	18.7	48.1	56.9	16.7	6.2	40.8
80%	26.4	20.3	14.2	8.6	5.4	2.9	1.9	1.8	1.7	5.7	23.0	26.5	4.4	2.7	17.5
90%	19.2	17.0	11.8	6.9	4.2	2.4	1.6	1.3	1.2	3.8	16.8	19.5	2.6	1.7	12.0
95% (low flow)	13.5	14.9	10.4	5.9	3.6	1.9	1.4	0.7	0.7	2.5	12.0	14.9	1.7	1.4	7.8
99% (extreme low flow)	8.6	11.8	8.9	5.3	2.3	1.5	0.9	0.2	0.4	1.3	4.7	10.1	0.8	0.6	2.8
Minimum flow	7.3	8.4	8.3	4.7	1.9	1.4	0.6	0.2	0.3	1.0	3.9	9.1	0.2		

The low flow statistics for the summer period (1st April to 30th September inclusive) are: Summer Q_{95} = 1.4Ml/d; Summer Q_{99} = 0.6Ml/d.

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

Figure B2.2 Afon Cefni at Bodffordd Flows (2005 – 2006)

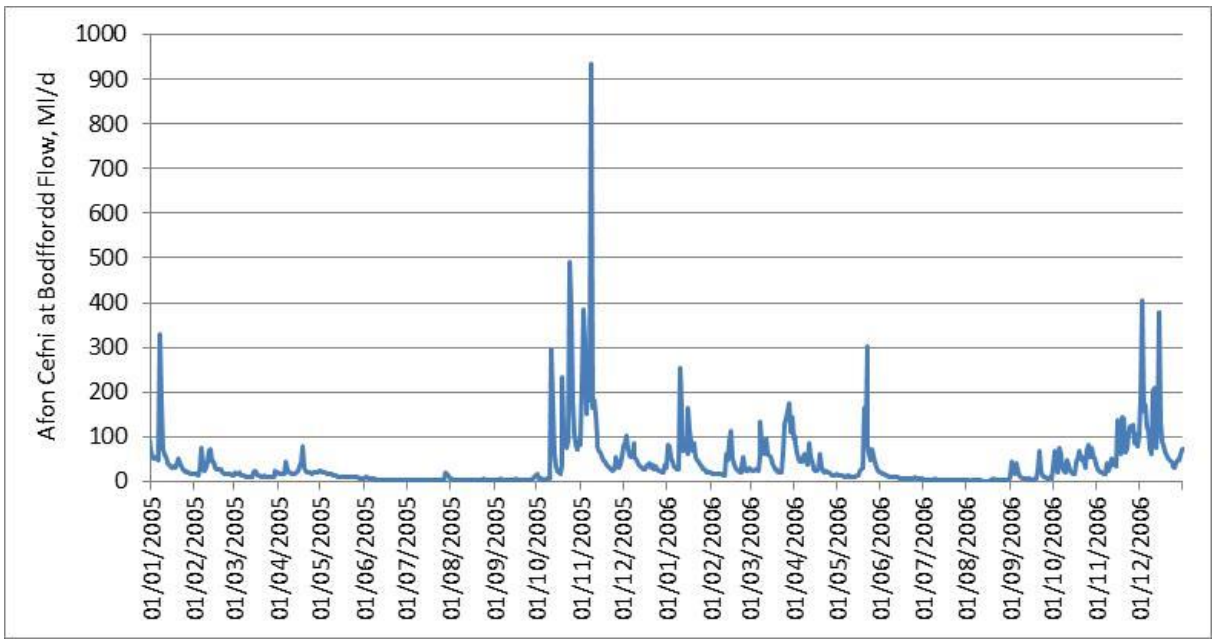
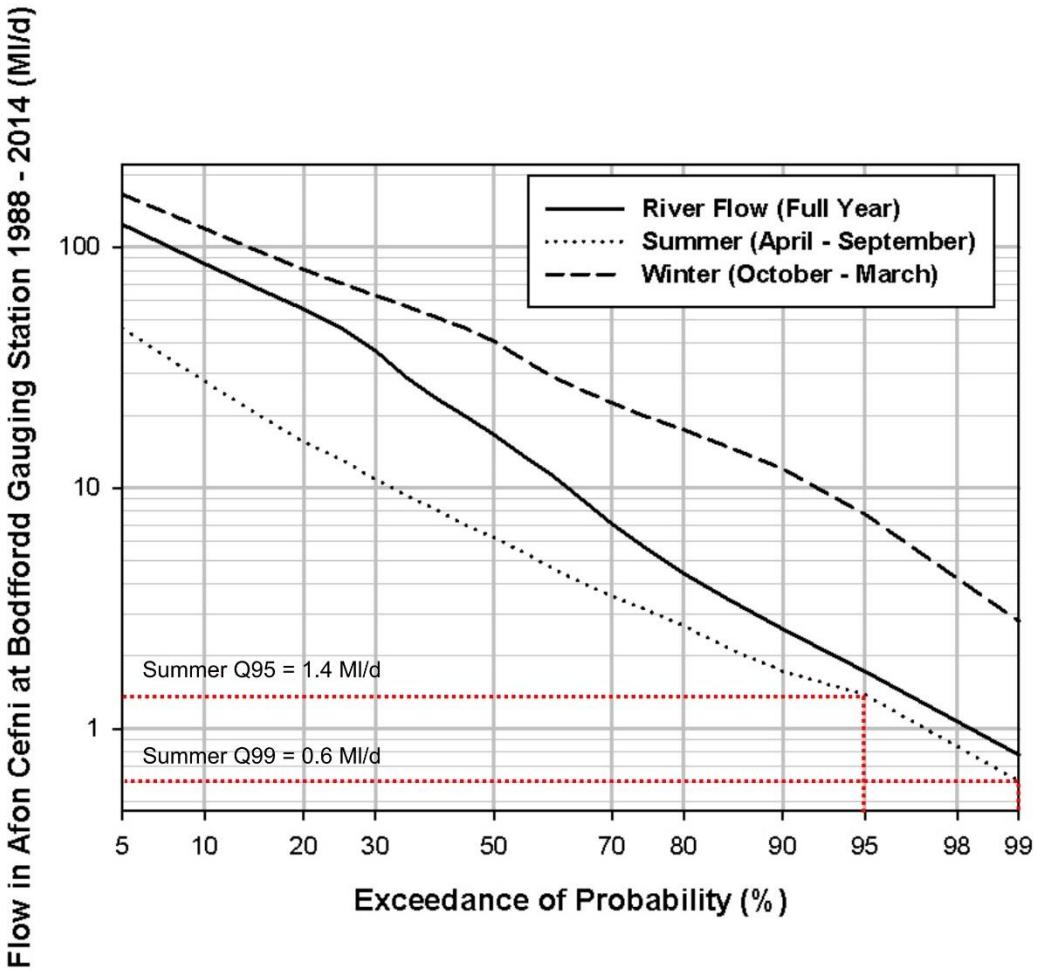


Figure B2.3 Afon Cefni at Bodffordd Flow Summary (1988 – 2014)



B.2.2 Hydrological Impact

B.2.2.1 Hydrological Zone of Influence

A review of the flows and physical habitat characteristics of the river network downstream of Cefni Reservoir has identified the likely hydrological zone of influence of the drought permit, which has been used to define the study area. The study area includes the Afon Cefni, comprising two distinct hydrological reaches, as shown on **Figure B1.1**:

- Reach 1 is the Afon Cefni, from the Cefni Reservoir outflow to Llangefni Industrial Estate.
- Reach 2 is the Afon Cefni, from Llangefni Industrial Estate to the tidal limit at Pentre Berw.

The potential hydrological impacts of the drought permit options have been assessed for Cefni Reservoir and the two separately identified river reaches, as summarised in **Table B2.5** and **Table B2.6** at the end of this section.

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

B.2.2.2 Hydrological Impact Assessment

Hydrological Reach – Cefni Reservoir

The impact on Cefni Reservoir would be a marginal increase in levels/storage, relative to the position without the drought permit, due to the reduced compensation flow which would help to conserve water in storage. The duration of shoreline exposure would be slightly shorter, compared to the baseline drought scenario, as the reservoir would reach top water level slightly earlier during the winter refill period. This would be considered as a minor positive impact and has not been assessed further.

River Reach Assessment

In the absence of any continuous gauged flow record in the downstream Afon Cefni catchment, we have estimated naturalised flow statistics at key locations on the Afon Cefni from the Bodffordd gauging station parameters, based on relative catchment areas. Standard rainfall statistics were not used in the apportionment as these were very similar for all the sub-catchments. The estimated summer low flow statistics for the Afon Cefni are 3.7Ml/d (Q_{95}) and 1.6Ml/d (Q_{99}) at Llangefni Industrial Estate, and 5.2Ml/d (Q_{95}) and 2.3Ml/d (Q_{99}) at the tidal limit at Pentre Berw. The estimated year round low and median flow statistics are 4.7Ml/d (Q_{95}) and 45.0Ml/d (Q_{50}) at Llangefni Industrial Estate, and 6.5Ml/d (Q_{95}) and 62.5Ml/d (Q_{50}) at the tidal limit at Pentre Berw (see **Table B2.3** below).

Table B2.3 Summary of Catchment Areas and Key Flow Statistics: Afon Cefni

Location	Grid Reference	Catchment area km²	Ratio of catchment areas to Bodffordd	Summer (April to September inclusive) Naturalised Low Flow Statistics		Year round Naturalised Flow Statistics		
				Q_{99}	Q_{95}	Q_{95}	Q_{50}	Source
Afon Cefni at Bodffordd	SH429768	21.7	100%	0.6	1.4	1.7	16.7	Data record
Afon Cefni at Cefni Reservoir outflow	SH 44609 77159	40.7	188%	1.1 (1.8*)	2.6	3.2	31.3	Area-flow apportionment
Afon Cefni at Llangefni Industrial Estate	SH 46037 74883	58.5	270%	1.6 (2.3*)	3.7	4.7	45.0	Area-flow apportionment
Afon Cefni at tidal limit at Pentre Berw	SH 45734 72800	81.3	375%	2.3 (3.0*)	5.2	6.5	62.5	Area-flow apportionment
Afon Clai at confluence with Afon Cefni	SH 4598 7588	12.0	55%	0.3	0.8	1.0	9.2	Area-flow apportionment
Afon Ceint at confluence with Afon Cefni	SH 4650 7375	17.2	79%	0.5	1.1	1.4	13.2	Area-flow apportionment

*Adjusted for compensation effects, as naturalised Q_{99} is lower than statutory compensation

In addition, we have reviewed the Cefni catchment spot flow gauging results for 1991 – 2003 and compared these with measured daily mean flows from the Bodffordd gauged record in order to assign approximate flow percentiles to each value. The results of this analysis are shown in **Table B2.4**.

Most of the available spot flow gauging results do not relate to low or extreme low summer flow statistics at the Bodffordd flow gauging station. However, there are two results which give an indication of approximate extreme low summer flow statistics: the measured value for Llangefni Town Centre (lower reach 1) on 9/8/1995, 5.32Ml/d, which is approximately equivalent to a Q_{99} value, and the measured value of 10.42Ml/d for Pont y Gors (mid reach 2) on 18/9/1996, which is approximately equivalent to a Q_{98} value.

Table B2.4 Summary of Spot Flow Gauging Results in the Study Area

Spot Gauge Location	Grid Reference	Date	Reach	Spot Flow (Ml/d)	Bodffordd daily mean flow (Ml/d)	Bodffordd Summer Q statistic
Llangefni Town Centre	SH46007560	23-May-91	1	9.70	5.44	55
		11-Jun-91		10.15	4.06	65
		15-Oct-91		5.67	2.94	-
		21-Nov-91		21.44	28.60	-
		20-Jan-92		10.01	16.85	-
		03-Feb-92		26.25	15.12	-
		18-Feb-92		72.49	45.27	-
		22-Apr-92		39.15	19.27	16
		04-Aug-92		4.47	3.02	75
		19-Oct-92		32.96	17.80	-
		07-Jan-93		74.37	48.99	-
		29-Jan-93		127.32	65.32	-
		19-Nov-93		62.86	24.71	-
		06-Jun-94		12.66	6.31	50
		07-Sep-94		28.30	3.63	69
		23-Nov-94		70.87	54.78	-
		09-Aug-95		5.32	0.69	99
		14-Nov-95		18.77	30.15	-
		31-Jul-03		13.48	4.32	63
		31-Jul-03		0.52	4.32	63
		31-Jul-03		2.25	4.32	63
		12-Jun-03		8.54	7.43	43
	SH4598875552	16-Oct-02		9.10	24.36	-
		22-Nov-02		122.62	56.07	-
		28-May-03		28.58	18.92	16
		28-May-03		8.54	18.92	16
	SH45957550	26-Apr-02		69.53	23.67	12
		11-Mar-02		79.88	40.18	-
		11-Jun-02		27.83	10.28	32
		14-May-02		21.05	8.73	37
		16-Jul-02		8.42	3.54	71
		13-Aug-02		6.46	4.41	62
		16-Dec-02		67.56	58.23	-
Pont y Gors	SH46507370	31-Jan-00	2	114.78	40.52	-
		16-Mar-00		77.30	19.87	-
		13-Apr-00		78.80	21.86	13
		09-May-00		44.271	9.07	36
		07-Jul-00		10.90	2.42	82
		07-Aug-00		11.51	2.94	77
	SH46467367	27-Mar-96		79.06	23.59	-
		25-Jun-96		8.88	2.42	82
		18-Sep-96		10.42	0.78	98

Spot Gauge Location	Grid Reference	Date	Reach	Spot Flow (Ml/d)	Bodffordd daily mean flow (Ml/d)	Bodffordd Summer Q statistic
		26-Nov-96		288.58	77.85	-
		16-Mar-00		77.30	19.87	-
		13-Apr-00		78.79	21.86	13
	SH46407360	20-May-99		17.30	6.65	48
	SH46167308	22-Mar-99		43.94	17.97	17
		22-Aug-99		43.95	2.76	79
		20-May-00		17.30	7.86	41
		24-May-00		44.27	10.89	30
	SH46157307	27-Mar-95		96.00	15.03	-
	SH46157307	27-Jun-95		11.74	2.33	83

Hydrological Reach 1 – Afon Cefni (Cefni Reservoir Outflow to Llangefni Industrial Estate)

The Afon Cefni is a typical Anglesey river; a sluggish low-gradient river flowing over boulder clay. The channel is heavily modified in Reach 1, is 5m wide at bankfull with a substantial embankment. The channel is underlain by a gravel-pebble substrate with silt and the flow pattern is smooth. There are no significant tributaries to the Afon Cefni downstream of the Cefni Reservoir outfall in Reach 1 and no continuous flow gauging. The compensation release from Cefni Reservoir is a substantial proportion of the flow in Reach 1 in the Afon Cefni during low flow periods.

The hydrological impacts associated with a 50% reduction in compensation discharge will include a significant reduction in wetted depth and width and flow velocity below those normally observed in the Afon Cefni. At the top of Reach 1, the reduction in compensation from 1.8Ml/d to 0.9Ml/d which is a 50% reduction in the flow. However, during periods of rainfall, the effect of the drought permit will be reduced by minor flow accretion in the downstream catchment, including a tributary joining the Afon Cefni near the town centre of Llangefni (Afon Clai). Hence the reduced compensation represents around a 24% reduction in the summer Q_{95} low flow statistic or a 17%-39% reduction in the Q_{99} low flow statistic towards the lower end of reach 1. (These percentages are based on both the spot flow Q_{99} value for lower reach 1, (5.32Ml/d), and the catchment ratio estimate adjusted for compensation effects, (2.3Ml/d).

The potential hydrological impact of the drought permit in hydrological reach 1 is, therefore, considered to be **major** during the period of implementation from July to December inclusive.

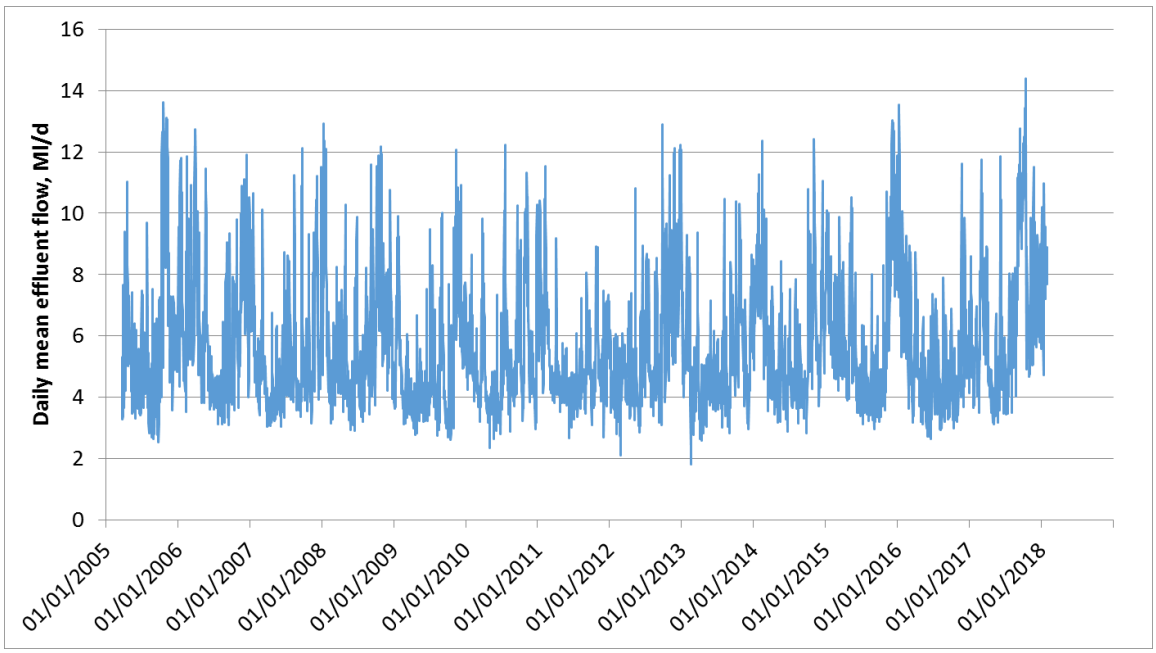
Hydrological Reach 2 – Afon Cefni (Llangefni Industrial Estate to tidal limit at Pentre Berw)

The Afon Cefni in hydrological reach 2 remains a sluggish low-gradient river flowing over boulder clay. In the early 19th century, Malltraeth marsh was drained and the channel straightened and raised above its natural floodplain. Malltraeth cob was built at the end of hydrological reach 2, which prevents the tidal influence reaching upstream to Llangefni.

Llangefni Wastewater Treatment Works (WwTW) discharges treated wastewater to the Afon Cefni, at a flow of 5.74Ml/d (consented dry weather flow). The WwTW discharge increases flow in the Afon Cefni but requires dilution from the flow in the river. The effect of the drought permit will also be reduced by minor flow accretion in the downstream catchment including a significant tributary, the Afon Ceint, which contributes around 0.5-1.1Ml/d at summer low and extreme low flows (see **Table B2.3**). Under low flow conditions in the Afon Cefni, flow in hydrological reach 2 is, therefore, significantly greater than in hydrological reach 1.

At the top of Reach 2, summer low and extreme low flow statistics are estimated by area-flow apportionment to be around 3.7M/d (Q_{95}) and 2.3Ml/d (Q_{99}), allowing for the effects of the existing compensation release rate. Assuming a dry weather flow of 5.74Ml/d from Llangefni WwTW effluent discharge, these flow values are increased to 9.44Ml/d (Q_{95}) and 8.04Ml/d (Q_{99}) downstream of the effluent discharge. The daily time series data for the effluent discharge from Llangefni WwTW is shown in **Figure B2.4**. The daily volume for the period March 2005 to January 2018 ranges from 1.8 Ml/d up to 14.4 Ml/d, with the overall daily average for the period being 5.64 Ml/d which indicates the assumption for the flow contribution is reasonable. A reduction of 0.9Ml/d in these flows therefore represents a reduction of 9.5% in the summer Q_{95} flow or 11.2% in the summer Q_{99} flow.

Figure B2.4 Effluent Discharge from Llangefni WwTW (2005 – 2018)



At the lower end of reach 2, allowing for the effects of the WwTW discharge and flow accretion, the low and extreme low flow statistics are estimated to be around 10.94Ml/d (Q_{95}) and 8.64M/d (Q_{99}), so the 0.9Ml/d reduction in compensation is a reduction of around 8% in the summer Q_{95} flow or 10% in the summer Q_{99} flow. (The Q_{98} flow value based on the spot flow results for Pont y Gors is of a similar magnitude at 10.42Ml/d and the percentage reduction based on this value would be around 9%.)

The potential hydrological impact of the drought permit in Reach 2 is, therefore, considered to be **minor** during the summer months of July to September inclusive.

During the winter, year round low and median flow statistics at the top of reach 2 are estimated by area-flow apportionment to be 4.7Ml/d (Q_{95}) and 45.0Ml/d (Q_{50}). Assuming a dry weather flow of 5.74Ml/d from Llangefni WwTW effluent discharge, these flow values are increased to 10.44Ml/d (Q_{95}) and 50.74Ml/d (Q_{50}) downstream of the effluent discharge. A reduction of 0.9Ml/d in these flows therefore represents a reduction of 8.6% in the year round Q_{95} flow or 1.8% in the year round Q_{50} flow. The potential hydrological impact of the drought permit in Reach 2 is therefore assessed as **negligible** during the winter months of October to December inclusive.

B.2.2.3 Hydrological Impact Summary

Two reaches have been considered for which the assessed hydrological impacts are **major** (Reach 1) and **negligible to minor** (Reach 2). The impacted reaches are shown in **Table B2.5** and **Table B2.6** and establish the full in-channel zone of influence of the drought permit for environmental sensitivity screening (see **Figure B1.1**).

The impact on Cefni Reservoir itself has been assessed as **minor beneficial**.

Table B2.5 Hydrological and Monitoring Reaches identified in the Study Area – Summer Impact (July – September)

Hydrological Reach		Reach boundary		Reach length	% flow reduction		Hydrological Impact (summer)
		Upstream	Downstream		Summer Q_{95}	Summer Q_{99}	
Cefni Reservoir		n/a	n/a	n/a	n/a	n/a	**Minor beneficial**
1	Afon Cefni	Cefni Reservoir Outflow	Llangefni Industrial Estate	3.8km	50%	50%	**Major**
2	Afon Cefni	Llangefni Industrial Estate	Tidal limit at Pentre Berw	2.6km	9.5%	11.2%	**Minor**

Table B2.6 Hydrological and Monitoring Reaches identified in the Study Area – Winter Impact (October - December)

Hydrological Reach		Reach boundary		Reach length	% flow reduction		Hydrological Impact (winter)
		Upstream	Downstream		Year round Q_{50}	Year round Q_{95}	
Cefni Reservoir		n/a	n/a	n/a	n/a	n/a	**Minor beneficial**
1	Afon Cefni	Cefni Reservoir Outflow	Llangefni Industrial Estate	3.8km	50%	50%	**Major**
2	Afon Cefni	Llangefni Industrial Estate	Tidal limit at Pentre Berw	2.6km	1.8%	8.6%	**Negligible**

B3 PHYSICAL ENVIRONMENT ASSESSMENT

B.3.1 Geomorphology and Sediment Transport

Geomorphological information for the Afon Cefni downstream of Llyn Cefni was obtained from RHS surveys and previous assessments as part of Cascade's 2007 DP EMP and augmented, where necessary, by extant aerial imagery. RHS data are available for two site in hydrological reach 1 (Survey IDs: 6396, 35373) and one site in hydrological reach 2 (Survey ID: 396). Hydrological reaches (table B2.5) are delineated by a change from a semi-natural to heavily modified watercourse and the river is low-gradient throughout its course. Underlying geology varies from rocks of Angelsey upstream, to a Tournasian and Visean geology downstream.

Reach 1 - Cefni Reservoir Outflow to Llangefni Industrial Estate

This is a sinuous, semi-natural reach with width varying from 2.9 m upstream to 6 m towards the downstream limit of the reach, according to RHS data. Adjacent land use is a mix of agricultural and urban. Riparian tree cover varies from scattered, occasional clumps in the upstream sections of the reach to at least semi-continuous downstream.

The channel is underlain by a gravel-pebble substrate with silt and the flow pattern is smooth. There are no significant tributaries to the Afon Cefni downstream of the Cefni Reservoir outfall in hydrological reach 1. As the compensation release from the Cefni Reservoir is a substantial proportion of the flow during low flow periods, reduced compensation discharge will cause significant reductions in wetted depth and width, and flow velocity. Flow patterns are dominantly smooth.

RHS data from the upstream survey (ID: 6396) suggests a pristine water course (HMS = 160), with minor impact from bridges and poaching. Towards the downstream limit of hydrological reach 1 modification is seen to increase as the rivers flows through urbanised areas. RHS data (survey ID: 35373) indicates a modified channel (HMS = 915), with impact from bridges, outfall deflectors, bed reinforcement and some impoundment (< 33%).

Reach 2 - Llangefni Industrial Estate to Tidal limit at Pentre Berw

This is a heavily straightened and sluggish reach. The river is raised above its natural floodplain and Malltraeth cob at the end of the reach prevents tidal influence reaching upstream to Llangefni. Width and depth from RHS data are 4 m and 0.5 m, respectively. In the upstream section of this reach right bank is predominantly rough grazing and the left bank is urban development. After Llangefni, agricultural land abuts the river on both banks, with a thin riparian zone and scattered tree cover.

Flowing over boulder clay, channel bed material is predominantly gravel-pebble, with some areas of exposed boulders. Some riffles were observed in the RHS survey (ID: 396), but in-channel features are low and flow patterns are dominantly smooth. RHS data indicates the heavily modified nature of this reach (HMS = 3070), with the presence of bridges, reinforced

and re-profiled earth banks and heavy resectioning.

B.3.2 Water Quality

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

To support the assessment of potentially sensitive environmental features (see Appendix D), an understanding has been developed of the water quality of the rivers within the zone of influence of the drought order, including trends over time and with respect to river flow. For Water Framework Classification (WFD) classification, the Environment Agency has set out[2] following UK Technical Advisory Group (UKTAG) evidence[3] of what pressures, including water quality pressures, each biological quality element is capable of responding to. For the purposes of assessment here, the supporting water quality parameters are set out: for fish and macroinvertebrates (where identified as sensitive features) as dissolved oxygen saturation and total ammonia concentration; and for macrophytes and algae (phytobenthos / diatoms) (where identified as sensitive features) as soluble reactive phosphorus (SRP). Specifically, for macrophytes, if the hydrological impacts of drought order implementation have been identified within the main macrophyte growing season (April to September), an assessment of SRP has been undertaken.

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

Ten years of NRW routine monitoring data were reviewed to provide an overview of water quality in the zone of impact. On the River Cefni, within the extent of influence of the drought order (Reaches 1 and 2), there are NRW water quality sampling sites (**Table B3.1** and **Figure B1.1**). Data are available for these sites (2006 to 2015) and include measurements of a suite of parameters. Some monitoring sites have data gaps, with some parameters only available up to 2010. Therefore, where data are lacking the assessment has been undertaken using professional judgement. Values at the limit of detection were halved in line with standard NRW practice.

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

[3] 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

Table B3.1 Details of NRW Water Quality Sampling Points on the River Cefni

Reach	Site Name	NRW Site Code	Grid reference	Location
-	Cefni Reservoir			
1	River Cefni, Pont Fawr, Llangefni	27505	SH4600075600	Centre of Llangefni
2	River Cefni, South end of industrial est., Llangefni	27504	SH4610074460	Just downstream of Llangefni
	River Cefni, Pont-y-gors, Gaerwen	27501	SH4614073060	A 1/3 of the way from Llangefito the tidal limit

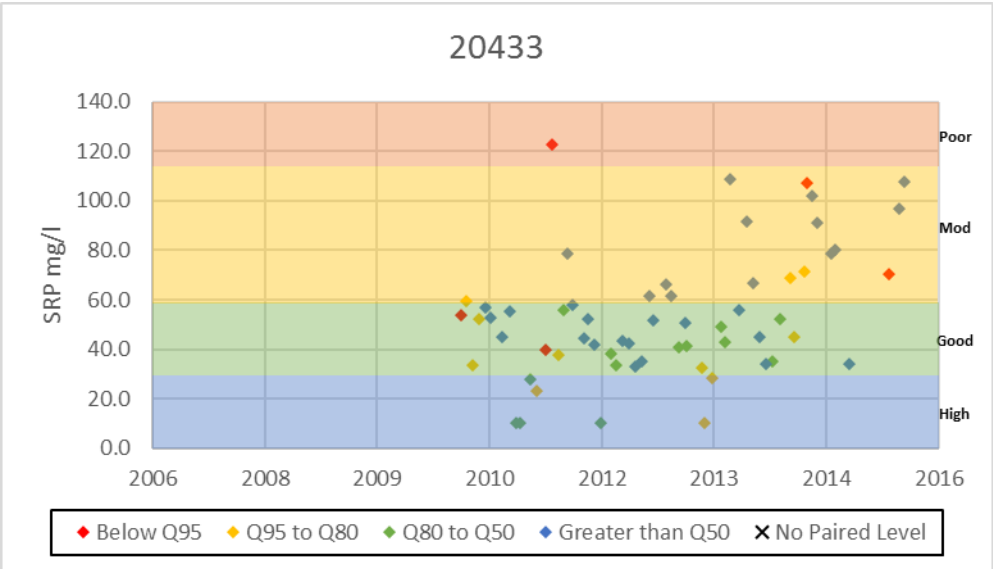
Reach – Cefni Reservoir

Water quality data are available for one NRW monitoring point in Cefni Reservoir (minor beneficial impact); Cefni Reservoir (site 20433).

Total Phosphorus

Total phosphorus concentration in Cefni Reservoir was reviewed and data are presented in **Figure B3.1** against the relevant WFD site specific standards provided by NRW[4].

Figure B3.1 Total Phosphorus in Cefni Reservoir, Incorporating Appropriate WFD Status Bands



Total phosphorus concentration Cefni Reservoir were predominantly consistent with the WFD standard to support good status for fish and invertebrates (29.13µgP/l). Values below this standard were noted in 33% of instances (19 occurrences). No relationship is apparent between total phosphorus concentration and reservoir level. No seasonality is apparent

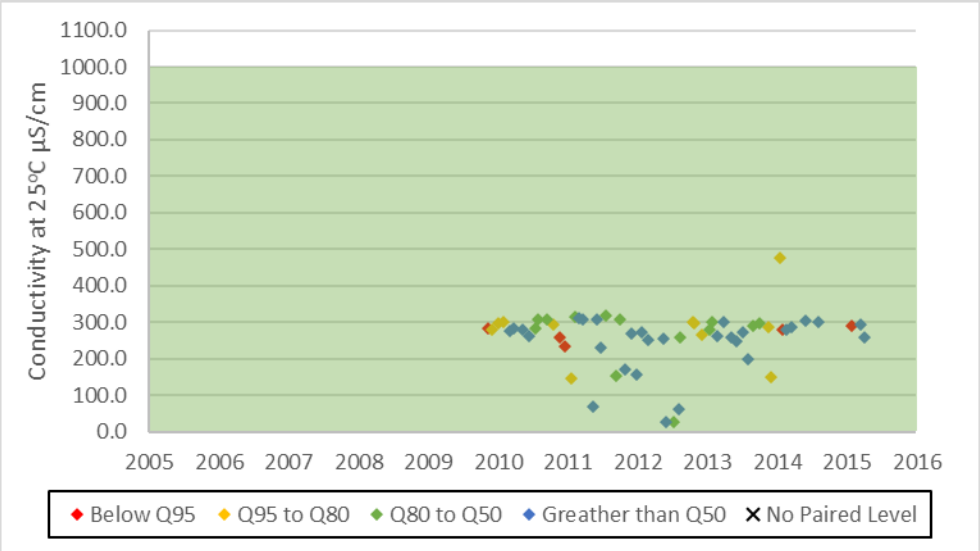
[4] The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

however occurrence of less than good status has increased in recent years.

Salinity (Conductivity)

Conductivity data in Cefni Reservoir were reviewed and data are presented in **Figure B3.2** against the relevant WFD standard for lakes[5].

Figure B3.2 Conductivity at Cefni Reservoir, Incorporating Appropriate WFD Status Bands



Conductivity measurements on the Cefni Reservoir (see **Figure B3.2**) were all consistent with the WFD standard to support good status for fish and invertebrates (1000µS/cm[3]). No relationship is apparent between conductivity and reservoir level.

Reach 1 (Cefni Reservoir Outflow to Llangefni Industrial Estate)

Data are available for River Cefni, Pont Fawr, Llangefni (site 27505), a monitoring point located in the downstream section of Reach 1.

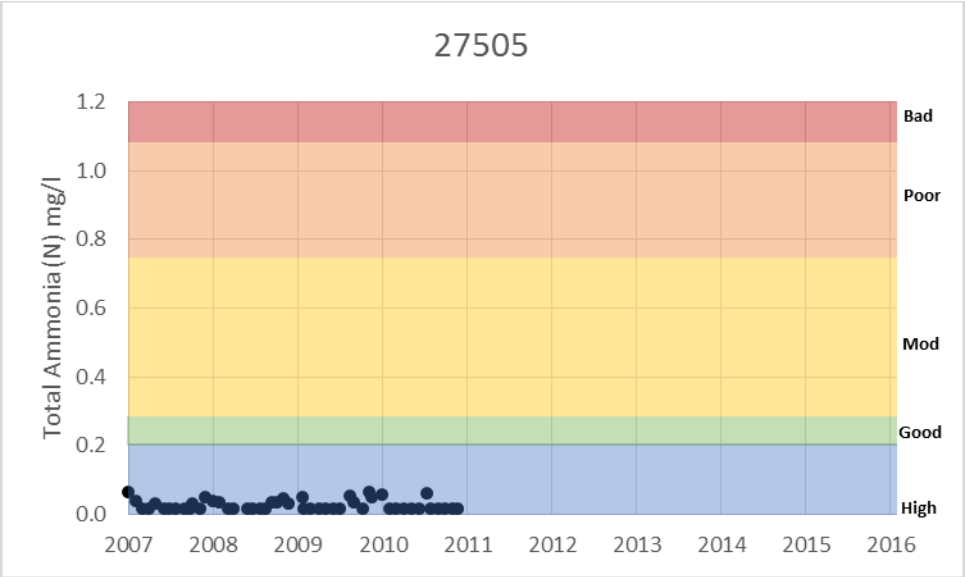
The average pH at River Cefni, Pont Fawr, Llangefni over the ten year review period was 8.04 and the maximum water temperature was 17.4°C.

Total ammonia concentration

Total ammonia concentration in the River Cefni, Pont Fawr, Llangefni was reviewed and data are presented in **Figure B3.3** against the relevant WFD standards for an upland low alkalinity river[6].

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

Figure B3.3 Total Ammonia in the River Cefni, Pont Fawr, Llangefni, Incorporating Appropriate WFD Status Bands



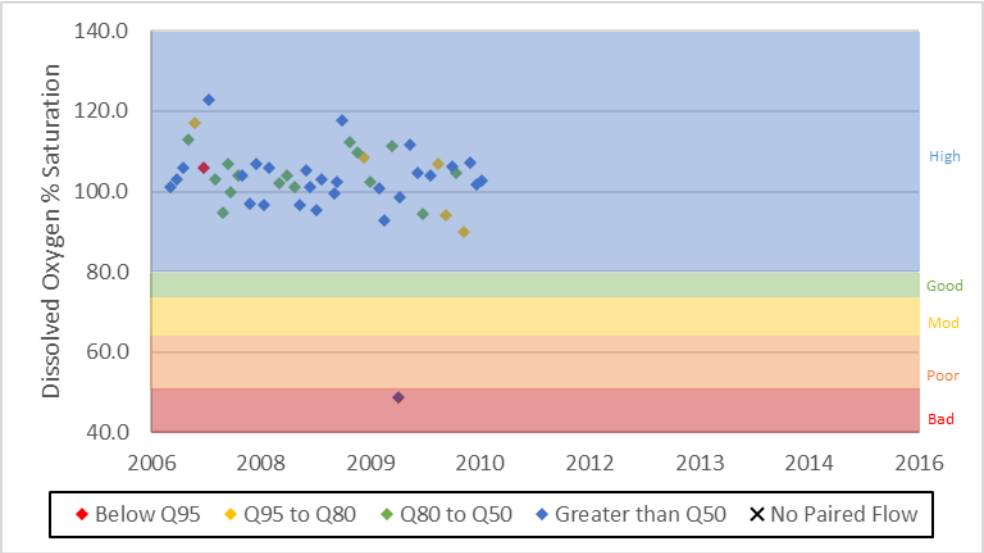
Total ammonia concentrations in the River Cefni, Pont Fawr, Llangefni (see **Figure B3.3**) were all consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l). No seasonality or change over time is apparent. This assessment is limited as no data are available after 2010 availability.

Dissolved oxygen saturation

Dissolved oxygen saturation in the River Cefni, Pont Fawr, Llangefni was reviewed and data are presented in **Figure B3.4** against the relevant WFD standards for an upland low alkalinity river[7].

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

Figure B3.4 Dissolved Oxygen Saturation in the River Cefni, Pont Fawr, Llangefni, Incorporating Appropriate WFD Status Bands



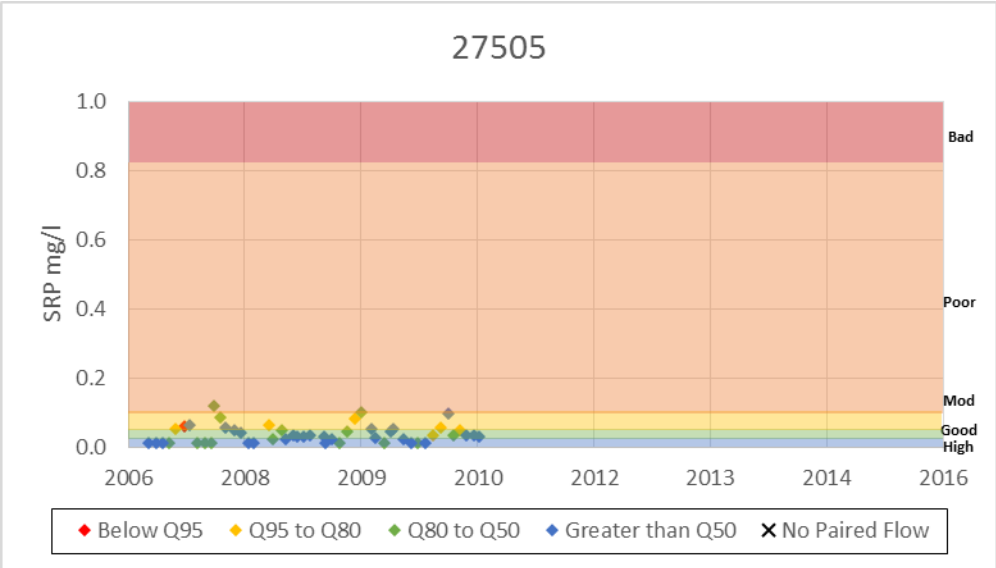
Dissolved oxygen saturation measurements at the River Cefni, Pont Fawr, Llangefni were predominantly consistent with the WFD standard to support high status for fish and invertebrates (80%). One exception is noted on 12/11/2009 with 48.5%. This appears to be an isolated incident. This assessment is limited as no data are available after 2010.

Soluble Reactive Phosphorus

Soluble reactive phosphorus concentration in the River Cefni, Pont Fawr, Llangefni was reviewed and data are presented in **Figure B3.5** against the relevant WFD site specific standards provided by NRW[8].

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

Figure B3.5 SRP in the River Cefni, Pont Fawr, Llangefni, Incorporating Appropriate WFD Status Bands



Soluble reactive phosphorus concentration at the River Cefni, Pont Fawr, Llangefni were mostly consistent with the WFD standard to support good status for fish and invertebrates (0.07mgP/l). Five values were reported below this standard: 0.096mgP/l on 15/07/2010; 0.117mgP/l on 12/10/2007; 0.087mgP/l on 12/11/2007; 0.099mgP/l on 07/07/2009 and 0.082mgP/l on 08/06/2010. Some seasonality is apparent with SRP concentrations higher in summer and autumn and lower in winter and spring. This assessment is limited as no data are available after 2010.

Reach 2 (Llangefni Industrial Estate to tidal limit at Pentre Berw)

Monitoring site 27504 on the River Cefni, South end of industrial estate, Llangefni represents the midstream section of Reach 2. Monitoring site 27501 on the River Cefni, Pont-y-gors, Gaerwen represents the downstream section of Reach 2.

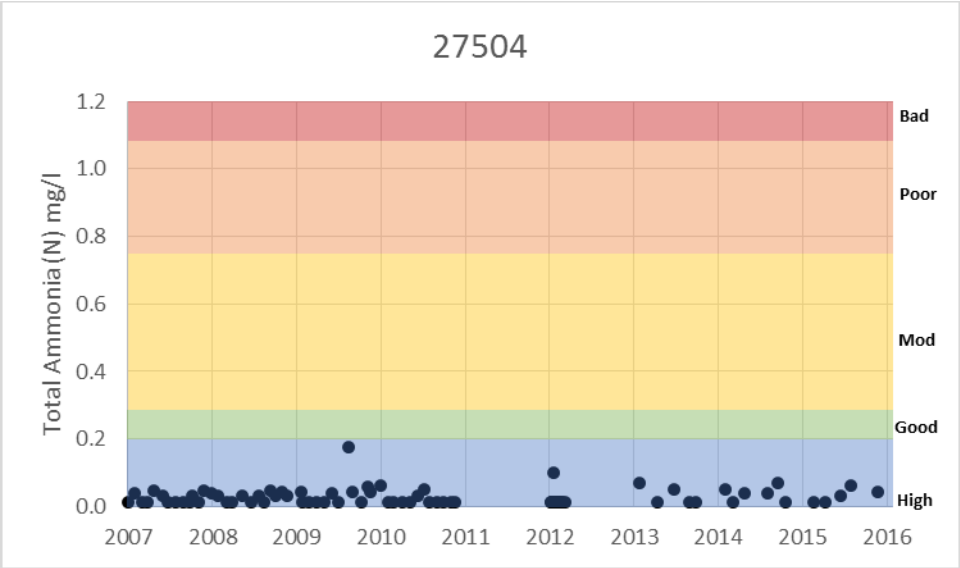
The average pH in Reach 2 over the ten year review period was 7.93 and the maximum water temperature was 19.01°C.

Total ammonia concentration

Total ammonia concentration in the River Cefni, South end of industrial estate, Llangefni and River Cefni, Pont-y-gors, Gaerwen were reviewed and data are presented in **Figure B3.6** and **Figure B3.7** respectively against the relevant WFD standards for an upland low alkalinity river[9].

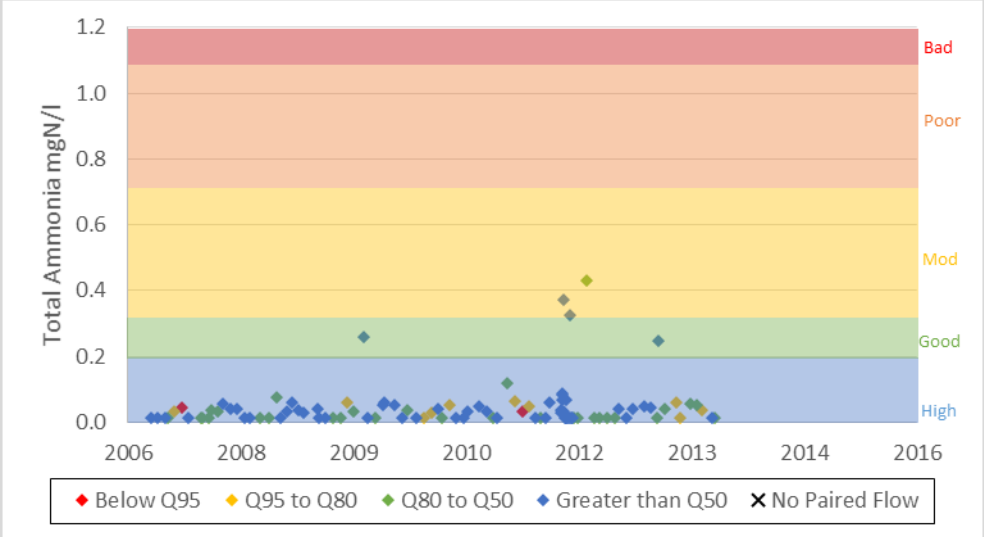
[9] The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Figure B3.6 Total Ammonia in the River Cefni, South End of Industrial Estate, Llangefni, Incorporating Appropriate WFD Status Bands



Total ammonia concentrations at the River Cefni, South end of industrial estate, Llangefni (see **Figure B3.7**) were all consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l).

Figure B3.7 Total Ammonia in the River Cefni, Pont-y-gors, Gaerwen, Incorporating Appropriate WFD Status Bands

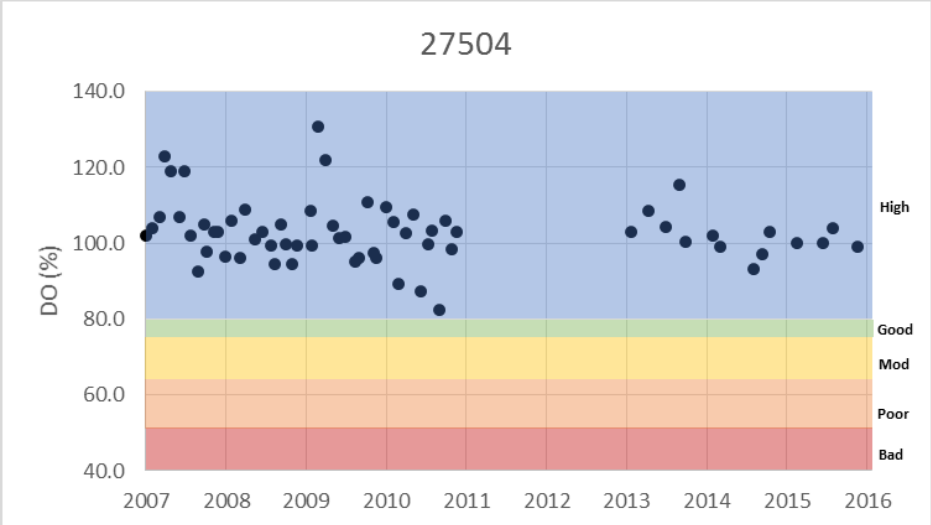


Total ammonia concentrations at the River Cefni, Pont-y-gors, Gaerwen (see Figure B3.3) were mostly consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l). Three instances were reported below this standard: 0.37mgN/l on 24/01/2012; 0.32mgN/l on 21/02/2012 and 0.43mgN/l on 04/05/2012.

Dissolved oxygen saturation

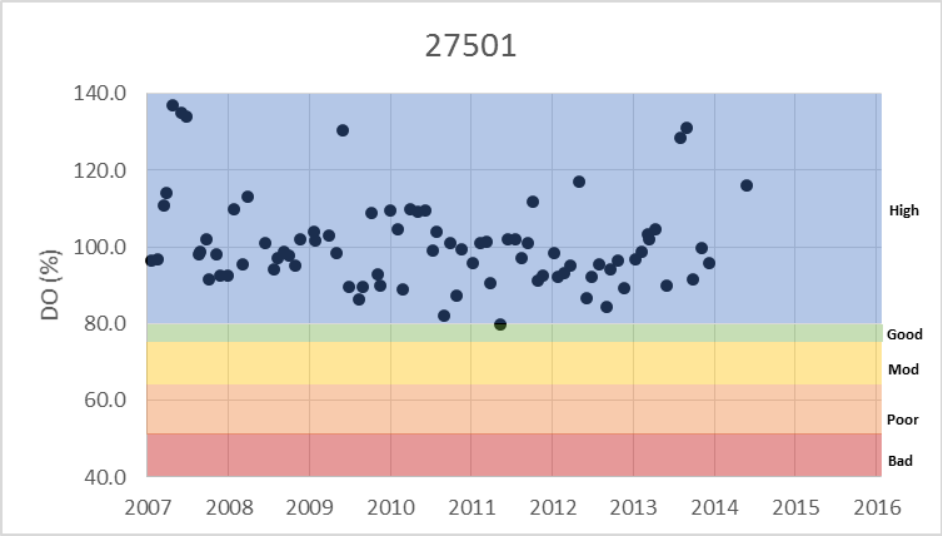
Dissolved oxygen saturation at the River Cefni, South end of industrial estate, Llangefni and River Cefni, Pont-y-gors, Gaerwen was reviewed and data are presented in **Figure B3.8** and **Figure B3.9** respectively, against the relevant WFD standards for an upland low alkalinity river[10].

Figure B3.8 Dissolved Oxygen Saturation in the River Cefni, South End of Industrial Estate, Llangefni, Incorporating Appropriate WFD Status Bands



Dissolved oxygen saturation measurements on the River Cefni, South end of industrial estate, Llangefni were all consistent with the WFD standard to support high status for fish and invertebrates (80%).

Figure B3.9 Dissolved Oxygen Saturation in the River Cefni, Pont-y-gors, Gaerwen, Incorporating Appropriate WFD Status Bands



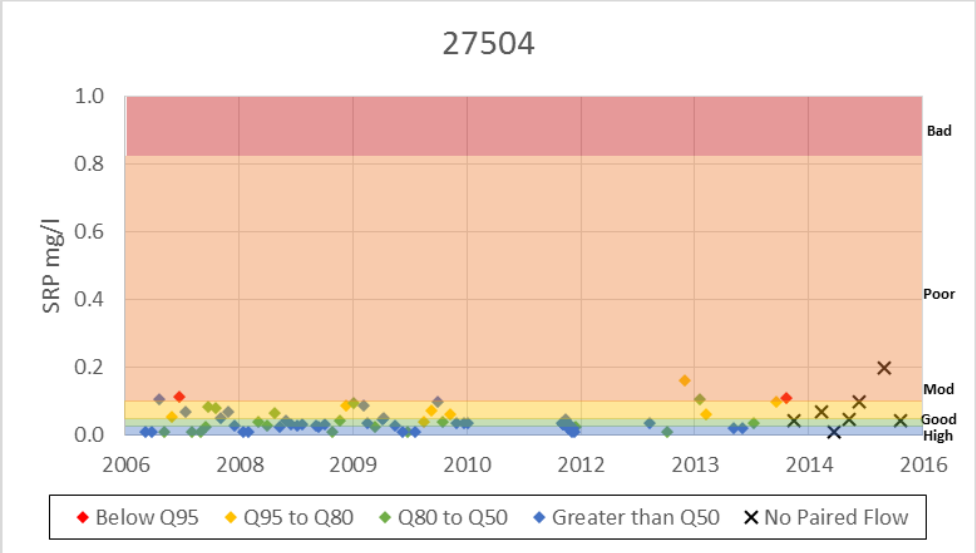
[10] The Water Environment (Water Framework Directive) (England and Wales) Directions 2015. ISBN 978-0-85521-192-9.

Dissolved oxygen saturation measurements on the River Cefni, Pont-y-gors, Gaerwen were all consistent with the WFD standard to support high status for fish and invertebrates (80%).

Soluble Reactive Phosphorus

Soluble reactive phosphorus concentration in the River Cefni, South end of industrial estate, Llangefn was reviewed and data are presented in **Figure B3.10** against the relevant WFD site specific standards provided by NRW[11].

Figure B3.10 SRP in the River Cefni, South End of Industrial Estate, Incorporating Appropriate WFD Status Bands

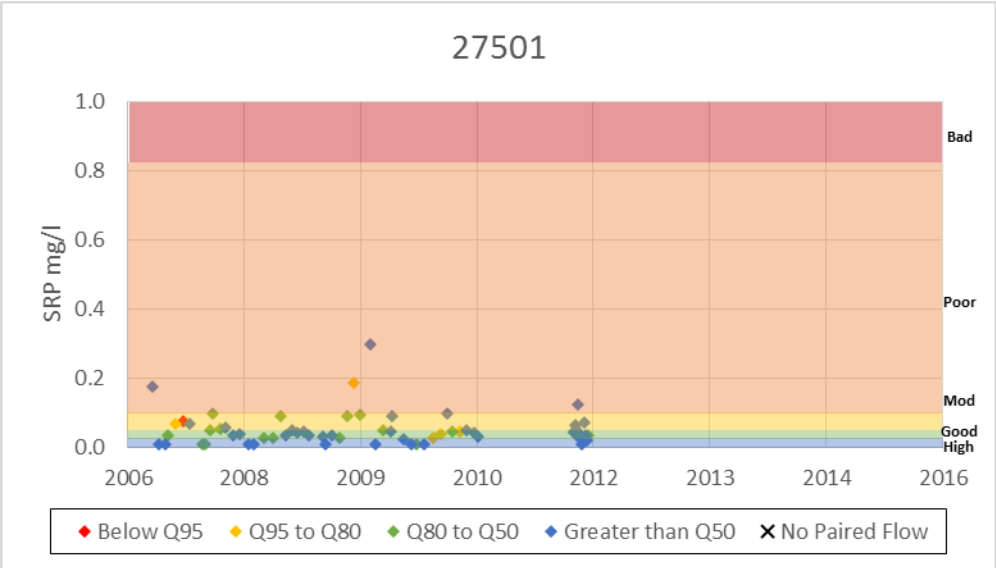


Soluble reactive phosphorus concentration at the River Cefni, South end of industrial estate, Llangefn were variable with the WFD standard to support good status for fish and invertebrates (0.03mgP/l). Values below this standard were reported in 60% of instances (49 occurrences). Some association between low flows and increased SRP concentration is apparent. Some seasonality is also noted with higher SRP in summer and autumn and lower SRP in winter and spring.

Soluble reactive phosphorus concentration in the River Cefni, Pont-y-gors, Gaerwen was reviewed and data are presented in **Figure B3.11** against the relevant WFD site specific standards provided by NRW[12].

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

Figure B3.11 SRP in the River Cefni, Pont-y-gors, Gaerwen, Incorporating Appropriate WFD Status Bands



Soluble reactive phosphorus concentration at the River Cefni, Pont-y-gors, Gaerwen were variable consistent with the WFD standard to support good status for fish and invertebrates (0.03mgP/l). Values below this standard were noted in 66% of instances (42 occurrences). Some association between low flows and increased SRP concentration is apparent. Some seasonality is also noted with higher SRP in summer and autumn and lower SRP in winter and spring. This assessment is limited as no data are available after 2011. .

Water Quality Summary

Assessment of risk to water quality as a result of the Cefni drought order is limited by the spatial and temporal extent of the data available in some instances.

Total ammonia concentrations were all consistent with the standard to support high status for fish and invertebrates throughout the zone of influence of the Cefni Reservoir drought order. Seasonal variability in total ammonia concentration was low. The risk of a reduction in flow resulting from drought order implementation to total ammonia concentration levels within the zone of influence is considered **minor** in Reaches 1 and **negligible** in Reaches 2.

Dissolved oxygen saturations were predominantly consistent with the standard to support high status for fish and invertebrates throughout the zone of influence of the Cefni Reservoir drought order. It is hence considered that the drought order would pose a **minor** risk in Reaches 1 and **negligible** risk in Reaches 2 dissolved oxygen saturation to support good or high status for fish and macroinvertebrates.

Soluble reactive phosphorus concentrations were variable with the standard to support high status for fish and invertebrates throughout the zone of influence of the Cefni Reservoir drought order. It is hence considered that the drought order would pose a **moderate** risk in Reaches 1 and 2 to SRP concentration to support good or high status for fish and

macroinvertebrates. Both reaches would be at moderate risk without implementation of the drought permit.

B.3.3 Environmental Pressures

B.3.3.1 Flow Pressures

Surface Water Abstractions

There are no licensed surface water abstractions in the study area apart from Welsh Water's abstraction from the Cefni Reservoir intake, the subject of this assessment.

There are no licensed surface water abstractions in the study area apart from Welsh Water's abstraction from the Cefni Reservoir intake, the subject of this assessment.

B.3.3.2 Water Quality Pressures

There are 12 consented discharges within the study area, seven of which have flow conditions attached (highlighted in **Table B3.2**). Changes in the dilution and dispersion of these discharges in the Afon Cefni during operation of the drought permit are considered significant.

Table B3.1 Consented Discharges in the Study Area

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)	Zone of influence (<500m)	Consideration of water quality pressure (during baseline low flow conditions)
CG0176801	Cefni z water treatment works	SH4461076970	0.022	Not Specified	Not Specified	Not Specified	Not Specified	1	Negligible
CG0176901	Cefni x water treatment works	SH4460077020	0.26	Not Specified	Not Specified	Not Specified	Not Specified	1	Negligible
CG0078002	Llangefni wastewater treatment works storm tank	SH4609774394	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	2	Negligible
CG0177001	Cefni y water treatment works	SH4460077070	0.022	Not Specified	Not Specified	Not Specified	Not Specified	6	Negligible
CG0114102	Gaerwen WwTW	SH4574372790	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	18	Negligible
CG0191201	Llangefni mh front ynys mon offices	SH4590075400	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	85	Negligible
CG0350801	Cefni water treatment works	SH4456077160	0.6	Not Specified	Not Specified	Not Specified	Not Specified	82	Minor
CG0078001	Llangefni wastewater treatment works	SH4609774396	Not Specified	5.74	27	2.5	27	2	Moderate
CG0188001	Llangefni main sps	SH4604774671	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified	5	Negligible

B4 PHYSICAL ENVIRONMENT IMPACT SUMMARY

Potential impacts on the physical environment associated with the Cefni Reservoir reduced compensation release 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 Cefni Reservoir Reduced Compensation Release Drought Permit

Afon Cefni (Reach 1)	
Flows in the Afon Cefni *Major impacts during the period July to December*	• Reductions of up to 50% in river flows with corresponding reductions in wetted depths/wetted widths (potential marginal habitats), during the period July to December
Water quality in the Afon Cefni *Moderate risk during the summer/autumn period*	• Minor risk to DO and ammonia in Reach 1. Moderate risk to SRP in Reach 1.
Afon Cefni (Reach 2)	
Flows in the Afon Cefni *Minor impacts during the period July to September; negligible impacts during the period October to December*	• Reductions of up to 11.2% in river flows with corresponding reductions in wetted depths/wetted widths (potential marginal habitats), during the summer period of July to September (flow reductions of up to 8.6% during the period October to December).
Water quality in the Afon Cefni *Moderate risk during the summer/autumn period*	• Negligible risk to DO and ammonia in Reach 2. Moderate risk to SRP in Reach 2.

B5 CUMULATIVE IMPACTS

The focus of this EAR is the Cefni Reservoir 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 permits / orders within a similar timeframe. The potential for options to act in combination is set out in **Table B5.1**.

Consideration has also been given to the potential for cumulative impacts of drought options implemented by neighbouring water companies (see **Table B5.1**). The assessment of the potential for cumulative impacts of Welsh Water's supply side and drought permit / order 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 Cefni Reservoir Drought Permit with other Drought Options

Organisation	Potential In-combination Impacts	Further Consideration Required (Yes/No)
Welsh Water - other drought options in the North Eryri Ynys Mon WRZ	8001-2 (Removal of Llyn Cwellyn 10Ml/d abstraction rate) – The impacts of this option do not occur within the same catchment and therefore no in-combination effects are anticipated.	No
	8001-3 (Reduction of Alaw Compensation water) – The impacts of this option do not occur within the same catchment and therefore no in-combination effects are anticipated.	No
	8001-4 (Reduction of Ffynnon Llugwy Compensation water) – The impacts of this option do not occur within the same catchment and therefore no in-combination effects are anticipated.	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 rivers[2].

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 rivers[3].

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/	Minor	Moderate
	≥3mg/l	Moderate	Major

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

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/	Minor	Moderate
	≥4mg/l	Moderate	Major

[d] Standards are WFD high/good threshold for BOD of 4mg/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 rivers[5].

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 rivers[6].

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 rivers[8].

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 rivers[9].

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 exisits 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 *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, as advised by NRW / Environment Agency.
Definition of Impacts
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. • 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
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: • 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 been 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 Managements (CIEEM) Ecological Impact Assessment (EcIA) guidance[10]. 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 *Salmo salar* and Brown/Sea trout *Salmo trutta*			
Spawning	• 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)	• Shallow areas with a low water velocity and pebble substrate, often at the margins of riffles	• 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: • 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.	• 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 *Lampetra planeri*			
Spawning	• 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	• 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**		
			Deterioration in water quality
Adults	• Cover (stones and vegetation) in the vicinity of spawning gravels.		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 *Lampetra fluviatilis*			
Spawning	• 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	• Areas of sandy silt with slow water velocity, often in the margins of watercourses, above the estuary. Variation in depth between 2cm and 30cm (>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	• 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.	• 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, *Petromyzon marinus*			
Spawning	• 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	• Areas of sandy silt with slow water velocity, often in the margins of watercourses, above the estuary. Variation in depth between 2cm and 30cm (>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	• 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.	• 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, *Cottus gobio*			
Spawning	• Coarse, hard substrate of gravel and stones.	• 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	• 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	• 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, *Anguilla anguilla*			
Juvenile (<30cm)	• Wetland habitats within 30km of tidal limit with high diversity and cover of vegetation, soft substrates and high productivity.	• Low productivity watercourses with dominance of coarse substrates and low macrophyte cover and diversity. • Habitats upstream of significant obstructions.	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Adult (>30cm, female >45cm)	• Deep, slow flowing watercourses and wetland habitats within 80km of tidal limit with high diversity and cover of vegetation, soft substrates and high productivity.		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
			Increased significance of barriers to impede migration as a result of decreased flows
			Increased water velocity and depth
			Increased risk of entrainment into water intake
			Deterioration in water quality
Barbel *Barbus barbus*			
Spawning	• Run/glide flow • Less than 50cm deep • Velocities greater than 0.5m/s • Substrate 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	• Marginal shallow bays set back from or within margins of main channel • Depths between 1cm and 30cm • No discernible to minimal flow • Substrate composed of >30% gravel and sand with low silt content • Lack 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	• Commonly associated with stretches of clean gravel and macrophyte beds, showing a preference to relatively fast-flowing stretches in the middle reaches of large 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, *Pisidium tenuilineatum* and depressed river mussel *Pseudanodonta complanata*			
All life stages	• Fine sediments of lowland rivers and canals,	• High velocity watercourses with coarse substrates.	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
White-clawed crayfish *Austropotamobius pallipes*			
All life stages	• 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	• 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 – 8001-5 ENVIRONMENTAL FEATURES ASSESSMENT

D1 INTRODUCTION

This appendix presents information regarding the environmental features associated with the Cefni Reservoir drought order. Baseline data and the impact assessments are presented for the environmental features that form part of the scope of the assessment. The features assessment is presented in full below.

Points of interest referred to throughout the text in Appendix D are indicated on **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 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**.

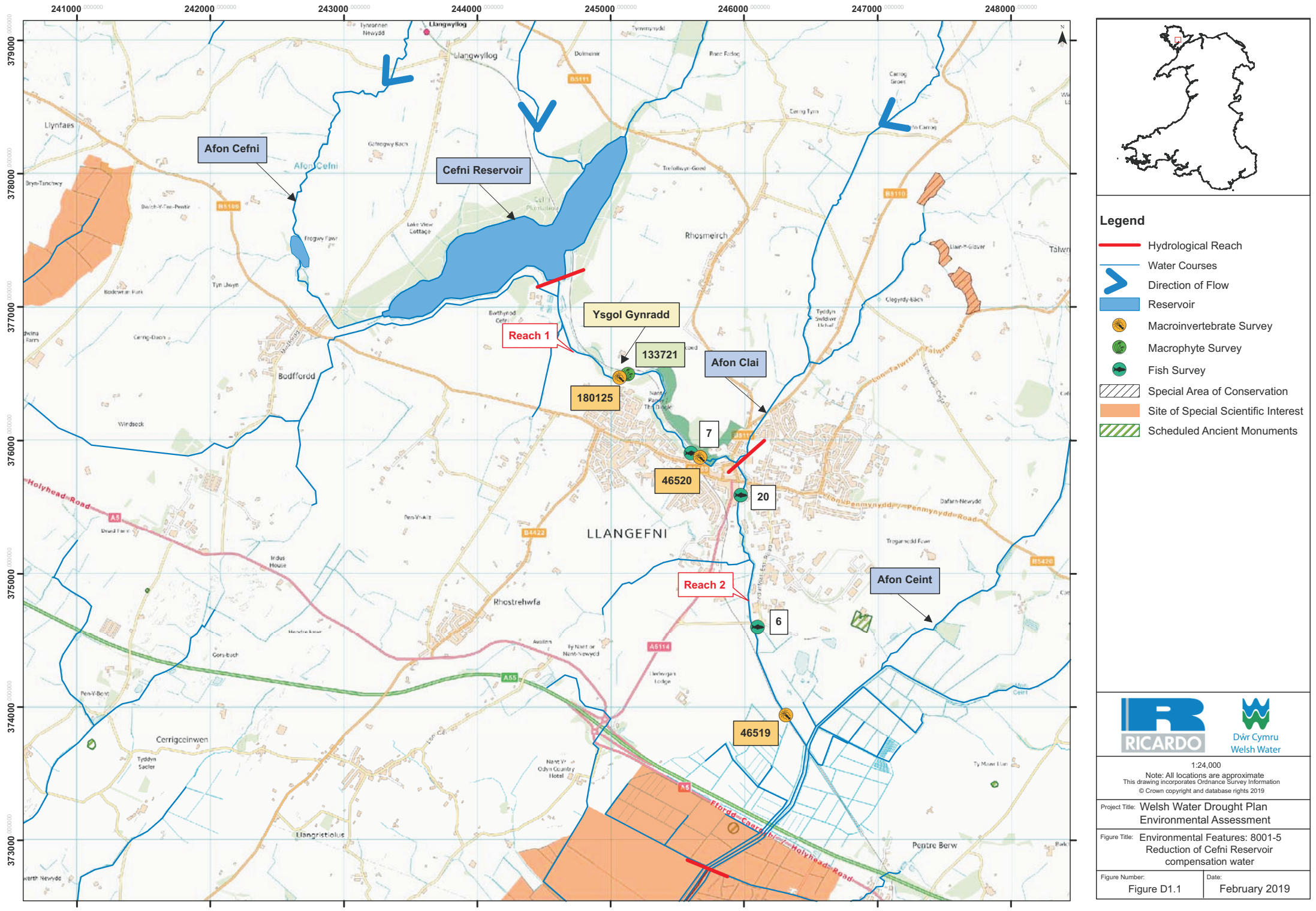
The ecological assessment has been undertaken recognising the Institute of Environmental Management and Assessment (IEMA)[1] [2] and the Chartered Institute of Ecology and Environmental Management (CIEEM) study guidelines[3]. The assessment of impacts on other environmental receptors e.g. recreation and landscape has been carried out largely by qualitative expert judgement. Specific assessment methodologies for key environmental features are set out in **Appendix C**.

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

This appendix is set out in the following sections:

Section D.2 Designated Sites
Section D.3 WFD Status and Community Assessment / Notable Species
Section D.4 Recreation

[1] IEMA (2004) Guidelines for Environmental Impact Assessment.
[2] IEMA (2011) Special Report – The State of Environmental Impact Assessment Practice in the UK
[3] CIEEM (2016) Guidelines for Ecological Impact Assessment in the UK and Ireland.



Legend

- Hydrological Reach
- Water Courses
- Direction of Flow
- Reservoir
- Macroinvertebrate Survey
- Macrophyte Survey
- Fish Survey
- Special Area of Conservation
- Site of Special Scientific Interest
- Scheduled Ancient Monuments

RICARDO

Dŵr Cymru Welsh Water

1:24,000

Note: All locations are approximate

Project Title: Welsh Water Drought Plan Environmental Assessment

Figure Title: Environmental Features: 8001-5 Reduction of Cefni Reservoir compensation water

Figure Number: Figure D1.1

Date: February 2019

D2 DESIGNATED SITES

The impact assessment for the remaining designated site identified follows guidance provided by CIEEM, providing a significance of impact which takes into consideration the magnitude of impact alongside the value of the feature (for the full assessment methodology, see **Appendix C**).

D.2.1 Malltraeth Marsh / Cors Ddyga SSSI

D.2.1.1 Baseline

Approximately 500m of the Afon Cefni upstream of the tidal limit falls within the extensive flood plain area designated as a SSSI (Malltraeth Marsh). This 1,365.6 ha site has been selected for its biological interest. It is especially important for its breeding bird community of lowland damp grassland, as a threatened habitat of wet meadows and for the botanical interest of its ditches and watercourses. Two species of botanical interest are the pillwort *Pilularia globulifera* a nationally scarce and NERC priority species for Wales, and the locally distributed autumnal water-starwort *Callitriche hermaphroditica*. The marsh provides feeding grounds for migrating and wintering waders and wildfowl including the important pintail *Anas acuta* population in the Cefni estuary. There is a diverse invertebrate assemblage with eleven species of dragonfly recorded, including the variable damselfly *Coenagrion pulchellum*, the scarce blue-tailed damselfly *Ischnura pumilio*, and the hairy dragonfly *Brachytron pratense*. Other invertebrates of ecological interest are the aquatic beetles *Laccobius sinuatus* and *Rhantus grapii*.

D.2.1.2 Assessment

The impacts on pillwort *Pilularia globulifera* and the macrophyte community are discussed in full in Section D3.1.2, as a feature of the SSSI are expected to be **minor** adverse within Reach 2 during summer/autumn and **negligible** in winter.

The impacts on the macroinvertebrate community, discussed in full in Section D.3.2.2, as a feature of Maelltrath Marsh SSSI are considered to be **minor** adverse.

No impacts on the breeding, migrating or wintering birds are anticipated as a result of the drought permit due to the timing and minor hydrological impacts in Reach 2.

D.2.2 The Dingle / Nant y Pandy Local Nature Reserve

D.2.2.1 Baseline

The Dingle Local Nature Reserve (LNR) is a 10 hectare (25 acre) wooded valley. The site contains areas of semi-natural ancient woodland, parts of which are dominated by sessile oak *Quercus robor*, ash *Fraxinus excelsior* and wild cherry *Prunus avium*, with groundflora dominated by bluebells *Hyacinthoides non-scripta*. There are amphibian and reptile populations within the site in including palmate newts *Lissotriton Helvetica,* common lizards

Zootoca vivipara, and adder *Vipera berus*. There is also a varied invertebrate community associated with the site. The site also contains a varied mammal population including eight species of bats and red squirrels *Scirius vulgaris*.

The Afon Cefni flows through the site and forms Llyn Pwmp where the river is impounded by a weir. Fish such as the brown trout *Salmo trutta*, roach *Rutilus rutilus*, and perch *Perca fluviatilis* may be seen in Llyn Pwmp, and sea trout *Salmo trutta* are occasional visitors, as are European eels *Anguilla anguilla*.

D.2.2.2 Assessment

The impacts on the fish community are discussed in full in Section D3.3.2, and as a feature of the LNR are expected to be **major** adverse within Reach 1 during summer / autumn.

No impacts on the woodland habitats, reptile or mammal populations present in the LNR are anticipated as a result of the drought permit as these features are not hydrologically dependent on the Afon Cefni.

Summary

The potential impacts of the Cefni Reservoir drought permit on designated sites are summarised in **Table D2.1**. The impacts, and their magnitude, have been based on the hydrological impacts (see **Appendix B**), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see **Appendix B**) and the sensitivities of the designated features. The impacts presented in **Table D2.1** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.6 Summary of Impacts on Designated Sites

Feature	Impact	Significance of Impact
Reach 1 – Afon Cefni		
The Dingle / Nanty Pandy Local Nature Reserve	• The impacts on the fish community as a feature of the LNR are expected to be major adverse within Reach 1 during summer / autumn.	**Major** (summer / autumn)
Reach 2 – Afon Cefni		
Malltraeth Marsh / Cors Ddyga SSSI	• The impacts on pillwort Pilularia globulifera and the macrophyte community, as a feature of the SSSI are expected to be minor adverse within Reach 2 during summer/autumn and negligible in winter. • No impacts on the breeding, migrating or wintering birds are anticipated as a result of the drought permit due to the timing and minor hydrological impacts in Reach 2.	**Minor** (summer / autumn) **Negligible** (winter / spring)

D3 WFD STATUS AND COMMUNITY ASSESSMENT / NOTABLE SPECIES

D.3.1 Macrophytes

D.3.1.1 Baseline

Baseline macrophyte monitoring information, received from Natural Resources Wales (NRW), within the reaches subject to hydrological impact consisted of two surveys at one site, Ysgol Gynradd, in Reach 1 (see **Figure D1**).

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

Macrophyte results were provided by (NRW) using the standard LEAFPACS2 methodology[4] 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 D3.1** provides a summary of RMNI, RMHI, MTR and MFR scores recorded at sites within the study reach. **Table D3.2** and **Table D3.3** identify the interpretation of MFR and MTR scores.

Table D3.1 Macrophyte LEAFPACS RMNI, MTR, and MFR scores from NRW monitoring sites on the Afon Cefni

Site/Station Name	Reach	Grid Reference	Sample Date	MTR Score	MFR Score	RMNI	RMHI
YSGOLGYNRADD	1	SH-45129-76496	Aug-07	40.9	2.31	6.83	6.88
			Jun-14	45.9	2.56	6.5	6.81

RMNI and RMHI are biotic indices used to determine the nutrient preference and flow

[4] WFD-UKTAG(2014) UKTAG river assessment method – macrophytes and phytobenthos (River LEAFPACS2).

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 D3.2 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 D3.3 Interpretation of MTR scores (from Holmes *et al.*, 1999[5])

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

RMNI scores at the Ysgol Gynradd site in Reach 1 range from 6.5 to 6.83 and indicate mesotrophic to eutrophic conditions. This is also shown by the MTR scores, of 40.9 and 45.9, which indicates the site is either eutrophic or at risk of becoming eutrophic.

RMHI scores at the Ysgol Gynradd site range from 6.81 to 6.88, indicating a macrophyte community that prefers moderate to slower flow conditions.

Table D3.4 presents the number of aquatic taxa (hydrophytes), number of functional groups and algal cover at the two sample occasions for the Ysgol Gynradd site in Reach 1. A peak count of 15 species were identified during NRW surveys in June 2014, of which 9 were hydrophytes. No data were included for the percentage of algal cover.

[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.

Table D3.4 Additional LEAFPACS metrics for the macrophyte sample site on the Afon Cefni

Site/Station Name	Reach	Grid Reference	Sample Date	No. aquatic taxa	No. functional groups	Algal cover
YSGOL GYNRADD	1	SH-45129-76496	Aug-07	11	7	-
			Jun-14	15	9	-

The macrophyte community is relatively diverse with all species present having lower levels of cover. The most abundant species were *Sparganium erectum*, and *Schoenoplectus lacustris* with 2.5% to 10% cover on both survey occasions, with Iris pseudacourus also having relatively high cover during 2007. These species are all marginal emergent macrophytes associated with slow flowing lowland waterbodies. In addition there was relatively high cover from the algae *Hildenbrandia rivularis* and Kneiff's feather moss *Amblystegium riparium*, although cover was lower for both species during the 2014 survey.

Notable Species

Pillwort *Pilularia globulifera* was not present in macrophyte data received from NRW but is a feature of the macrophyte community for which Malltraeth Marsh SSSI is designated so is considered to be present in impacted Reach 2 as a precautionary approach.

Pilularia globulifera typically occupies bare gravel or silt on the margins of lakes, ponds and temporary pools usually in areas where fluctuating water levels suppress competition from higher plants, it will also survive permanently submerged habitat[6]. As such *P. globulifera* is susceptible to stabilisation of water levels and drainage of temporary wetlands as it can allow for colonisation of its habitat by more proliferant macrophyte species. it is possible that even low-level eutrophication may pose a threat as it enables colonisation of otherwise unsuitable habitat by more aggressive plants.

D.3.1.2 Assessment

The assessment of impacts on the macrophyte community should be considered in the context of the watercourse under baseline conditions.

The assessment of impacts on the macrophyte community should be considered in the context of the watercourse under baseline conditions. Baseline data indicates that the macrophyte communities in the hydrological zone of influence of the drought permit are marginal emergent dominated, adapted to slow to moderate flow velocities. Reduction in flows could affect macrophyte communities in a number of ways:

[6] Lansdown, R.V. 2013. Pilularia globulifera. The IUCN Red List of Threatened Species 2013: e.T167887A6406472. http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T167887A6406472.en

- Reduction in velocity favouring species adapted to slower flow conditions;
- Proliferation of filamentous algae due to decreases in velocity / increases in water temperature;
- Shading of macrophyte stands by epiphytic algae, due to decreases in velocity/increases in water temperature;
- Desiccation of submerged macrophyte beds due to reduced wetted width and water depth;
- Encroachment of marginal emergent species into the channel;
- Reduction or movement of the splash zone from where this usually occurs, both at the edges of the channel and around in-stream features such as boulders and exposed bedrock, leading to desiccation of species present within these areas, particularly bryophytes.

The additional risk of water quality deterioration associated with SRP, which is moderate for Reach 1, could encourage macrophyte growth and increase the occurrence of more opportunistic 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. There is already a high relative proportion of filamentous algae (*Cladophora* species) at some monitoring sites.

Hydrological impacts as a result of drought order implementation in Reach 1 are anticipated to be major adverse all year round when the reservoir is below spill level, including a reduction of 50% of the summer low flows (Q_{95}) and summer extreme low flows (Q_{99}) with corresponding reductions in wetted depths / wetted widths during the summer and autumn period.

Due to the potential extent of change to, wetted area and depth, flow velocities, during the main macrophyte growing season, operation of the drought permit has the potential to affect the condition, composition and extent of macrophyte communities. Low flows may also favour the proliferation of filamentous algae species due to changes in velocity, water temperature, and concentrations of nutrients (soluble reactive phosphorous).

Given the paucity of flow sensitive taxa recorded and the high relative abundance of marginal emergent species adapted to low flows in combination with the limited duration of the drought order; it is expected that any effects on the macrophyte community would be reversed following return to the normal hydrological regime. Therefore the impacts of the drought order on the macrophyte communities of Reach 1 are expected to be **moderate** adverse, short term, and reversible during the growing season and **minor** adverse, short term, and reversible during the winter.

Hydrological impacts on Reach 2 are expected to be minor with a lesser reduction in summer low and extreme low flows than Reach 1 (9% of the summer Q_{95} and 11% of the summer Q_{99}).

The slower flow adapted community present in Malltraeth Marsh SSSI in Reach 2, are unlikely to be significantly adversely affected by a reduction in flow and levels. The macrophyte community in Reach 2 is considered to be susceptible to water quality deterioration due to SRP as this could alter the community composition due to the proliferation of opportunistic taxa. There is also a risk to community composition and diversity due proliferation of filamentous algae due to decreases in velocity / increases in water temperature. The impact on the macrophyte community of this reach is considered to be **minor** adverse, short term and reversible during summer and autumn. Due to the timing of macrophyte senescence, impacts during the winter period are considered to be **negligible**.

Notable Species

As such *P. globulifera* is susceptible to stabilisation of water levels, drainage of temporary wetlands, and water quality deterioration / eutrophication (associated with increased SRP concentrations) as it can allow for colonisation of its habitat by opportunistic macrophyte species. Given the limited hydrological and water quality impacts predicted within Reach 2 the impacts on *P. globulifera* are considered to be **minor.**

Summary

The potential impacts of the Cefni Reservoir compensation flow drought permit on the macrophyte community are summarised in **Table D3.4**. The impacts, and their magnitude, have been based on the hydrological impacts (see **Appendix B**), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Appendix B) and the sensitivities of the macrophyte community. The impacts presented in **Table D3.5** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.5 Summary of Impacts on Macrophyte Community

Reach 1 – Afon Cefni		
Feature	**Impact**	**Significance of Impact**
Macrophytes	• 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 width. • Increase in filamentous algae levels due to increased nutrients or water temperature and decreased velocity.	**Moderate** (July - September) **Minor (**October - December)
Reach 2 – Afon Cefni		
Macrophytes	• Reduction in growth as a result of minor impacts on water levels and flows. • Changes to community composition due to changes to flow rates and habitat loss due to reduction in wetted width.	**Minor** (July - September) **Negligible (**October - December)
Pilularia globulifera	• Increased in competition from macrophytes due to increased nutrients or altered hydrological regime.	**Minor**

The macrophyte subcomponent of the Cefni - Ceint to Cefni reservoir (GB110102058770)

waterbody is classed as having high WFD status.

Consequently, there is a **moderate** to **minor** risk of short term deterioration to the WFD status macrophyte subcomponent of the Cefni - Ceint to Cefni reservoir (GB110102058770) water body.

D.3.2 Macroinvertebrates

D.3.2.1 Baseline

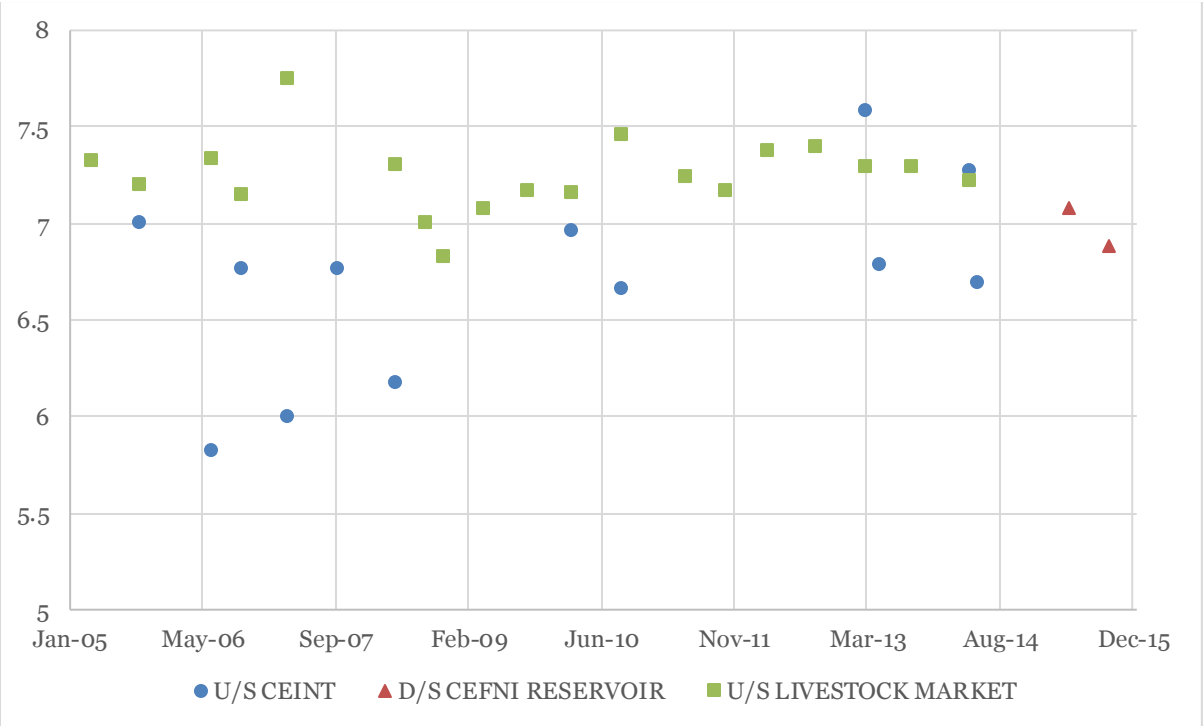
Baseline information received from NRW included three sites on the Afon Cefni; D/S Cefni Reservoir and U/S livestock in Reach 1, and U/S Ceint in Reach 2. The data presented covers the period 2005 to 2015 inclusive (see **Figure D1.1**).

Sampling was conducted following the standard NRW / Environment Agency (EA) protocol involving a three-minute kick / sweep sample encompassing all the available instream habitats in proportion to their occurrence[7]. For data collected between 2006 and 2015 macroinvertebrates were identified in some cases to species level and the abundances recorded as actual values. These datasets are used to calculate a series of standard biotic indices; Biological Monitoring Working Party (BMWP) scores, Average Score Per Taxon (ASPT) scores, Lotic Invertebrate Flow Evaluation (LIFE) and number of taxa. There are no quality bands for BMWP scores and ASPT scores. However, as a guide, BMWP scores of 200 with ASPT values above 6 are indicative of rivers of exceptionally good quality, while BMWP scores of 100 with ASPT values of 5 are indicative of reasonably good water quality. Data for LIFE, ASPT and BMWP are graphically presented in **Figures D3.1, D3.2** and **D3.3** for the Afon Cefni.

LIFE scores in the Afon Cefni range from 5.82 to 7.75. The LIFE scores from site in Reach 1 ranged from 6.83 to 7.75 with an average of 7.22 across all samples from the D/S Cefni Reservoir and U/S Livestock Market sites. At the U/S Ceint site in Reach 2 LIFE scores were more variable and lower than Reach 1 with a range from 5.82 to 7.58 and an average of 6.70. The LIFE scores from Reach 1 indicate the presence of invertebrate families that favour predominately moderate to fast velocity habitats. The samples from the U/S Ceint site in Reach 2 show a wide range of LIFE scores. The lowest scores all occurred in spring samples between 2006a nd2008 with the corresponding autumn samples for these years being notably higher. On average the LIFE scores for Reach 2 indicate the presence of invertebrate families that favour predominately slow - moderate velocity habitats.

[7] Environment Agency (1999) *Procedures for Collecting and Analysing Macroinvertebrate Samples* (Issue 2.0), Environment Agency BT001.

Figure D3.1 Observed Family LIFE Scores within the Afon Cefni



The ASPT scores in the Afon Cefni range from 4.32 to 6.21, with between 19 and 30 taxa recorded per sample, this indicates moderate to good water quality. This is supported by the presence of invertebrate taxa that favour clean water with high oxygen levels.

The D/S Cefni Reservoir and U/S Livestock market in Reach 1 returned ASPT scores of 5.67 to 5.71 and 4.86 to 6.0, respectively. This indicates an invertebrate community of marginally higher quality than the the U/S Ceint site in Reach 2 which returned more variable ASPT scores ranging from 4.32 to 6.21.

The composition and abundance of the macroinvertebrate communities at the sampling locations are indicative of moderate to high diversity. Both sites, D/S Cefni Reservoir and U/S Livestock returned BMWP scores within the range 106 to 149 and with similar levels species diversity, indicating good water quality. At the U/S Ceint site in Reach 2 had a greater range of BMWP scores from 82 to 162 with between 20 and 28 scoring taxa; indicating more variable water quality than in Reach 1, with a range from moderate to very good water quality.

ASPT and Number of taxa values show some variation across the monitoring period with evidence for a more stable, marginally higher quality community in Reach 1. Overall both reaches provide evidence for macroinvertebrate communities which are subject to minor to moderate anthropogenic impacts.

Figure D3.2 Observed ASPT Scores within the Afon Cefni

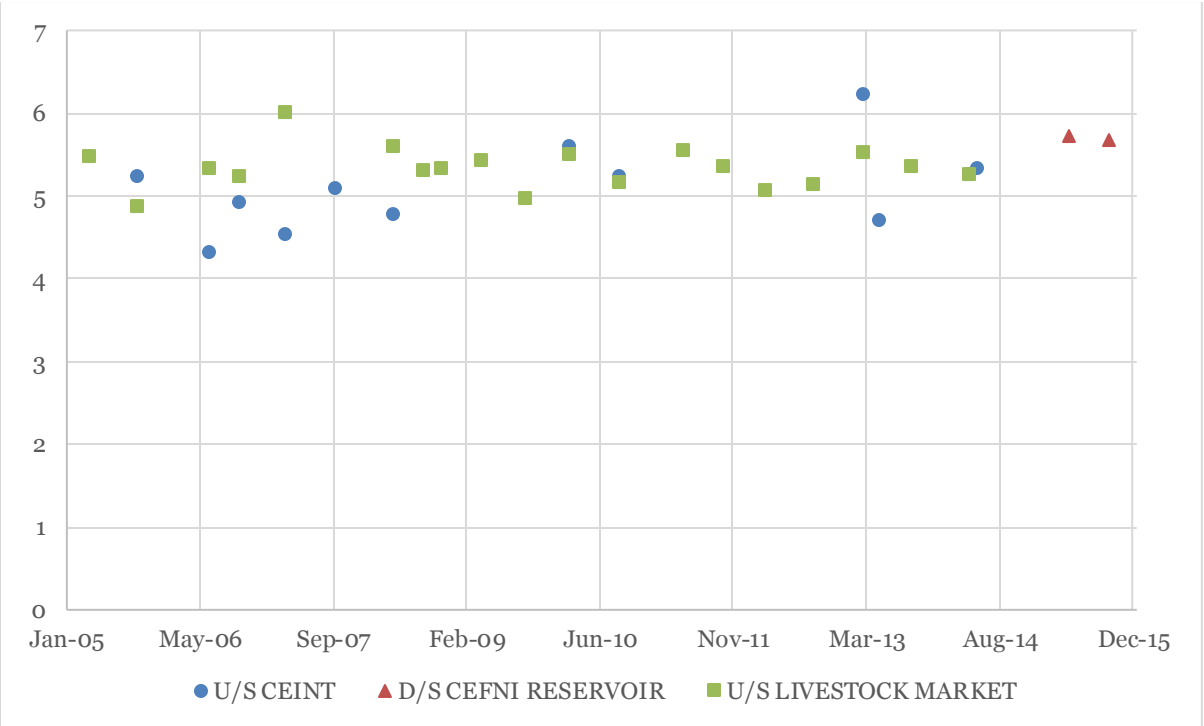
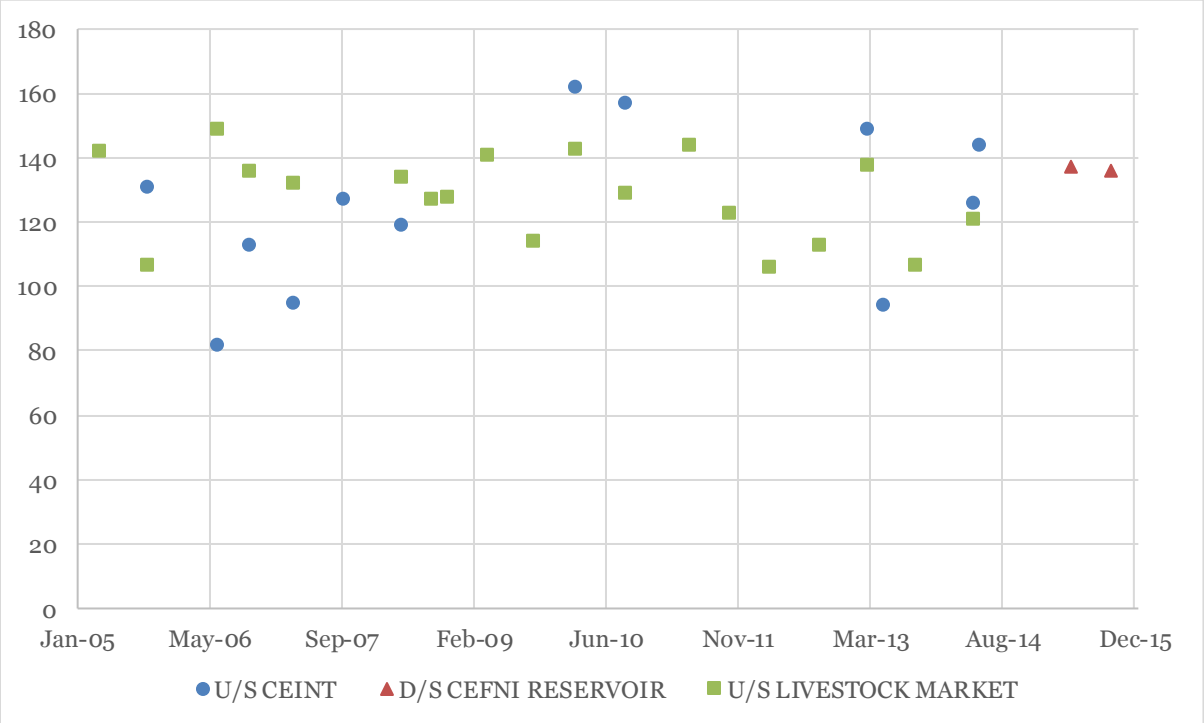


Figure D3.3 Observed BMWP Scores within the Afon Cefni



D.3.2.2 Assessment

As the drought permit will result in a reduction in flows and wetted depth / width, it is likely that many of the flow sensitive taxa will be temporarily lost from the reach, including many stonefly, mayfly, and caddisfly taxa such as Leuctridae, Rhyacophilidae, and Goeridae. The

LIFE scores for the sites in all reaches indicated taxa with a preference for slow to moderate flows but contained a number of taxa associated with fast flows. t 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 slower flows.

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

The reduced flows could also result in a short-term change to composition of the substrate, with finer substrates potentially deposited. Although this is a temporary impact, in the short-term, this could result in the smothering of individuals[8] and changes to habitat suitability for taxa that require clear stony substrates, which could result in a reduction in species diversity. However, significant increases to sedimentation are considered unlikely (see **Appendix B**, Section B3.1 geomorphology), as such the magnitude of the related impacts are not considered to be above low for any of the impacted reaches.

There is a minor risk water quality deterioration associated with dissolved oxygen and ammonia in Reach 1. The BMWP and ASPT scores indicate the presence of macroinvertebrate communities with a high proportion of taxa sensitive to decreases in dissolved oxygen. Consequently, it is likely that in the short-term this impact will modify the macroinvertebrate community with a minor reduction in abundance of species which require high oxygen levels (such as stonefly and mayfly species) and proliferation of taxa which can tolerate lower dissolved oxygen levels. 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 with a reduction in abundance of ammonia sensitive species. The impacts due to water quality deterioration are considered to be low in Reach 1 and negligible in Reach 2.

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** for Reach 1 all year round, and **minor** for Reach 2 due to potential impacts on emergence and recolonisation during the summer / autumn months. Impacts during the winter period are considered to be negligible for Reach 2.

Summary

The potential impacts of the Cefni Reservoir drought permit on the macroinvertebrate community are summarised in **Table D3.6**. The impacts, and their magnitude, have been based on the hydrological impacts (see Appendix B), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Appendix B) and the sensitivities of the macroinvertebrate community. The impacts

[8] Ryan, P. A. (1991) Environmental effects of sediment on New Zealand streams: A review. *New Zealand Journal of Marine and Freshwater Research* 25 pp 207 - 221.

presented in **Table D3.6** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.6 Summary of Impacts on Macroinvertebrate Community

Reach 1 – Afon Cefni		
Feature	**Impact**	**Significance of Impact**
Macroinvertebrates	• 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 • Reduction in species diversity and abundance as a result of reduced recruitment. • Reduction is species abundance and/or diversity due to water quality deterioration.	**Moderate**
Reach 2 – Afon Cefni		
Macroinvertebrates	• Loss of marginal habitats and reduction in abundance and distribution of species utilising such habitats • Reduction in species diversity and abundance as a result of reduced recruitment.	**Minor**

The Cefni - Ceint to Cefni reservoir (GB110102058770) waterbody has been classified as having good ecological status for macroinvertebrates.

Consequently, there is a **moderate** to **minor** risk of short term deterioration to the WFD status macroinvertebrate component of the Cefni - Ceint to Cefni reservoir water body.

D.3.3 Fish

D.3.3.1 Baseline

Information regarding fish populations within the potential zone of influence on the Afon Cefni is limited to the data resulting from semi-quantitative fish surveys undertaken by NRW (and previously EA - Wales) at three sites. The available data are sufficient to provide a general understanding of the fish population in the potential zone of influence but are not adequate to allow a detailed or robust assessment of the impact of a drought permit.

Existing data

Semi-quantitative fish survey data from three sites were made available (see **Table D3.7** 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 and counts of other species (for surveys undertaken post-2014 only).

Table D3.7 NRW fish survey locations on Afon Cefni

NRW Site Code	NGR	Sampling years
Site 6	SH4610074600	1999 & 2015
Site 7	SH4560375906	1999, 2004, 2011 & 2014
Site 20	SH4597475587	2015

A fisheries monitoring programme was recommended as part of the EMP process[9], however, no additional monitoring has yet been undertaken with the exception of the routine NRW fish surveys discussed above.

The 'Cefni - Ceint to Cefni reservoir' waterbody (GB110102058770) was assessed as being at high status for fish in 2015.

Species composition

Seven fish species have been recorded in the Afon Cefni within the potential zone of influence; Atlantic salmon, brown / sea trout, European eel *Anguilla anguilla*, flounder *Platichthys flesus* and minnow *Phoxinus phoxinus* along with unidentified lamprey and stickleback species.

The available data suggest above average juvenile trout densities (Grades A to C[10]) but juvenile Atlantic salmon densities were generally poor (or absent). No area (m^2) data was made available for the surveys so it is not possible to investigate the density of the other species recorded in these NRW surveys.

Records of lamprey and stickleback species are not speciated in the data so it is not known which of the protected lamprey species (brook lamprey *Lampetra planeri*, river lamprey *Lampetra fluviatilis* or sea lamprey *Petromyzon marinus*) are present.

Flounder appear in the data at Sites 6 and 20 (both in Llangefni – the upper part of Reach 2) and are likely to represent juveniles which utilise freshwater habitat in the lower reaches of rivers, generally in their first year, prior to migrating to estuarine and marine environments.

The available data does not allow any meaningful investigation into the status of fish populations within the zone of influence.

Data limitations

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

The precautionary principle has therefore been used in the following assessment which is based on a conservative approach assuming 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 (including lamprey-

[9] Cascade Consulting (2007). Provision of an Environmental Monitoring Plan. Environmental Monitoring Plan for Cefni Reservoir (N5). Final. 29th May 2007. A report for DCWW by Cascade Consulting in association with APEM.
[10] 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).

specific 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 the lamprey species are NERC Act Section 41 and Habitats Directive Annex II species and are considered to be of National importance. Brown / sea trout (NERC Act Section 41 species) and European eel (NERC Act Section 41 and I UCN Red List 'Critically Endangered' species) are also considered to be of National importance. Flounder, minnow and stickleback species are considered to be of Local importance only.

D.3.3.2 Assessment

Hydrological variability in rivers can have a significant influence on the distribution of fish. When extreme low flows, or prolonged periods of low flow, are experienced, 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 the wetted area and volume with the potential for subsequent impacts on fish populations as a result of, for example, intra- and inter-specific interactions (e.g. increased competition for optimal habitat and food)[11,12], reduced water quality and reduced reproductive success, growth and condition[13].

Potential impacts relating to habitat loss, water quality and migration are of relevance. These are discussed for key fish species in the sections which follow with particular focus on those aspects of fish ecology (e.g. migration and juvenile lifestages) most susceptible during the summer / autumn impact period (taken as May to November).

Reach 1 is predicted to undergo a reduction in flow of up to 50% with a drought order and, whilst mortality under these conditions may be significant, fish species have evolved mechanisms in order to cope with low flow conditions, for example, avoidance behaviour (i.e. moving downstream as water levels drop) or the ability to persist in pooled areas of deeper water. However, flow sensitive species such as Atlantic salmon and brown trout are, nonetheless, susceptible to reduced flows.

Atlantic Salmon

Atlantic Salmon Migration

Atlantic salmon have been recorded in the Afon Cefni and it is likely that a limited number of adults spawn in the Afon Cefni below the reservoir in most years. Reaches 1 and 2 are therefore a migratory pathway for the species. The majority of Atlantic salmon migration into Afon Cefni is likely to occur from October to December and a drought permit may affect part of this

[11] 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
[12] 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.
[13] 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.

migration. The majority of out-migrating smolt would be likely to migrate between mid-March and mid-May depending on water temperature and therefore a drought permit may also interact with the very end of this migration.

Adult and smolt-stage Atlantic salmon migrations are linked to flow increases and river flow is considered to be a primary cue. Very low flows are likely to delay migration, thereby increasing mortality due to increased predation and stress. The impact is therefore considered to be of high magnitude, short-term, temporary and reversible. The impact on Atlantic salmon migration is therefore considered to be **major** adverse in Reach 1 and **minor** adverse in Reach 2 from **October to November** and in **May**, due to potential delays caused by a reduction in flow.

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 to increase stress and subsequent loss of condition. Atlantic salmon are susceptible to poor water quality and particularly dissolved oxygen and water temperature. The effects of reduced water quality are likely to impact particularly sensitive juvenile life stages. The impact 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 in Reach 1 and **negligible** in Reach 2, due to a potential reduction in water quality.

Juvenile Atlantic Salmon

There is the potential for reduced flow to result in a decrease in river levels and wetted width. There is therefore the potential for a loss or degradation of juvenile habitat along with gravel spawning habitat. Provided minimum low flows are available, juvenile Atlantic salmon are likely to relocate to areas of suitable habitat if river levels decrease, however, competition and stress would increase. Due to the potential timing of a drought permit, gravels containing alevins and / or early-stage fry (likely to occur in April and May) may be affected, along with fry and parr populations which are susceptible during the summer and autumn. The impact is therefore considered to be of high magnitude, short-term, temporary and reversible. The impact on juvenile Atlantic salmon is therefore considered to be **major** adverse in Reach 1 and **minor** adverse in Reach 2, due to potential habitat loss.

<u>Brook, river and sea lamprey</u>

Migration of river and sea lamprey

Mature river lamprey migrate upstream into freshwater in the autumn (from October to December[14]). River lamprey ammocoetes metamorphose after three to five years in freshwater and then descend to estuarine and marine environments. The migration tends to occur over the period July to September in smaller rivers[14]. These migration windows may be impacted

[14] Maitland PS (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No.5. English Nature, Peterborough

by a drought permit, however, unlike some diadromous fish species such as Atlantic salmon, river lamprey migrations are not primarily linked to periods of increased flow and, provided minimum low flows are available, migrations are unlikely to be affected. The impact is therefore considered to be of low magnitude, short-term, temporary and reversible. The impact on river lamprey migration is therefore considered to be **minor** adverse in Reach 1 and **negligible** in Reach 2 from **October to November** and **July to September**.

Mature sea lamprey migrate upstream into freshwater in April and May prior to spawning in the lower reaches of rivers. Sea lamprey ammocoetes metamorphose after approximately five years in freshwater and then descend to marine environments. The migration tends to occur in the period July to September[14]. This migration window also overlaps with a potential drought permit. However, both migrations are not linked particularly to periods of increased flow and, like river lamprey, provided minimum low flows are available, migrations are unlikely to be affected. The impact is therefore considered to be of low magnitude, short-term, temporary and reversible. The impact on sea lamprey migration is therefore considered to be **minor** adverse in Reach 1 and **negligible** in Reach 2 and from **July to September**.

Spawning and juvenile (ammocoete and transformer) brook, river and sea lamprey habitat

There is the potential for reduced flow to result in a decrease in river levels and wetted width. This has particular significance for juvenile (ammocoetes and transformer) lamprey habitat which tends to consist of silt in shallow, marginal areas. There is therefore the potential for a loss or degradation of this habitat along with gravel spawning habitat. Provided minimum low flows are available, juvenile lamprey are likely to relocate to areas of suitable habitat if river levels decrease, however, competition and stress would likely increase. If nests with incubating eggs (likely to occur in April and May prior to hatching) become de-watered this is likely to have a more significant effect with the potential for significant mortality due to desiccation and increased predation. The impact is therefore considered to be of high magnitude, short-term, temporary and reversible. The impact on lamprey spawning and juvenile habitat is therefore considered to be **major** adverse in Reach 1 and **minor** adverse in Reach 2, due to potential habitat loss.

Water quality

Water quality impacts (e.g. reduced dissolved oxygen and increased water temperature) are not expected to have a significant impact on the lamprey species which are not particularly sensitive to these effects. The impact on brook, river and sea lamprey is therefore considered to be **negligible** in Reaches 1 and 2.

<u>Brown / Sea Trout</u>

Sea Trout Migration

It is not known whether sea trout are currently migrating into the Afon Cefni. However, the precautionary approach suggests that sea trout *may* be utilising spawning and nursery habitat within Reaches 1 and 2. The majority of any sea trout migration into the Afon Cefni is likely to

occur from September to November and there is the potential for a drought permit to interact with this migration. The majority of out-migrating smolt would be likely to migrate between mid-March and mid-May depending on water temperature and therefore be partially affected by a drought permit. Adult and smolt-stage sea trout migration, like Atlantic salmon, is 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. The impact is therefore considered to be of high magnitude, short-term, temporary and reversible. The impact on sea trout migration is therefore considered to be **major** adverse in Reach 1 and **minor** adverse in Reach 2 from **September to November** and in **May,** due to potential delays caused by a reduction in flow.

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 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 impact particularly sensitive juvenile life stages. 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 **negligible** in Reach 2, due to a potential reduction in water quality.

Juvenile Brown / Sea Trout

There is the potential for reduced flow to result in a decrease in river levels and wetted width. There is therefore the potential for a loss or degradation of juvenile habitat along with gravel spawning habitat. Provided minimum low flows are available, juvenile brown / sea trout are likely to relocate to areas of suitable habitat if river levels decrease, however, competition and stress would increase. Due to the likely timing of a drought permit, gravels containing alevins and / or early-stage fry (likely to occur in April and May) may be affected along with fry and parr populations which are likely to be particularly susceptible during the summer and autumn. The impact is therefore considered to be of high magnitude, short-term, temporary and reversible. The impact on juvenile brown / sea trout is therefore considered to be **major** adverse in Reach 1 and **minor** adverse in Reach 2, due to potential habitat loss.

<u>European Eel</u>

Elver 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 have a significant impact on migration. The downstream migration of mature (silver) eel is linked to an increase in flow and tends to occur between September and December in most rivers and there is therefore the potential for a drought permit to impact this migration. European eel of a wide age range are likely to be present in low densities throughout Afon Cefni but the species is tolerant of high temperatures and relatively poor water quality and is considered resilient to drought conditions. The impacts on European eel are therefore

considered to be limited to silver eel migration and this is considered to be **moderate** adverse in Reach 1 and **negligible** in Reach 2 from **September to November**. Impacts on other European eel life stages are considered to be **negligible**.

Other fish species

Flounder are only likely to be present in Reach 2 and thus be largely unaffected by the increased impacts of the proposed drought order associated with Reach 1. Minnow spawning and egg incubation may be affected by drought permit implementation. Sensitive life stages of this species are susceptible to impacts associated with low flows. However, the stickleback species are considered particularly tolerant of poor habitat and water quality. The impact is therefore considered to be of high magnitude, short-term, temporary and reversible. The impact on other fish species is therefore considered to be **major** adverse in Reach 1 and **minor** adverse in Reach 2.

Summary

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

Table D3.8 Summary of Impacts on Fish Community

Feature	Impact	Significance of Impact
Reach 1- Afon Cefni		
Atlantic salmon	• Delays and potential cessation of adult and smolt migrations due to reduced flows.	**Major (Oct- Nov)**
	• Reduced water quality	**Minor**
	• Reduction in spawning and juvenile survival due to habitat loss.	**Major**
Brook, river and sea lamprey	• Migration of river adults and transformers affected or halted by a reduction in flow.	**Minor (Oct-Nov and Jul-Sep)**
	• Migration of sea lamprey adults and transformers affected or halted by a reduction in flow.	**Minor (Jul-Sep)**
	• Loss of spawning and juvenile habitat as a result of reduced river levels.	**Major**
	• Reduced water quality	**Negligible**
Brown/sea trout	• Delays and potential cessation of adult and smolt migrations due to reduced flows.	**Major (Sep-Nov and May)**
	• Reduced water quality	**Minor**

Feature	Impact	Significance of Impact
	• Reduction in spawning and juvenile survival due to habitat loss.	**Major**
European eel	• Delays and potential cessation of silver eel migration due to reduced flows.	**Moderate (Sep-Nov)**
	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow.	**Negligible**
Other species	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow.	**Major**
Reach 2- Afon Cefni		
Atlantic salmon	• Delays and potential cessation of adult and smolt migrations due to reduced flows.	**Minor (Oct- Nov)**
	• Reduced water quality	**Negligible**
	• Reduction in spawning and juvenile survival due to habitat loss.	**Minor**
Brook, river and sea lamprey	• Migration of river adults and transformers affected or halted by a reduction in flow.	**Minor (Oct-Nov and Jul-Sep)**
	• Migration of sea lamprey adults and transformers affected or halted by a reduction in flow.	**Minor (Jul-Sep)**
	• Loss of spawning and juvenile habitat as a result of reduced river levels.	**Major**
	• Reduced water quality	**Negligible**
Brown/sea trout	• Delays and potential cessation of adult and smolt migrations due to reduced flows.	**Minor (Sep-Nov)**
	• Reduced water quality	**Minor**
	• Reduction in spawning and juvenile survival due to habitat loss.	**Minor**
European eel	• Delays and potential cessation of silver eel migration due to reduced flows.	**Negligible**
	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow.	**Negligible**
Other species	• Habitat loss and reduced water quality. Reduction in survival due to potential cessation of flow.	**Minor**

There is a risk of short-term deterioration in status of the fish component of the 'Cefni - Ceint to Cefni reservoir' waterbody (GB110102058770) due to the drought permit. Impacts of drought permit implementation on the fish communities of the impacted reaches have been summarised as negligible to major adverse, short-term, temporary and reversible. Consequently, the fish component of these waterbodies is considered to be at **major** risk of short-term deterioration.

D.3.4 Phytobenthos

D.3.4.1 Baseline

No baseline diatom monitoring information was received from NRW for the hydrologically impacted reaches on the Afon Cefni.

D.3.4.2 Assessment

Impacts on the phytobenthos assemblages of the Afon Cefni could occur due to the operation of the drought order, 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 life cycle of algal species, phytobenthos communities can respond to rapidly to environmental change. Therefore, the major and minor hydrological effects of operation of the drought order in Reaches 1 and 2 respectively are likely to result in changes to the phytobenthos communities present within the timeframe of the drought order.

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, and therefore any effect of the drought order on WFD phytobenthos assessment is likely to be **minor (uncertain)** for Reaches 1 and 2. However, monitoring of phytobenthos communities within the affected reach would be required to fully assess the effects of the proposed drought order.

Summary

The potential impacts of the Cefni Reservoir drought permit on the diatom community are summarised in **Table D3.9**. The impacts, and their magnitude, have been based on the hydrological impacts (see Appendix B), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Appendix B) and the sensitivities of the diatom community. The impacts presented in **Table D3.9** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

Table D3.9 Summary of Impacts on Diatom Community

Feature	Impact	Significance of Impact
Reaches 1 and 2: Afon Cefni		
Diatoms	• Changes to community composition due to changes in velocity and water quality	**Minor**

The phytobenthos subcomponent of the Cefni - Ceint to Cefni reservoir (GB110102058770) waterbody is classed as having moderate WFD status.

Consequently, there is a **moderate** to **minor** risk of short term deterioration to the WFD

status macrophyte sub-component of the Cefni - Ceint to Cefni reservoir water body.

D.3.5 Invasive Species

D.3.5.1 Baseline

Two non-native species were present in the macroinvertebrate data received from NRW; a freshwater shrimp *Crangonyx pseudogracilis*, New Zealand mud snail *Potamopyrgus antipodarum*. Both species were regularly recorded at all monitoring sites within the impacted reaches of the Afon Cefni. New Zealand mud snail and *C. pseudogracilis* are both widespread and naturalised across England and Wales, as such changes to the hydrological regime are unlikely to increase the distribution and are not considered further in this assessment.

Table D3.10 Summary of Impacts on Invasive Species

Feature	Impact	Significance of Impact
Reach 1		
Crangonyx pseudogracilis New Zealand mud snail	• Implementation of the drought permit will do nothing favour proliferation of this species.	**Negligible**

D4 RECREATION

D.4.1.1 Baseline

The Afon Cefni provides recreational opportunities, especially for walkers, bikers, fishers and boaters.

D.4.1.2 Assessment

A review of the hydrological implications of implementing a drought permit has identified major hydrological impacts in Reach 1 and minor hydrological impacts in Reach 2. The impacts include a significant reduction in surface water baseflow, wetted width and wetted depth below those observed in surface watercourses within the area of influence without the drought permit. Any reduction in wetted width and depth may influence water-dependent activities such as angling and canoeing. However, water levels will be naturally low in times of drought and the impacts will be temporary in nature and will be ameliorated once the drought has passed. Therefore the recreational impacts are assessed with limited data as having a **negligible** risk.

Table D4.1 Summary of Impacts on Recreation

Feature	Impact	Significance of Impact
Reach 1 and 2: Afon Cefni		
Recreation	• Impacts on recreation activities (e.g. angling, canoeing, walking) are not anticipated over those from the natural drought conditions	**Negligible**