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Dŵr Cymru Welsh Water

## Environmental Assessment of Aled Isaf - Llyn Aled Drought Permit (8012-6)

Final

March 2019

**Client:** Dŵr Cymru Welsh Water

**Title:** Environmental Assessment of Aled Isaf - Llyn Aled Drought Permit (8012-6)

**Project No:** ED10929

**Date of Issue:** March 2019

**Status:** Final

**Version No:** 1.5

**Produced By**

**Authorised for Release By**




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## NON-TECHNICAL SUMMARY

### INTRODUCTION AND PURPOSE OF THIS REPORT

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

A drought permit or order is a drought management measure 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 Aled Isaf – Llyn Aled, over and above those arising due to natural effects of drought and those which would occur under "normal" abstraction licence conditions.

Aled Isaf and Llyn Aled are located in Welsh Water's Clwyd Coastal Water Resource Zone (WRZ). The Clwyd Coastal WRZ supplies the population in the northern coastal and inland area in the vicinity of Rhyl and Prestatyn.

The Coed Nant-y-Merddyn-Uchaf Site of Special Scientific Interest (SSSI), Coed Llys-Aled SSSI and Mnydd Hiraethog SSSI are located within the study area. Consideration has, therefore, been given to the potential impacts of drought permit implementation on these statutory 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 with the latest information to support any future required application by Welsh Water to Natural Resources Wales for a drought permit at Aled Isaf – Llyn Aled.**

### PROPOSED DROUGHT PERMIT DETAILS

In order to protect essential public water supplies within Welsh Water's Clwyd Coastal WRZ in the event of a future severe drought, Welsh Water may need to make an application to Natural Resources Wales for a drought permit

Despite the two licensed stream capture systems, Llyn Aled Reservoir has limited catchment area and consequent poor refill characteristics. Water from Aled Isaf

Reservoir could be pumped up to Llyn Aled Reservoir to support refill. Such usage is not authorised by the existing abstraction licence and a drought permit would be required; this would be applied for under this drought option. Daily pumping rates have not been specified at this stage and so the assessment is based on an assumed transfer rate of 19.5Ml/d.

The drought permit is most likely to occur during the autumn and winter period and is considered not to extend outside the period November to February. This has been confirmed by Welsh Water's water resources modelling and understanding of operating the assets.

The assessment includes Llyn Aled Reservoir, Aled Isaf Reservoir itself and the Afon Aled from the reservoir outflow to its confluence with the Afon Elwy.

The revised abstraction arrangements under the drought permit would be authorised for a maximum of four months, but would be removed sooner if the water resources situation within the Clwyd Coastal WRZ returns to adequate levels to safeguard essential 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 options considered by Welsh Water to maintain essential water supplies to its customers will be completed at the time of application for the drought permit. This will provide further justification for the need for the drought permit.

#### **POTENTIAL IMPACTS OF DROUGHT PERMIT IMPLEMENTATION**

The scope of this drought permit environmental assessment has been defined by a screening and scoping exercise in accordance with national drought planning guidance.

### ***Summary of the Hydrological Assessment for the Afon Aled***

The assessment has concluded that there is a **moderate** to **minor** impact on river flows as a result of implementing the drought permit. There are also **low** risks to the physical environment of the river, including water quality.

### ***Summary of the Environmental Features Screening for the Afon Aled***

Environmental assessment is required and included for features where screening has identified a major or moderate impact. Screening identified the Coed Llys-Aled SSSI, Coed Nant Y Merddyn Uchaf SSSI and Mnydd Hiraethog SSSI, WFD status and Community Assessment / Environment (Wales) Act Section 7 species, landscape and recreation as environmental features for which an environmental assessment was required. The assessment has concluded that there are **moderate** impacts on aquatic ecology, specifically: moderate impacts on spawning and juvenile salmon habitat; minor impacts on macroinvertebrates, negligible impacts on Coed Llys-Aled SSSI, Coed Nant Y Merddyn Uchaf SSSI, Mnydd Hiraethog SSSI, macrophytes and phytobenthos.

### ***Cumulative Impacts***

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

## **MITIGATION AND MONITORING**

The environmental assessment has identified significant impacts of implementation of a drought permit at Llyn Aled. 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**

It has been concluded that the environmental effects on river flows, water quality and ecology of implementing a drought permit at Aled Isaf - Llyn Aled would be **moderate**. This includes consideration of the effects on the Coed Llys-Aled SSSI, Coed Nant Y Merddyn Uchaf SSSI and Mnydd Hiraethog SSSI in accordance with the requirements of the Crow Act.

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**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 temporarily modify the abstraction licence conditions to allow the pumping of dead storage from Aled Isaf Reservoir to Llyn Aled Reservoir via the Afon Aled in the Clwyd Coastal 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 Aled Isaf - Llyn Aled. A drought permit is a management action that, if granted, can help ensure essential water supplies are maintained to homes and businesses. The circumstances under which a drought permit may be required is set out in the Welsh Water Drought Plan.

The assessment presented in this EAR considers the effects of implementation of the drought permit over the months of September to January 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 Llyn Aled drought permit, covers the following waterbodies:

- Afon Aled – upstream confluence with Deunant (GB110066054930)
- Afon Aled – confluence with Afon Elwy to confluence with Afon Deunant (GB110066059770)

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 / Natural Resource Wales Drought Plan Guideline<sup>1</sup> (DPG); specifically Section 5 and Appendix I and J, and Welsh Government / Defra / NRW / Environment Agency guidance on drought permits and drought orders<sup>2</sup>.

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 assessments 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

<sup>1</sup> 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.

<sup>2</sup> Welsh Government / Defra / Natural Resources Wales / Environment Agency (2015) *Apply for a drought order or emergency drought order*, <https://www.gov.uk/guidance/apply-for-a-drought-order-or-emergency-drought-order#after-youve-received-your-drought-order>, Accessed 21 December 2018.

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

The Clwyd Coastal WRZ supplies the population in the northern coastal and inland area in the vicinity of Rhyl and Prestatyn.

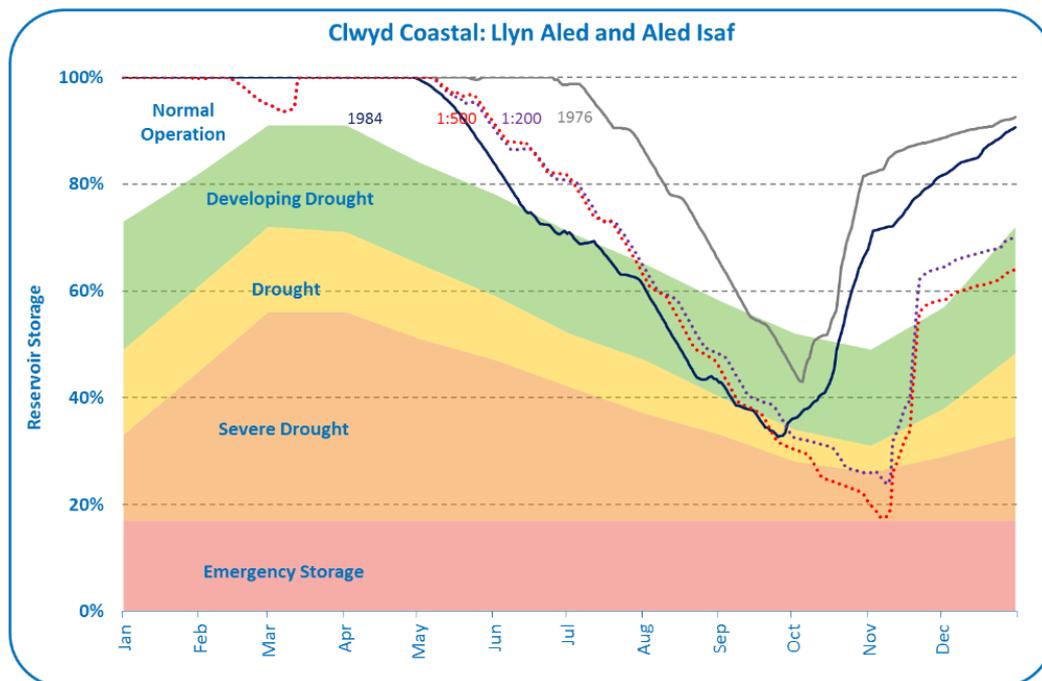
**Figure 2.1 Welsh Water Water Resource Zones**



Llyn Aled Reservoir is located on the mainland, in the Clwyd Coastal region. The trigger levels for applying for a drought permit at Llyn Aled are based on reservoir storage falling below a defined level; this is shown in **Figure 2.2** (orange shading labelled as ‘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 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 Llyn Aled Drought Action Zones and Historic Droughts**



**2.2 DESCRIPTION OF EXISTING ARRANGEMENTS AT LLYN ALED**

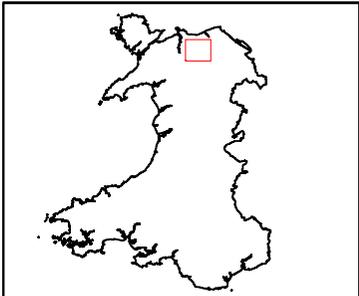
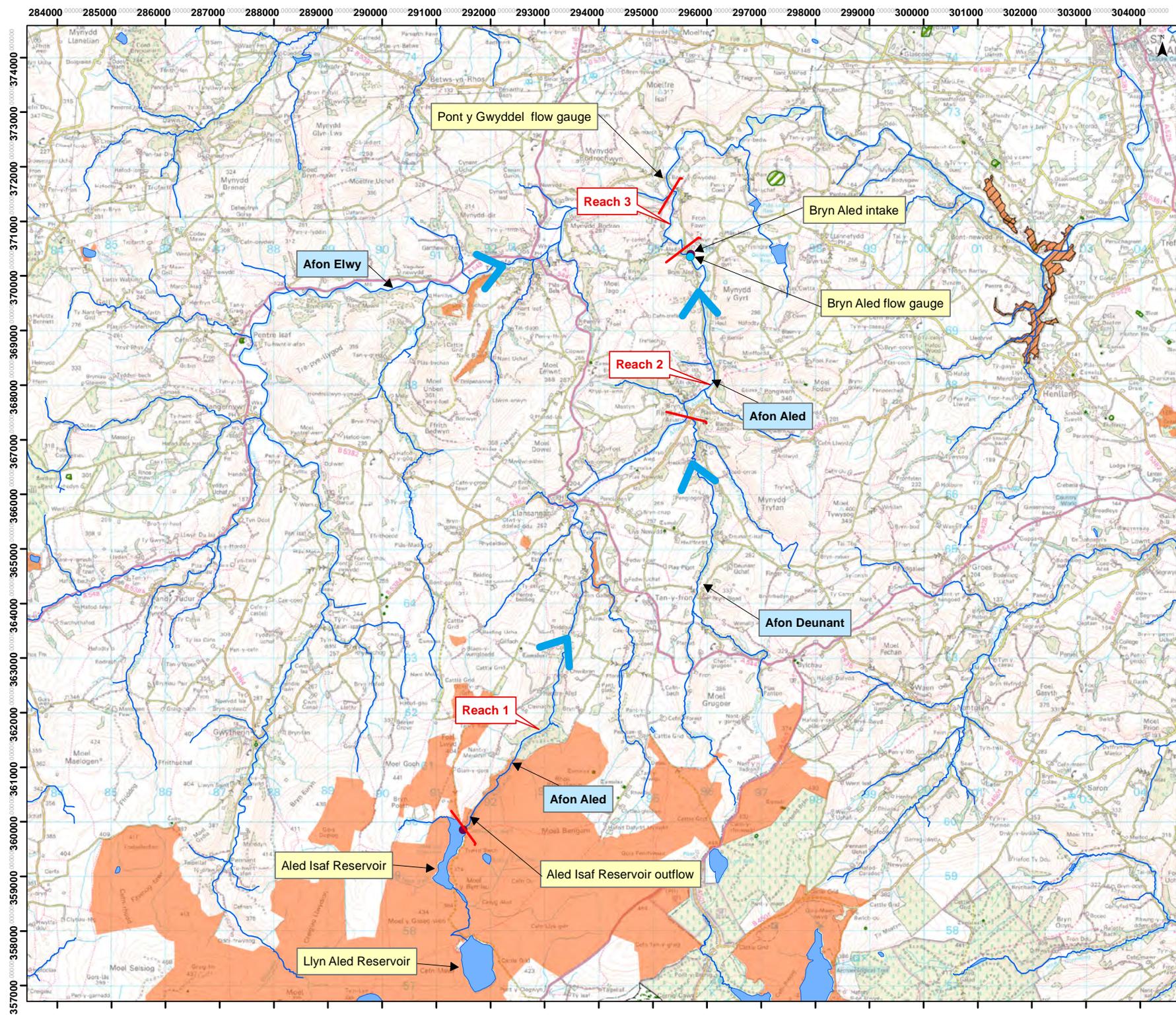
Water is stored in Llyn Aled Reservoir upstream of the Aled Isaf Reservoir from which the Afon Aled flows. Welsh Water, in accordance with a Section 20 Operating Agreement with NRW, abstract water from the Afon Aled at Bryn Aled intake to pump to Plas Uchaf reservoir. From Plas Uchaf Reservoir water is pumped to Glascoed Water Treatment Works, which supplies the Clwyd Coastal WRZ. The Afon Aled abstraction licence (number 24/66/5/7, variation no. 1) includes the following conditions:

- 4,318 million litres (Ml) authorised to be abstracted per annum
- Abstraction rate of 27.3Ml/d
- The low flow of the Afon Aled is regulated by controlled discharges from Aled Isaf impounding reservoir, supplemented from storage in Llyn Aled impounding reservoir as necessary. These controlled releases consist of the following:
  - A fixed statutory compensation water discharge of 2.27Ml/d at all times for the general benefit of riparian interests
  - Regulation releases to support the abstraction at Bryn Aled intake that

include the following scenarios:

- Controlled releases from Aled Isaf Reservoir to maintain a residual flow of 11.4Ml/d over the Bryn Aled weir downstream of the Bryn Aled intake (1 February – 31 May inclusively during intake operation)
- Daily regulation releases from Aled Isaf Reservoir shall not be less than the daily abstraction rate at intake when flow at Bryn Aled weir is less than 29.5Ml/d (1 June to 31 January inclusively)
- Fisheries management releases (made from a bank of water reserved in the licence under the terms of the Section 20 Operating Agreement with NRW).

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



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



1:65,000  
 Note: All locations are approximate  
 This drawing incorporates Ordnance Survey Information  
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Project Title: **Welsh Water Drought Plan**  
**Environmental Assessment**

Figure Title: **Study Area: 8012-6**  
**Transfer water from Aled Isaf Reservoir to Llyn Aled Reservoir**

Figure Number: <b>Figure 2.3</b>	Date: <b>February 2019</b>
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## 2.3 WELSH WATER'S DROUGHT PLANNING PROCESS

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

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

*4(b) for a revised drought plan –*

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

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

## 2.4 STATEMENT OF THE NEED FOR DROUGHT PERMIT

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

## 2.5 DROUGHT PERMIT – REGULATORY ARRANGEMENTS

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

Drought permits are granted by NRW, and allow a water company powers to abstract from specified water sources, or to modify or suspend the conditions set out in existing abstraction licences. Drought orders are granted by the Welsh Ministers and give powers either to a water company or to NRW to abstract from specified water sources, or to modify or suspend the conditions set out in existing abstraction licences, but also to allow the discharge of water to specified places, modify or suspend conditions relating to a discharge or prohibit or limit particular non-essential uses of water as set out in the Drought Plan (Wales) Direction 2017. Emergency drought orders grant the same powers as a drought order, 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 Clwyd Coastal WRZ in the event of a future severe drought, Welsh Water may need to make an application to NRW for a drought permit

Water from Aled Isaf Reservoir could be pumped up to Llyn Aled Reservoir to support refill. Such usage is not authorised by the existing abstraction licence and a drought permit would be required; this would be applied for under this drought option. Daily pumping rates have not been specified at this stage and so the assessment is based on an assumed transfer rate of 19.5Ml/d.

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

The drought permit is most likely to occur during the autumn and winter period and is considered not to extend outside the period November to February. This has been confirmed by Welsh Water's water resources modelling and understanding of operating the assets.

The assessment includes Llyn Aled Reservoir, Aled Isaf Reservoir itself and the Afon Aled from the reservoir outflow to its confluence with the Afon Elwy.

**Construction / Decommissioning Phase – Temporary pumps and pipeline**

Temporary pumps and pipelines will need to be constructed in order to transfer water from the Aled Isaf Reservoir to the Llyn Aled Reservoir as part of the implementation of this drought permit. A features assessment for the construction and decommissioning of the pumps & pipeline will be completed at the time of application for a drought permit.

**Table 2.1 Llyn Aled Existing and Proposed Drought Permit Abstraction**

<b>Abstraction Water Source</b>	<b>NGR</b>	<b>Normal Abstraction</b>	<b>Proposed Drought Permit Abstraction</b>	<b>Benefit ML/d</b>
Aled Isaf	SH 91800 57382	<p>Welsh Water’s licence (24/66/5/7 variation n o. 1) to abstract water under the Water Resources Act from the Afon Aled at Bryn Aled intake includes the following conditions:</p> <ul style="list-style-type: none"> <li>• 4,318 million litres (ML) authorised to be abstracted per annum</li> <li>• Abstraction rate of 27.3 ML/d1</li> <li>• The low flow of the Afon Aled is regulated by controlled discharges from Aled Isaf impounding reservoir, supplemented from storage in Llyn Aled impounding reservoir as necessary. These controlled releases consist of the following:</li> </ul> <p>a) A fixed statutory compensation water discharge of 2.27ML/d at all times for the general benefit of riparian interests</p> <p>b) Regulation releases to support the abstraction at Bryn Aled intake:</p> <ul style="list-style-type: none"> <li>i) From 1 February to 31 May inclusive, and when the Bryn Aled intake is in operation: controlled releases from Aled Isaf Reservoir maintain a residual flow of 11.4ML/d over the Bryn Aled weir downstream of the Bryn Aled intake</li> <li>ii) From 1 June to 31 January inclusive: when flow at Bryn Aled weir is less than 29.5ML/d, daily regulation releases from Aled Isaf Reservoir shall not be less than the daily abstraction rate at Bryn Aled intake</li> </ul> <p>c) Fisheries management and angling releases.</p>	<p>Under the drought permit water from Aled Isaf Reservoir would be pumped up to Llyn Aled Reservoir to support refill. Such usage is not authorised by the existing abstraction licence and a drought permit would be required.</p>	N/A

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

## **2.8 DROUGHT PERMIT PROGRAMME**

Drought actions and any future application for a drought permit would be managed by the Aled Consultative Group which would be convened under the terms of the Section 20 Operating Agreement with NRW. Decisions around which permit to apply for in the Clwyd Coastal WRZ will be made in liaison with the Section 20 consultative groups to ensure the best option for the environment and water resource situation is chosen.

The drought permit is most likely to occur during the autumn and winter period and is considered not to extend outside the period November to February. This has been confirmed by Welsh Water's water resources modelling and understanding of operating the assets.

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 a the continuation of a compensation release from Aled Isaf of 2.27Ml/d (daily average) and seasonal (July to October) fisheries releases of between 2.0 to 3.8Ml/d, as per existing arrangements. The baseline also includes the continuation of daily abstraction at Bryn Aled intake on Afon Aled for potable supply.

## 3 APPROACH

### 3.1 INTRODUCTION

The DPG states that the environmental report must include information on:

- i. 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 mitigation that may be required to prevent or reduce impacts on sensitive features

Items i and ii above were subject to an initial screening process as part of the scoping exercise. Section 3.2 below describes the screening approach taken. This has provided the relevant study area for the drought permit assessment 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.

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 / order 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.

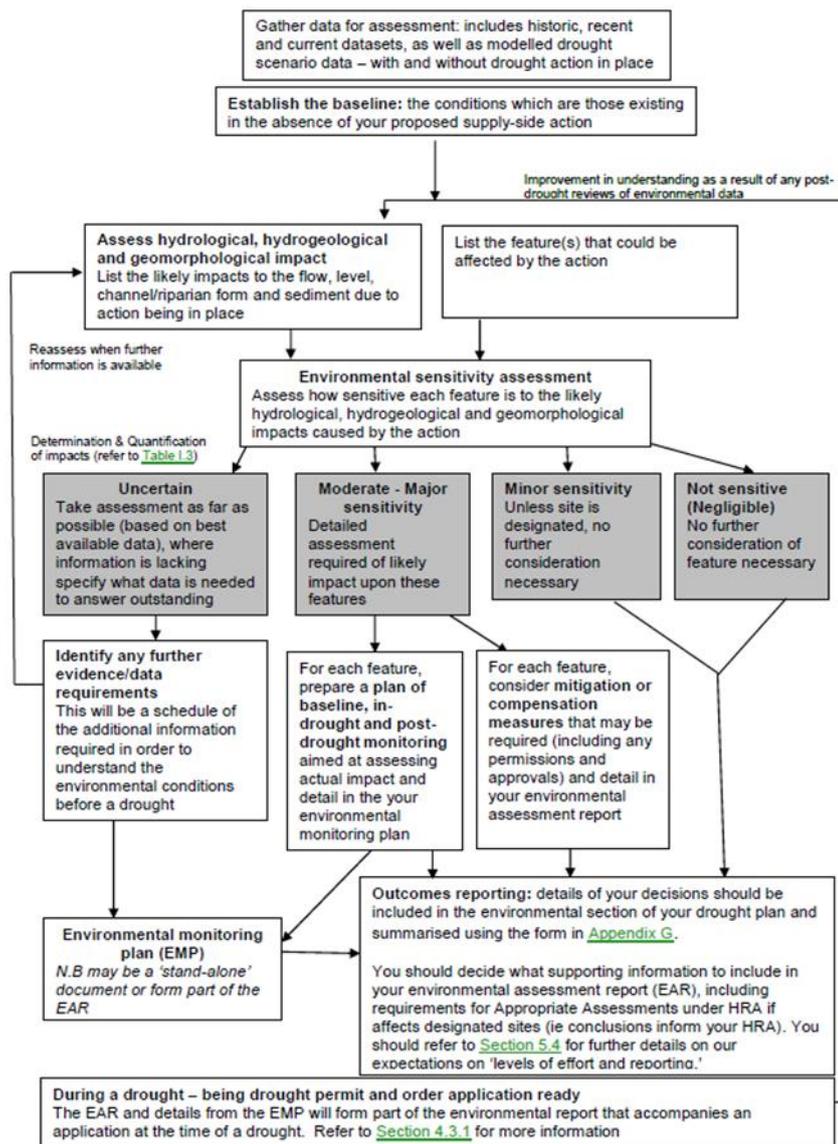
This is discussed further in Section 7.

## **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” 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** – this 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 outcome 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 Aled Isaf - Llyn Aled.**

### ***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 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 and 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 outcomes 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 Aled Isaf - Llyn Aled 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).

The environmental sensitivity screening identifies the outcome for each listed feature. DPG Figure 5 categorises four outcomes 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.

For each feature identified, the assessment methodology used in the EAR to identify the magnitude and significance of impact has been defined (see Section 3.3 below).

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.

### **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<sup>3</sup>
- UKWIR (2007, updated 2012) Strategic Environmental Assessment – Guidance for Water Resources Management Plans and Drought Plans. Prepared by Cascade Consulting
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)
- Council Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat , December 1975
- 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

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<sup>3</sup> CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal. September 2018.

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<sup>45</sup>, and the CIEEM<sup>6</sup> study guidelines. 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 DPG states that mitigation and / or monitoring is not required for features where minor (unless a site is designated) or negligible impacts are identified.

The mitigation and monitoring proposals (see Sections 6 and 9) will act as a safeguard that responds and is responsive to both predicted and unpredicted drought impacts. Future data collection and monitoring can then be focused to identify the aquatic 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.

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<sup>4</sup> IEMA (2004) Guidelines for Environmental Impact Assessment.

<sup>5</sup> IEMA (2011) Special Report – The State of Environmental Impact Assessment Practice in the UK

<sup>6</sup> CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland.

### **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 and 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 ALED ISAF - LLYN ALED 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 Aled Isaf, Llyn Aled and the Afon Aledduring 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 the 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 Llyn Aled Reservoir, Aled Isaf Reservoir itself and the Afon Aled from the reservoir outflow to its confluence with the Afon Elwy.

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 in the Afon Aled
- Change in levels in Llyn Aled Reservoir and Aled Isaf 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 autumn and winter period, considered to not extend outside the period November to February.

#### **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**

<b>Llyn Aled Reservoir</b>	
Level of Llyn Aled Reservoir <i>Minor impacts (minor beneficial)</i>	<ul style="list-style-type: none"> <li>The hydrological impact of this option is assessed as being minor (beneficial).</li> </ul>
<b>Aled Isaf Reservoir</b>	
Level of Aled Isaf Reservoir <i>Negligible impacts during the period November to February inclusive</i>	<ul style="list-style-type: none"> <li>The hydrological impact of this option is assessed as being negligible due to a decrease in minimum water levels of up to 1.9%.</li> </ul>
<b>Afon Aled (Reach 1) – downstream of Aled Isaf Reservoir</b>	
Flows in the Afon Aled <i>Moderate impacts for up to about 2 weeks during the period November to February inclusive</i>	<ul style="list-style-type: none"> <li>The impact on Reach 1 has been assessed as moderate, with no reduction in year round Q<sub>95</sub> and an 51% reduction in year round Q<sub>50</sub>.</li> </ul>
Water quality in the Afon Aled <i>Low risk during the period November to February</i>	<ul style="list-style-type: none"> <li>Low risk of deterioration linked to dissolved oxygen and ammonia</li> </ul>
<b>Afon Aled (Reach 2) – downstream of Afon Deunant</b>	
Flows in the Afon Aled <i>Minor impacts for up to about 2 weeks during the period November to February inclusive</i>	<ul style="list-style-type: none"> <li>The impact on Reach 2 has been assessed as minor with a 0% reduction in year round Q<sub>95</sub> and a 234% reduction in year round Q<sub>50</sub>.</li> </ul>
Water quality in the Afon Aled <i>Low risk (assumed) during the period November to February</i>	<ul style="list-style-type: none"> <li>Low risk of deterioration linked to dissolved oxygen and ammonia</li> </ul>
<b>Afon Aled (Reach 3) – downstream of Bryn Aled</b>	
Flows in the Afon Aled <i>Minor impacts for up to about 2 weeks during the period November to February inclusive</i>	<ul style="list-style-type: none"> <li>The impact on Reach 3 has been assessed as minor with a 0% reduction in year round Q<sub>95</sub> and a 19% reduction in year round Q<sub>50</sub>.</li> </ul>
Water quality in the Afon Aled <i>Low risk during the period November to February</i>	<ul style="list-style-type: none"> <li>Low risk of deterioration linked to dissolved oxygen and ammonia</li> </ul>

#### **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 ALED ISAF - LLYN ALED PROUGHT PERMIT ENVIRONMENTAL FEATURES ASSESSMENT**

### **5.1 INTRODUCTION**

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

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

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

### **5.2 SUMMARY OF STAGE 2 SCREENING AND SCOPING**

#### **5.2.1 Designated Sites and Other Sensitive Fauna and Flora**

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

**Table 5.1 Designated Sites and Other Sensitive Receptors within the Zone of Influence of the Aled Isaf - Llyn Aled 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)
Coed Lly s-Aled SSSI	Moderate	Designated due to high botanical importance. The woods represent one of the best examples in Clwyd of a woodland-type at medium altitudes and rainfall conditions. Upland oak woodland considered to be highly water dependent.	Minor	Yes
Coed Nant-y-Merddy n-Uchaf SSSI	Moderate	A mixed deciduous woodland, also representing one of the best examples in Clwyd of a woodland-type at medium altitudes and rainfall conditions. Upland oak woodland considered to be highly water dependent.	Minor	Yes
Mny dd Hiraethog SSSI	Moderate	Designated for sub-montane heather landscapes containing <i>Calluna vulgaris</i> ; the area is one of the two largest areas of blanket peat bog in the Clwyd county. The SSSI supports extensive areas of soligenous mires with a range of mesotrophic flora including <i>Carex paniculata</i> . The area is host to a diverse upland breeding bird population, predominantly the golden plover, other species of note include; Dunlin, snipe, curlew, lapwing and sand piper. Red Grouse, peregrine falcon, kestrel, buzzard, merlin, hen harrier, the short eared owl and black headed gulls are amongst the diverse bird population in the area	Minor	Yes
Macrophyte communities	Moderate/Minor	Reduction in flow and levels 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 macroinvertebrate communities	Moderate/Minor	The hydrological impacts are anticipated to reduce the availability of habitats or lead to exposure of benthic macroinvertebrate habitats and reduce habitat suitability by altering habitat suitability for flow sensitive species	Moderate	Yes
<b>Notable Species – Fish</b> Brook lamprey <i>Lampetra planeri</i> Atlantic salmon <i>Salmo salar</i> Bullhead <i>Cottus gobio</i> Brown and sea trout <i>Salmo trutta</i>	Moderate/Minor	Reduction in level and flow is anticipated to reduce the availability of habitat for fish, increase the risk of predation and impact on fish movement in the river.	Moderate	Yes
<b>Notable Species – Mammals</b> Otter <i>Lutra lutra</i>	Moderate/Minor	Otter are known to be present in the catchment, however these species are not expected to be significantly impacted by drought permit implementation as habitat and availability and quality is not anticipated to be altered.	Negligible	No

<b>Site/Feature and designation</b>	<b>Hydrological Impact at Location (Major, Moderate, Minor)</b>	<b>Susceptibility to flow and level impacts</b>	<b>Sensitivity (Uncertain, Moderate/Major, Minor, Negligible)</b>	<b>Further Consideration Required (Yes/No)</b>
Invasive flora and fauna	Moderate/Minor	New Zealand pigmyweed <i>Crassula helmsii</i> may be present in the catchment. There is uncertainty surrounding the likely effect of flow velocity and level impacts on the invasive species ability to distribute further within the watercourse	Uncertain	Yes
Landscape and visual amenity	Minor / Moderate	The study area is located in the Conwy Uplands Cultural landscape area and the Mynydd Hiraethog Cultural landscape area.	Uncertain	Yes
Recreation	Moderate/Minor	The area is used for a range of recreational activities including salmon and coarse fishing walking, canoeing, sailing and windsurfing. Any reduction in compensation releases may influence the water-dependant activities for a short period of time.	Uncertain	Yes

### 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 ecological status or potential and/or high / good 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	Aled - above Deunant (GB110066054930)		Aled - Elwy to Deunant (GB110066059770)	
<b>Hydrological Impact at Location (Major, Moderate, Minor, Negligible)</b>	Moderate		Minor	
Heavily Modified Waterbody (Y/N)	Yes		Yes	
RBMP Cycle	RBMP2 (2015) <sup>7</sup>	2018 Cycle 2 Interim Classification <sup>8</sup>	RBMP2 (2015)	2018 Cycle 2 Interim Classification
Overall Biological	Good	Good	Good	Good
Fish	High	High	High	High
Macrophytes	Not assessed	Not assessed	Not assessed	Not assessed
Phytobenthos	Not assessed	Not assessed	Not assessed	Not assessed
Macro-invertebrates	High	High	High	High
Total P/ Phosphate	Good	High	High	High
Ammonia	High	High	High	High
Dissolved Oxygen	High	High	High	High
pH	High	High	High	High
<b>Sensitivity (Uncertain, Moderate/Major, Minor, Not sensitive)</b>	Moderate		Minor	
<b>Further Consideration Required (Y/N)</b>	Yes		No	

### 5.3 FEATURES ASSESSMENT

This section describes and assesses the potential impacts on the sensitive features during the period of implementation of the drought permit and subsequent reservoir storage / water level recovery.

Based on the sensitive features identified in Section 5.2.1, 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 relevant reservoir / river reaches for the Llyn Aled

<sup>7</sup> NRW (2017) <https://drive.google.com/file/d/0B2hsDbbdxztZHItRU9lNkg1YWw/view>

<sup>8</sup> NRW (2018) [https://drive.google.com/file/d/14w17jLo5sNuToVELqMCK\\_yo6DdHU7STb/view](https://drive.google.com/file/d/14w17jLo5sNuToVELqMCK_yo6DdHU7STb/view)

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. The approach is described in Section 3.3.

### 5.3.1 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
<b>Reach 1 – Afon Aled (Aled Isaf Outflow to Afon Deunant confluence)</b>													
Coed Llys-Aled SSSI		N	N	N/A	N	N							
Coed Nant-y-Merddyn-Uchaf SSSI		N	N	N/A	N	N							
Mynydd Hiraethog SSSI		N	N	N/A	N	N							
Macrophytes		N	N	N/A	N	N							
Phy to benthos		N	N	N/A	N	N							
Risk to WFD waterbody macrophyte/phytobenthos status		N	N	N/A	N	N							
Macroinvertebrates				N/A									
Risk to WFD waterbody macroinvertebrate status				N/A									
Atlantic Salmon, Brown / Sea trout	Upstream migration	N	N	N/A									
	Water quality			N/A									
	Spawning and juveniles (loss of habitat)			N/A									
Bullhead				N/A									
European eel				N/A									
Lamprey	Migration			N/A									
	Juvenile (ammocoete and transformer) brook and river lamprey habitat			N/A									
	Water quality	N	N	N/A	N	N							
Other fish species- Minnow, Stone loach and Three-spined stickleback				N/A									
Risk to WFD waterbody fish status				N/A									
Landscape and Visual Amenity		N	N	N/A	N	N							
Recreation		N	N	N/A	N	N							
<b>Reach 2 – Afon Aled (Afon Deunant confluence to Bryn Aled intake)</b>													
<b>Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence</b>													
Macrophytes		N	N	N/A	N	N							
Phy to benthos		N	N	N/A	N	N							
Macroinvertebrates		N	N	N/A	N	N							
Atlantic Salmon, Brown / Sea trout	Upstream migration	N	N	N/A									
	Water quality			N/A									
	Spawning and juveniles (loss of habitat)			N/A									
Bullhead		N	N	N/A	N	N							
European eel				N/A									
Lamprey	Migration			N/A									
	Juvenile (ammocoete and transformer) brook and river lamprey habitat			N/A									
	Water quality	N	N	N/A	N	N							

Month	J	F	M	A	M	J	J	A	S	O	N	D
Other fish species- Minnow, Stone loach and Three-spined stickleback	N	N	N/A	N								
Risk to WFD waterbody fish status			N/A									
Landscape and Visual Amenity	N	N	N/A	N								
	N	N	N/A	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

**5.3.2 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**. The assessment has been made on a precautionary basis in the absence of any reliable data (see **Appendix D**). Collection of baseline data may provide the basis for a revised conclusion.

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

Designation	Impact	Significance of Impact
Coed Llys-Aled SSSI	<ul style="list-style-type: none"> <li>The woodland habitats present in the Coed Llys-Aled SSSI are not dependent on the Afon Aled and are therefore not susceptible to impacts arising from the implementation of the Llyn Aled Drought permit; impacts to the designated features of the SSSI are assessed as negligible.</li> </ul>	<b>Negligible</b>
Coed Nant-y-Merddyn-Uchaf SSSI	<ul style="list-style-type: none"> <li>The woodland habitat present in the Coed Nant-y-Merddyn-Uchaf SSSI are not dependent on the Afon Aled and are therefore not susceptible to impacts arising from the implementation of the Llyn Aled Drought permit; impacts to the designated features of the SSSI are assessed as negligible.</li> </ul>	<b>Negligible</b>
Mynydd Hiraethog SSSI	<ul style="list-style-type: none"> <li>The notable bryophytes at the site are typically associated with base rich wet flushes and fens so are susceptible to changes in water level but are not dependent on the Afon Aled or reservoirs.</li> </ul>	<b>Negligible</b>

### 5.3.3 WFD and Community Assessment

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

The Environment Agency<sup>9</sup> 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 good ecological status. Where the designated use includes for impacts on flow and flow-related mitigation measures the measured status of the fish and macroinvertebrate

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<sup>9</sup> Environment Agency (2011) Method statement for the classification of surface water bodies v2.0 (external release) Monitoring Strategy v2.0 July 2011

communities do not affect the classification of good ecological potential.

### Assessment

A summary of the potential impacts of the drought permit on macrophyte, macroinvertebrate 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. The assessment has been made on a precautionary basis in the absence of any reliable data (see **Appendix D**). Collection of baseline data may provide the basis for a revised conclusion.

**Table 5.5 Summary of Impacts of Drought Permit Implementation on Macrophytes**

WFD Waterbody	Impact	Significance of Impact
Aled - above Deunant (GB110066054930) Current status: Good (overall status)	<ul style="list-style-type: none"> <li>There is a negligible risk of short term deterioration in the status of the macrophyte community.</li> </ul>	Negligible
Aled - Elwy to Deunant (GB110066059770) Current status: Good (overall status)		Negligible
Feature	Impact	Significance of Impact
<b>Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence</b>		
Macrophytes	<ul style="list-style-type: none"> <li>Decreased wetted width and / or depth resulting in desiccation of marginal macrophytes</li> <li>Decrease in flow affecting macrophyte community composition</li> </ul>	Negligible
<b>Reach 2 – Afon Aled, Afon Deunant confluence to Bryn Aled intake</b>		
Macrophytes	<ul style="list-style-type: none"> <li>Decreased wetted width and / or depth resulting in desiccation of marginal macrophytes</li> <li>Decrease in flow affecting macrophyte community composition</li> </ul>	Negligible
<b>Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence</b>		
Macrophytes	<ul style="list-style-type: none"> <li>Decreased wetted width and / or depth resulting in desiccation of marginal macrophytes</li> <li>Decrease in flow affecting macrophyte community composition</li> </ul>	Negligible

### Macroinvertebrates

**Table 5.6** presents a summary of the potential impacts of the drought permit

identified from the assessment of macroinvertebrates. The assessment has been made on a precautionary basis in the absence of any reliable data (see **Appendix D**). Collection of baseline data may provide the basis for a revised conclusion.

**Table 5.6 Summary of Impacts of Drought Permit Implementation on Macroinvertebrates**

WFD Waterbody		Significance of Impact
Aled - above Deunant (GB110066054930) Current status: High	<ul style="list-style-type: none"> <li>There is a risk of short term deterioration in the status of the macroinvertebrate community.</li> </ul>	Minor
Aled - Elwy to Deunant (GB110066059770) Current status: High	<ul style="list-style-type: none"> <li>There is a risk of short term deterioration in the status of the macroinvertebrate community.</li> </ul>	Negligible
Species	Impact	Significance of Impact
Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence		
Macroinvertebrates	<ul style="list-style-type: none"> <li>Reduction in species diversity and abundance as a result of reduced recruitment.</li> <li>Reduction in species diversity as a result of the loss of flow-sensitive taxa</li> </ul>	Minor
Reach 2 – Afon Aled, Afon Deunant confluence to Bryn Aled intake		
Macroinvertebrates	<ul style="list-style-type: none"> <li>Reduction in species diversity and abundance as a result of reduced recruitment.</li> <li>Reduction in species diversity as a result of the loss of flow-sensitive taxa</li> </ul>	Negligible
Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence		
Macroinvertebrates	<ul style="list-style-type: none"> <li>Reduction in species diversity and abundance as a result of reduced recruitment.</li> <li>Reduction in species diversity as a result of the loss of flow-sensitive taxa</li> </ul>	Negligible

*Fish*

**Table 5.7** presents a summary of the potential impacts of the drought permit identified from the assessment of fish. The assessment has been made on a precautionary basis in the absence of any reliable data (see **Appendix D**). Collection of baseline data may provide the basis for a revised conclusion.

**Table 5.7 Summary of Impacts of Drought Permit Implementation on Fish**

WFD Waterbody		Significance of Impact
Aled - above Deunant GB110066054930 Current status: High	<ul style="list-style-type: none"> <li>There is a risk of short-term deterioration in fish status of the water body due to the drought permit.</li> </ul>	<b>Major</b>
Aled - Elwy to Deunant (GB110066059770) Current status: High	<ul style="list-style-type: none"> <li>There is a risk of short-term deterioration in fish status of the water body due to the drought permit.</li> </ul>	<b>Minor</b>
Species	Impact	Significance of Impact
<b>Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence</b>		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	<b>Moderate</b>
	• Reduced water quality	<b>Minor</b>
	• Reduction in spawning and juvenile survival due to habitat loss.	<b>Moderate</b>
Bullhead	• Increase in mortality due to habitat loss.	<b>Minor</b>
Lamprey species	• Delays and potential cessation of adult river lamprey migration due to decreased flows.	<b>Moderate</b>
	• Loss of juvenile habitat as a result of reduced river levels.	<b>Moderate</b>
	• Reduced water quality	<b>Negligible</b>
European eel	• Increased mortality due to habitat loss.	<b>Moderate</b>
Other species	• Increased mortality due to habitat loss.	<b>Minor</b>
<b>Reach 2 - Afon Aled (Afon Deunant confluence to Bryn Aled intake)</b>		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	<b>Minor</b>
	• Reduced water quality	<b>Minor</b>
	• Reduction in spawning and juvenile survival due to habitat loss.	<b>Minor</b>
Bullhead	• Increase in mortality due to habitat loss.	<b>Negligible</b>
Lamprey species	• Delays and potential cessation of adult river lamprey migration due to decreased flows.	<b>Minor</b>
	• Loss of juvenile habitat as a result of reduced river levels.	<b>Minor</b>
	• Reduced water quality	<b>Negligible</b>
European eel	• Increased mortality due to habitat loss.	<b>Minor</b>
Other species	• Increased mortality due to habitat loss.	<b>Negligible</b>
<b>Reach 3 - Afon Aled (Bryn Aled intake to Afon Elwy confluence)</b>		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	<b>Minor</b>
	• Reduced water quality	<b>Minor</b>
	• Reduction in spawning and juvenile survival due to habitat loss.	<b>Minor</b>
Bullhead	• Increase in mortality due to habitat loss.	<b>Negligible</b>
Lamprey species	• Delays and potential cessation of adult river lamprey migration due to decreased flows.	<b>Minor</b>
	• Loss of juvenile habitat as a result of reduced river levels.	<b>Minor</b>
	• Reduced water quality	<b>Negligible</b>
European eel	• Increased mortality due to habitat loss.	<b>Minor</b>
Other species	• Increased mortality due to habitat loss.	<b>Negligible</b>

*Phytobenthos*

**Table 5.8** presents a summary of the potential impacts of the drought permit identified from the assessment of phytobenthos. The assessment has been made on a precautionary basis in the absence of any reliable data (see **Appendix D**). Collection of baseline data may provide the basis for a revised conclusion.

**Table 5.8 Summary of Impacts of Drought Permit Implementation on Phytobenthos**

WFD Waterbody		Significance of Impact
Aled - above Deunant (GB110066054930) Current status: Good (overall status)	There is a risk of short-term deterioration in biological status of the water body due to the drought permit.	Negligible
Aled - Elwy to Deunant (GB110066059770) Current status: Good (overall status)		Negligible
Feature	Impact	Significance of Impact
<b>Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence</b>		
Diatoms	<ul style="list-style-type: none"> <li>Decrease in flow affecting phytobenthos community composition</li> <li>Decreased wetted width and / or depth resulting in desiccation of phytobenthos</li> </ul>	Negligible
<b>Reach 2 - Afon Aled (Afon Deunant confluence to Bryn Aled intake)</b>		
Diatoms	<ul style="list-style-type: none"> <li>Decrease in flow affecting phytobenthos community composition</li> <li>Decreased wetted width and / or depth resulting in desiccation of phytobenthos</li> </ul>	Negligible
<b>Reach 3 - Afon Aled (Bryn Aled intake to Afon Elwy confluence)</b>		
Diatoms	<ul style="list-style-type: none"> <li>Decrease in flow affecting phytobenthos community composition</li> <li>Decreased wetted width and / or depth resulting in desiccation of phytobenthos</li> </ul>	Negligible

**5.3.4 Invasive Flora**

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

**Table 5.9 Summary of Impacts of Drought Permit Implementation on Landscape, Heritage and Recreation**

Feature	Impact	Significance of Impact
<b>Llyn Aled</b>		
New Zealand pigmyweed <i>Crassula helmsii</i>	<ul style="list-style-type: none"> <li>Survey has confirmed that <i>Crassula helmsii</i> is not present in Aled Isaf. Therefore the pumped transfer will not transfer the species to Llyn Aled and increase the range of the species.</li> </ul>	None

### 5.3.5 Landscape, Heritage and Recreation

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

**Table 5.10 Summary of Impacts of Drought Permit Implementation on Landscape, Heritage and Recreation**

<b>Feature</b>	<b>Impact</b>	<b>Significance of Impact</b>
<b>Reaches 1 – 3</b>		
Landscape	<ul style="list-style-type: none"> <li>Flows during drought conditions will naturally be low therefore the implementation of the drought permit is not expected to lead to any material additional landscape and visual amenity impacts</li> </ul>	<b>Negligible</b>
Recreation	<ul style="list-style-type: none"> <li>Impacts on recreation activities (e.g. angling, canoeing, walking) are not anticipated over those from the natural drought conditions</li> </ul>	<b>Negligible</b>

## **6 ALED ISAF - LLYN ALED DROUGHT PERMIT – MITIGATION**

The environmental assessment has identified some significant impacts, including moderate hydrological impacts, low risk to water quality impacts, major aquatic ecology impacts including a moderate impact on fish, minor impact on macroinvertebrates, negligible impacts on macrophytes and phytobenthos.

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

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

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 <sup>10</sup> 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 Llyn Aled 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.

<sup>10</sup> 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 the NRW Review of Consents reports
- Assessment of cumulative impacts of the drought permit with other Welsh Water supply-side and drought order / 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 other neighbouring water company Drought Plans, Natural Resources Wales Drought Plan
  - 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 Aled Isaf – Llyn Aled drought permit with other drought order / permit schemes have been identified.

***Welsh Water WRMP schemes***

No WRMP schemes identified with cumulative impacts.

***Drought options from other neighbouring water company Drought Plans and Natural Resources Wales Drought Plans***

No cumulative schemes have been identified for assessment.

***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 Environmental Monitoring Plan (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 ALED ISAF - LLYN ALED 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 Llyn Aled drought permit meets the requirements of Section 5.2 (Monitoring) and informs the requirements of Section 5.3 (Mitigation) of 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 (in relation to any proposals that may affect any SACs, SPAs, NNRs, SSSIs or RAMSAR sites) 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 Monitoring and Mitigation Recommendations**

Feature reach and	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period	Post Drought Permit	Responsibility	
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring		Monitoring and post-drought mitigation (where applicable)
		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
Fish (including salmon, brown trout, lamprey and eel) <b>Reach 1</b>	Reduction in spawning and juvenile survival due to habitat loss.  Increase in mortality due to habitat loss.  Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.  Delays and potential cessation of downstream adult eel migration due to reduced flows.	Fish populations are well understood as a result of recent NRW and Welsh Water monitoring <sup>11</sup> . Surveys to be repeated every three years  Monitoring sites are located at:  Reach 3 – NRW Site 1  Quantitative, lamprey-specific electric fishing surveys targeting known optimal and sub-optimal habitat. 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 sections known to be susceptible to lower flows: <ul style="list-style-type: none"> <li>• Identification of key habitats which are at risk of fragmentation.</li> <li>• Identification of key</li> </ul>	Electric-fishing surveys to monitor fish populations at one site in each of the impacted reaches. One site in each of the impacted reaches.  Quantitative, lamprey-specific electric fishing surveys targeting known optimal and sub-optimal habitat. 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 sections known to be susceptible to lower flows: <ul style="list-style-type: none"> <li>• Identification of key habitats which are at risk of fragmentation.</li> <li>• Identification of key</li> </ul>	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 high fish densities, spawning, nursery and cover habitats. Record extent of exposed marginal habitats, spawning habitats, bed substrates and estimates of overlying 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	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: <ul style="list-style-type: none"> <li>• Gravel washing of key spawning areas to be undertaken prior to salmonid spawning period (winter)<sup>12</sup></li> <li>• Targeted installation of woody debris features to increase localised flow velocity/scour at impacted spawning gravels (to aid sediment transport and increase</li> </ul>	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.  Quantitative, lamprey-specific electric fishing surveys targeting known optimal and sub-optimal habitat. One site in each of the impacted reaches.  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

<sup>11</sup> Apem (2018) Dwr Cymru Welsh Water Drought Plan Monitoring 2017 to 2018: Aled Isaf and Llyn Aled, July 2018

<sup>12</sup> Wild Trout Trust Habitat Management Sheet – Gravel Cleaning [http://www.wildtrout.org/sites/default/files/library/Gravel\\_Cleaning\\_Apr2012\\_WEB.pdf](http://www.wildtrout.org/sites/default/files/library/Gravel_Cleaning_Apr2012_WEB.pdf)

Feature reach and	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set of environmental drought	During Drought Permit Implementation Period	Post Drought Permit	Responsibility	
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring		Monitoring and post-drought mitigation (where applicable)
			<p>structures which may provide a barrier at lower flows.</p> <p>Approximation of the number of each fish species (e.g. 10s, 100s) in each ponded reach, where safe and practical to do so.</p> <p>Measure dissolved oxygen, conductivity and temperature in the field using calibrated handheld equipment.</p> <p>Appropriate trigger values would be set for level and flow for spawning habitats based on local circumstances, timing, seasonality and expert opinion.</p>	<p>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).</p> <p>Frequency of fish passage assessments to be determined based on the on-set of environmental drought walkover and expert judgement of the resolution required to monitor the impacts of the drought.</p> <p>Measure dissolved oxygen, conductivity and temperature in the field using calibrated handheld equipment.</p> <p>Deployment of automated water quality equipment that continuously monitors for dissolved oxygen.</p>	<p>water depth for spawning depth)</p> <p>If the results of the walkovers deem important habitats to be at risk to exposure/reduction (in extent), the following mitigation action/s may be undertaken:</p> <ul style="list-style-type: none"> <li>• Targeted installation of woody debris features to increase flow heterogeneity/scour and marginal cover in shallow areas of the channel<sup>13</sup></li> <li>• Deployment of aeration equipment in key reaches that have standing or slow flowing water with low oxygen levels.</li> <li>• Targeted installation of woody debris features to provide submerged and overhead cover from predation where significant abundances of fish have been identified by walkover</li> </ul>	<p>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 overlying silt cover.</p> <p>If the results of the walkovers deem spawning gravels to have suffered from siltation, the following mitigation action/s may be undertaken:</p> <p>Gravel washing of key spawning areas to be undertaken prior to salmonid spawning period (winter)<sup>14</sup></p> <p>Targeted installation of woody debris features to:</p> <ul style="list-style-type: none"> <li>• increase flow heterogeneity/scour and marginal cover in shallow areas of the channel<sup>15</sup></li> <li>• increase localised flow velocity/scour at impacted spawning gravels (to aide</li> </ul>	

<sup>13</sup> Wild Trout Trust Chalkstream Habitat Manual – Use of Large Woody Debris [http://www.wildtrout.org/sites/default/files/library/Large\\_Woody\\_Debris.pdf](http://www.wildtrout.org/sites/default/files/library/Large_Woody_Debris.pdf)

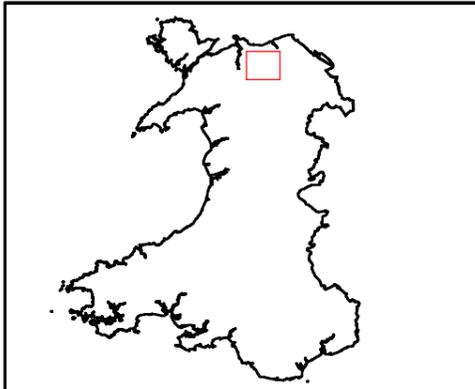
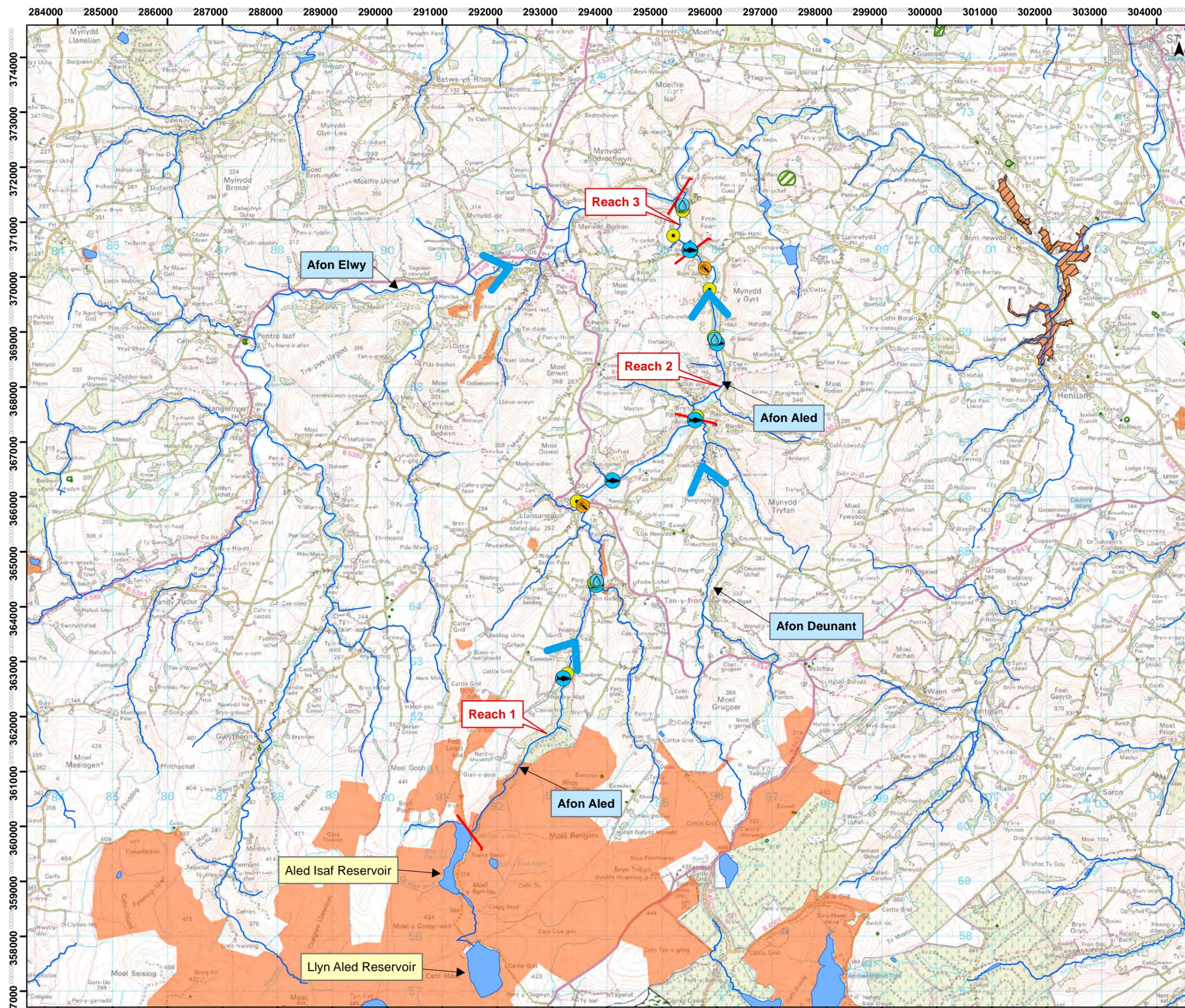
<sup>14</sup> Wild Trout Trust Habitat Management Sheet – Gravel Cleaning [http://www.wildtrout.org/sites/default/files/library/Gravel\\_Cleaning\\_Apr2012\\_WEB.pdf](http://www.wildtrout.org/sites/default/files/library/Gravel_Cleaning_Apr2012_WEB.pdf)

<sup>15</sup> Wild Trout Trust Chalkstream Habitat Manual – Use of Large Woody Debris [http://www.wildtrout.org/sites/default/files/library/Large\\_Woody\\_Debris.pdf](http://www.wildtrout.org/sites/default/files/library/Large_Woody_Debris.pdf)

Feature reach and	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set environmental drought	During Drought Permit Implementation Period	Post Drought Permit	Responsibility	
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring		Monitoring and post-drought mitigation (where applicable)
					<p>surveys.</p> <p>Consider provision of physical deterrents to deter piscivorous birds at significant locations (e.g. scare crows) in consultation with NRW.</p> <p>In extreme cases (where environmental parameters such as dissolved oxygen and temperature allow), consider removal of concentrated abundances of fish deemed to be stranded/at risk, relocating fish to suitable locations outside of the impacted reach within more suitable catchment, but would need to be discussed with NRW to ensure compliance with the Keeping and Introduction of Fish Regulations 2014.</p> <p>Modify any impacted fish passes (where possible) to ensure passage is maintained during key migration periods (e.g. agree to provide an appropriate proportion of flow into the pass to enable passage).</p> <p>Consider 'Trap &amp; Transport' of concentrated abundances</p>	<p>sediment transport and increase water depth for spawning depth)</p> <p>If the results of the walkovers deem important habitats to be at risk to exposure/ reduction (in extent), the following mitigation action/s may be undertaken:</p> <ul style="list-style-type: none"> <li>• 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).</li> <li>• Modify any impacted fish passes (where possible) to ensure passage is achievable during key migration periods (e.g. agree to provide an appropriate proportion of flow into the pass to enable passage). Where fish passage is not currently provided at a barrier, investigate appropriate methods of improving passage (e.g. fish passage</li> </ul>	



Feature reach and	Potential Impact identified in EAR	Pre-drought baseline monitoring	On-set environmental drought	During Drought Permit Implementation Period	Post Drought Permit	Responsibility	
		Key locations	Monitoring and trigger setting	Trigger and monitoring to inform mitigation action	Mitigation actions triggered by monitoring		Monitoring and post-drought mitigation (where applicable)
					<p>of migrating fish accumulated below impassable barrier/s to spawning grounds upstream of the impacted reach (where environmental parameters such as dissolved oxygen and temperature allow).</p> <p>Alternatively, mitigation should seek to protect any populations 'trapped' as a result of the barrier/s until flows increase for example by using aeration (if dissolved oxygen levels are low) or preventing predation (see Increased Mortality impact mitigation actions outlined above).</p> <p>Deployment of aeration equipment in key reaches that have standing or slow flowing water with low oxygen levels.</p>	design and installation).	



- Legend**
- Hydrological Reach
  - Water Courses
  - Reservoir
  - Spot Flow & Water Quality Survey Site
  - Fish Survey Site
  - Macrophyte Survey
  - Phytobenthos survey
  - Macroinvertebrate Survey
  - Special Area of Conservation
  - Site of Special Scientific Interest
  - Scheduled Ancient Monuments
  - Direction of Flow



1:65,000  
 Note: All locations are approximate  
 This drawing incorporates Ordnance Survey Information  
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Project Title: **Welsh Water Drought Plan  
 Environmental Assessment**

Figure Title: **Environmental Monitoring: 8012-6  
 Transfer water from Aled Isaf Reservoir  
 to Llyn Aled Reservoir**

Figure Number: **Figure 9.1**      Date: **February 2019**

## 10 CONCLUSIONS

This EAR provides an assessment of the potential environmental impacts relating to the implementation of the Aled Isaf - Llyn Aled drought permit. If granted and implemented, the drought permit would enable Welsh Water to pump water from Aled Isaf Reservoir up to Llyn Aled Reservoir to support refill. Such usage is not authorised by any existing abstraction licence and a drought permit would be required; this would be applied for under this drought option. Daily pumping rates have not been specified at this stage and so the assessment is based on an assumed transfer rate of 19.5Ml/d.

The drought permit is most likely to occur during the autumn and winter period and is considered not to extend outside the period November to February. This has been confirmed by Welsh Water's water resources modelling and understanding of operating the assets. This option would continue until winter rainfall caused the total reservoir storage to improve significantly.

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/order (Stage 2).

The hydrological / hydrogeological impact assessment identified a **moderate to minor** impact on flows in the Afon Aled and a minor beneficial impact on Llyn Aled Reservoir and Aled Isaf Reservoir.

An environmental assessment was therefore required and included for features where screening has identified a major to minor impact. Screening identified Coed Llys-Aled SSSI, Coed Nant-y-Merddyn-Uchaf SSSI, Mnydd Hiraethog SSSI, WFD Status and Community Assessment / Environment (Wales) Act Section 7 Species, and landscape and recreation as environmental features for which an environmental assessment was required. The assessment has concluded that there are -major impacts on aquatic ecology, specifically: **moderate** impacts on fish, minor impacts on macroinvertebrates, negligible impacts on macrophytes and phytobenthos.

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

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



# **APPENDIX A**

# **HYDROLOGY AND HYDROGEOLOGY**

# **METHODOLOGY**

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

Consideration is required (by the DPG<sup>1</sup>) 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<sup>2</sup> 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<sup>3</sup>. Where possible, the hydrological assessments presented in previous EMPs and EARs of the drought options have been used to

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

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

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

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

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

**Figure A.1 Hydrological Assessment Matrix (Upland)**

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

**Figure A.2 Hydrological Assessment Matrix (Lowland)**

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

**Figure A.1** illustrates that at the time of implementation of a drought order / permit, upland river systems of relevance to each of these proposed options will exhibit high sensitivity to changes in low flow (represented by Q<sub>95</sub>, summer<sup>4</sup>) and very high sensitivity to changes in extreme low flow (represented by Q<sub>99</sub>, 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<sub>95</sub>), but similarly sensitive to reductions in extreme summer low flows (summer Q<sub>99</sub>).

**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 (Q<sub>95</sub>) and year round median flow (Q<sub>50</sub>).

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

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

<sup>4</sup> Flow statistics indicate the proportion of days a flow is equalled or exceeded. Therefore Q<sub>95</sub> 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		
		<10%	10-25%	>25%
Year round Q50	<20%	Negligible	Minor	Moderate
	20-50%	Minor	Moderate	Major
	>50%	Moderate	Major	Major

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

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

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

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

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

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

### Intermittently flowing watercourse hydrological methodology

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

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

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

### Reservoir hydrological methodology

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

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

**Figure A.6 Hydrological Assessment Matrix (Reservoir Impacts)**

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

Additional Considerations

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

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



# **APPENDIX B HYDROLOGY AND PHYSICAL ENVIRONMENT ASSESSMENT**

## **B1 INTRODUCTION**

This appendix assesses the potential impacts on the physical environment of the Llyn Aled and Aled Isaf Reservoirs and the Afon Aled 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 a compensation release from Aled Isaf of 2.27Ml/d (daily average) and seasonal (July to October) fisheries releases of between 2.0 to 3.8Ml/d, as per existing arrangements. The baseline also includes the continuation of daily abstraction at Bryn Aled intake on Afon Aled for potable supply. The assessed drought permit assumes the continuation of Welsh Water’s abstraction at a maximum daily rate of 27.3Ml/d and Aled Isaf compensation release flow of 2.27Ml/d (daily average), with a daily pumped transfer of 19.5Ml/d from Aled Isaf Reservoir to Llyn Aled Reservoir during the winter refill period. Seasonal fisheries releases are assumed to continue unchanged during the relevant months.

### **B.1.1 WELSH WATER’S EXISTING OPERATIONS**

Welsh Water abstract water from the Afon Aled at Bryn Aled intake to pump to Plas Uchaf Reservoir. From Plas Uchaf Reservoir water gravitates to Glascoed Water Treatment Works, which supplies the Clwyd Coastal water resources zone (average demand 19.8Ml/d in 2012/13). The Afon Aled abstraction licence (number 24/66/5/7, variation no. 1) includes the following conditions:

- 4,318 million litres (Ml) authorised to be abstracted per annum
- Abstraction rate of 27.3Ml/d
- The low flow of the Afon Aled is regulated by controlled discharges from Aled Isaf impounding reservoir, supplemented from storage in Llyn Aled impounding reservoir as necessary. These controlled releases consist of the following:
  - A fixed statutory compensation water discharge of 2.27Ml/d at all times for the general benefit of riparian interests
  - Regulation releases to support the abstraction at Bryn Aled that include the following scenarios:
    - Controlled releases from Aled Isaf Reservoir to maintain a residual flow of 11.4Ml/d over the Bryn Aled weir downstream of the Bryn Aled intake (1 February – 31 May inclusively during intake operation)
    - Daily regulation releases from Aled Isaf Reservoir shall not be less than the daily abstraction rate at intake when flow at Bryn Aled weir is less than 29.5Ml/d (1 June to 31 January inclusively)

- Fisheries management and angling releases.

The abstraction of water is taken from the Afon Aled at the Bryn Aled intake and pumped to Plas Uchaf impounding reservoir. Water from Plas Uchaf reservoir is abstracted and treated at Glascoed water treatment works (WTW) for public supply. Abstraction at the Bryn Aled intake is typically continuous during the summer and autumn period. The abstraction rate is typically 9.2Ml/d, the capacity of the smaller of the two abstraction pumps. The bigger, variable speed pump is used for larger abstractions when required, up to 16Ml/d. In winter, abstractions are still required to support the potable supply but are made at a lower rate.

Compensation, regulation and freshet releases from Aled Isaf Reservoir are controlled through a series of manually operated valves on the reservoir drawoff tower. These are measured prior to release to the Afon Aled.

Freshet releases are made from a bank of water reserved in the licence under the terms of the Section 20 Operating Agreement with NRW. Welsh Water control the basic fisheries release seasonally. Fisheries releases are specified by NRW but typically a flow of 3.8Ml/d is released continuously during the period 1 July to 15 September and a flow of 2.0Ml/d is released continuously during the period 16 September to 20 October. Outside these periods no freshet releases are made.

During the period 01 September to 25 January, a series of valves in the Aled Isaf Reservoir drawoff tower are kept open for flood mitigation. These releases are also made through the flow measurement structure. At high reservoir levels (above the spillway crest level) excess water spills from Aled Isaf Reservoir to the Afon Aled.

Llyn Aled Reservoir is located approximately 1km upstream of Aled Isaf Reservoir on the Afon Aled. Together, these two reservoirs provide a total live storage volume of 2,862Ml for controlling releases to the Afon Aled from Aled Isaf Reservoir. There are no licensed controls on the operation of Llyn Aled Reservoir. Water is released through a manually operated drawoff from Llyn Aled Reservoir and flows through an open channel (a channelised section of the Afon Aled) to Aled Isaf Reservoir.

Welsh Water also has two licences for the abstraction of water from local streams to supplement inflow to Llyn Aled Reservoir. These licences are not affected by this drought permit.

### **B.1.2 WELSH WATER'S PROPOSED DROUGHT PERMIT OPERATIONS**

Despite the two licensed stream capture systems, Llyn Aled Reservoir has limited catchment area and consequent poor refill characteristics. Water from Aled Isaf Reservoir could be pumped up to Llyn Aled Reservoir to support refill. Such usage is not authorised by the existing abstraction licence and a drought permit would be required. Daily pumping rates have not been specified at this stage and so the assessment is based on an assumed transfer rate of 19.5Ml/d.

The drought permit is most likely to be implemented during the period November to February, once the winter refill period has commenced. This option would continue until winter rainfall caused the total reservoir storage to improve significantly.

Implementation of the drought permit would require temporary pumps and pipework to be installed to allow transfer of water between the two reservoirs.

The assessment includes Llyn Aled Reservoir, Aled Isaf Reservoir itself and the Afon Aled from the reservoir outflow to its confluence with the Afon Elwy. The study area is shown on **Figure B1.1**.

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

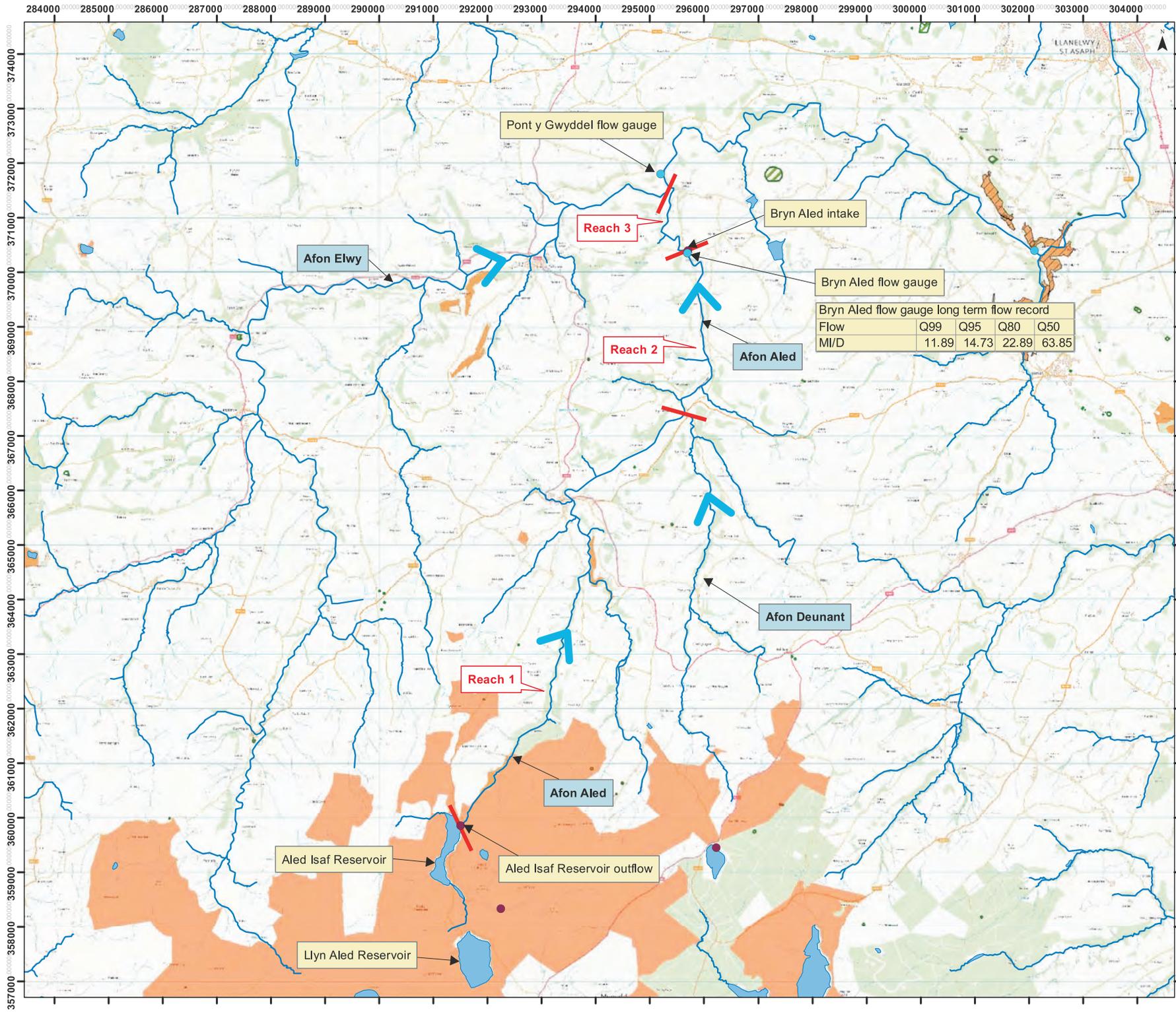
1. List the likely impacts (low, moderate or high) to the flow/level regime due to supply-side drought management actions as required by the DPG<sup>1</sup> and set out in Figure 5 of the DPG
2. Support the screening and assessment of sensitive features (including ecological features and designated sites) 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.

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

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<sup>1</sup> Welsh Ministers / Defra / NRW / Environment Agency (2011). Water Company Drought Plan Guideline. June 2011.



Pont y Gwyddel flow gauge

Reach 3

Bryn Aled intake

Afon Elwy

Bryn Aled flow gauge

Reach 2

Afon Aled

Bryn Aled flow gauge long term flow record				
Flow	Q99	Q95	Q80	Q50
MI/D	11.89	14.73	22.89	63.85

Reach 1

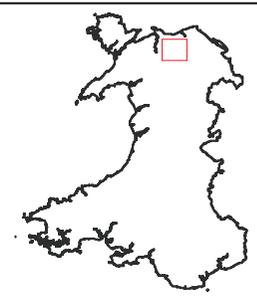
Afon Deunant

Afon Aled

Aled Isaf Reservoir

Aled Isaf Reservoir outflow

Llyn Aled Reservoir



**Legend**

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



1:65,000

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

Figure Title: **Study area: 8012-6 Transfer water from Aled Isaf Reservoir to Llyn Aled Reservoir**

Figure Number: **Figure B1.1**

Date: **February 2019**

## **B2 HYDROLOGICAL IMPACT**

### **B.2.1 Reference Conditions**

#### ***B.2.1.1 Catchment Overview***

##### *Llyn Aled and Aled Isaf Reservoirs*

The Llyn Aled and Aled Isaf Reservoirs are located in the county of Conwy, North Wales, to the south-west of the Clwyd Coastal water resources zone (8012) which includes Prestatyn and Rhyl. The reservoir system is fed by a 12km<sup>2</sup> headwater catchment, which ranges in altitude from 350m to 496m and is covered by moorland, heath and unimproved grassland. Llyn Aled Reservoir is the upper reservoir at an altitude of 373m and has a surface area of 45ha. Aled Isaf Reservoir is the lower reservoir, directly linked to Llyn Aled Reservoir by a 1km channelised section of the Afon Aled. Aled Isaf Reservoir is at an altitude of 366m and has a surface area of 26ha. The total usable storage volume of the two reservoirs is 2,862Ml, approximately 60% of this storage is in the Llyn Aled Reservoir (1726Ml) whilst the storage capacity of Aled Isaf Reservoir is 1136Ml. The presence of the two reservoir dams introduces discontinuity between the headwater catchment and the downstream river system.

##### *Afon Aled*

The Afon Aled is 14.7km long, stretching from the outlet at Aled Isaf Reservoir flowing north to the confluence with the Afon Elwy just upstream of the Pont-y-Gwyddel flow gauge, with a catchment area of 145km<sup>2</sup>, draining upland areas. The Afon Elwy continues downstream for 20 km, flowing into the Clwyd Estuary and Liverpool Bay at Rhyl.

#### ***B.2.1.2 Baseline Data Availability***

Continuous monitoring is undertaken by Welsh Water to monitor its operations in the Afon Aled catchment namely:

- Daily Llyn Aled Reservoir water level data 2001-present (in addition to some manual level readings for the period 1995-1996).
- Daily Aled Isaf Reservoir water level data 1989-present.
- Daily controlled outflow data from Aled Isaf Reservoir (compensation releases, regulation releases, freshet releases and flood mitigation releases combined) 1995-present.
- Daily abstraction data from Bryn Aled intake 1989-present.
- Bryn Aled flow gauge; daily river flow data 1990-present.

In addition, Natural Resources Wales (NRW) operate a high flow gauge for flood warning on the Afon Elwy, 300m downstream of the confluence with the Afon Aled:

- Pont Gwyddel flow gauge; daily river flow data 1973-present.

The reference conditions of Llyn Aled Reservoir, Aled Isaf Reservoir and the Afon Aled and Afon Elwy catchments are summarised below.

### B.2.1.3 Hydrology

#### Llyn Aled Reservoir

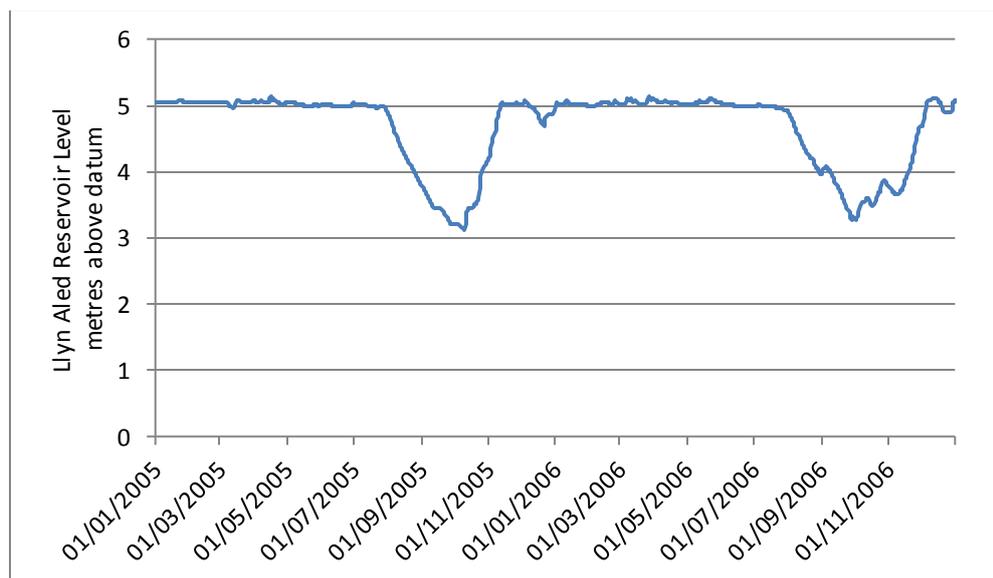
Typically reservoir levels range from about 3m to about 5m (data from 2001 – 2015) above datum in Llyn Aled, the upper of the two reservoirs in the catchment. The top water level is at 5m above datum and when the reservoir is at full capacity, any overflows pass down the channel linking the two reservoirs and form part of the inflow to Aled Isaf. A summary of reservoir levels is given in **Table B2.1** below. This data includes the manual readings from 1995-1996; the lowest level recorded in 1995 was 2.1m. The minimum levels recorded during the winter months of October to February inclusive are likely to be related to drawdowns carried out for reservoir safety reasons.

**Table B2.1 Summary of Recorded Mean, Maximum and Minimum Daily Reservoir Level in Llyn Aled Reservoir (January 1995 – December 1996 and February 2001 – December 2015)**

Percentage of time lake 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
Maximum reservoir level	5.2	5.2	5.1	5.3	5.2	5.2	5.2	5.1	5.2	5.1	5.2	5.1	5.3
10% (high level)	5.1	5.1	5.1	5.1	5.1	5.0	5.1	5.0	5.0	5.1	5.1	5.1	5.1
50%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.7	4.5	5.0	5.0	5.0
80%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.5	3.9	3.8	4.5	5.0	4.9
90%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.2	3.5	3.5	4.1	4.9	4.4
95%	5.0	5.0	5.0	5.0	4.9	5.0	5.0	4.0	3.3	3.2	3.8	4.7	4.0
99% (low level)	4.1	5.0	5.0	4.9	4.8	4.8	4.9	3.8	3.1	3.0	3.4	3.3	3.3
Minimum reservoir level	3.4	4.0	5.0	4.9	4.7	4.8	4.7	3.5	2.1	2.4	2.7	3.2	2.1

**Figure B2.1** illustrates the typical drawdown patterns in Llyn Aled over the period 2005–2006. The lowest levels (below 4.0m) are understood to be due to reservoir drawdown for dam maintenance works.

**Figure B2.1 Llyn Aled Reservoir Level (1 January 2005 to 31 December 2006)**



Aled Isaf Reservoir

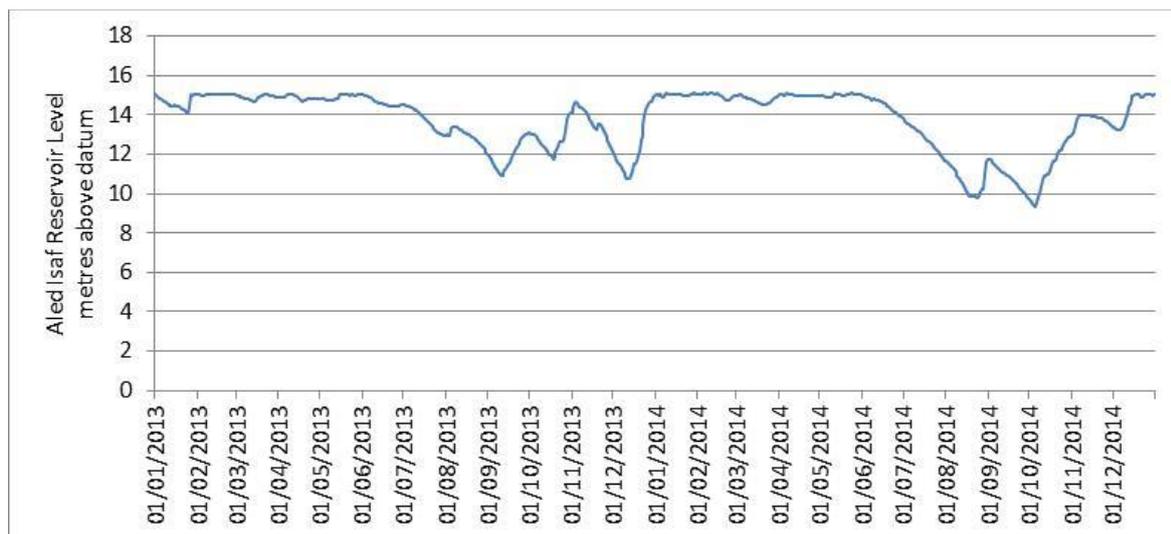
Top water level at Aled Isaf (at which overflow occurs) is at 15 m. Typically reservoir levels in Aled Isaf range from around 8 m up to 15 m, although in some drier years (for example 1993 due to dam maintenance works) levels have dropped to around 5 m or below (see also **Table B2.2**). Generally, transfers from Llyn Aled are undertaken to maintain levels in Aled Isaf above 8m; the minimum levels recorded in the months of July to December inclusive are related to drawdowns undertaken for reservoir safety reasons.

**Table B2.2 Summary of Recorded Mean, Maximum and Minimum Daily Reservoir Level in Aled Isaf Reservoir (January 1989 – November 2015)**

Percentage of time lake 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
Maximum reservoir level	15.2	15.2	15.2	15.1	15.1	15.2	15.1	15.1	15.2	15.1	15.2	15.1	15.2
10% (high level)	15.0	15.1	15.1	15.1	15.0	15.0	14.7	14.6	14.8	15.0	15.0	15.0	15.0
50%	14.9	15.0	15.0	15.0	15.0	14.3	12.9	11.5	11.1	12.5	14.0	14.8	14.7
80%	14.5	14.9	14.8	14.8	14.6	13.4	11.3	9.5	9.2	9.8	11.5	12.8	12.1
90%	13.3	14.6	14.7	14.3	14.1	12.9	10.3	8.4	8.8	9.0	9.3	11.5	10.1
95%	12.1	12.8	13.9	13.9	13.8	12.7	9.3	5.7	7.6	7.4	8.3	11.0	9.2
99% (low level)	11.4	11.4	13.1	12.6	12.1	12.0	6.5	3.9	6.6	6.8	7.6	10.1	6.8
Minimum reservoir level	10.5	11.2	12.3	12.4	11.8	10.9	2.0	2.0	5.1	6.4	6.5	7.5	2.0

**Figure B2.3** illustrates the typical drawdown patterns in Aled Isaf over the period 2013–2014.

**Figure B2.3 Aled Isaf Reservoir Level (1 January 2013 to 31 December 2014)**



Afon Aled

The Afon Aled is 14.7km long, stretching from the outlet at Aled Isaf Reservoir to the confluence with the Afon Elwy just upstream of the Pont-y-Gwyddel flow gauge, with a catchment area of 145km<sup>2</sup>, draining upland areas. Flow is measured at Bryn Aled, just downstream of Welsh Water’s abstraction intake. A summary of key flow statistics for this site is provided in **Table B2.3** and the flow duration curve is shown in **Figure B2.5**. A hydrograph of flows in a typical dry year (1996) is shown in **Figure B2.6**.

**Table B2.3 Summary of Recorded Mean, Maximum and Minimum Daily Flow in the Afon Aled at Bryn Aled gauging station (October 1990 – October 1999 and November 2000- November 2015)**

Percentage of time river flow equalled or exceeded	Mean daily flow Ml/d, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum flow	1313.5	1079.6	1099.5	896.0	494.3	1055.7	934.6	434.2	1075.8	997.5	1446.3	1173.3	1446.3
10% (high flow)	478.7	407.5	229.1	198.2	129.6	104.1	96.2	55.5	116.9	254.9	366.7	503.7	280.4
50%	170.0	104.7	76.6	59.9	39.3	26.2	20.4	22.9	29.1	66.1	129.6	168.0	62.9
80%	91.3	60.1	48.0	26.0	20.6	17.1	15.5	15.4	16.4	29.3	69.4	77.2	22.8
90%	61.0	44.6	34.2	19.2	15.9	14.6	13.3	13.8	14.5	20.8	57.3	63.8	16.6
95% (low flow)	40.2	34.0	27.8	16.1	13.2	13.0	11.7	13.0	12.9	15.9	46.2	56.5	14.4
99% (extreme low flow)	29.1	25.9	15.9	13.4	11.8	9.3	10.3	11.2	10.9	12.7	22.1	39.8	11.5
Minimum flow	25.6	15.8	13.0	12.4	9.7	8.4	8.5	8.5	7.9	11.0	16.6	16.7	7.9

The key flow statistics for the summer period (April – September inclusive) are: Q<sub>95</sub> = 13.1 Ml/d, and Q<sub>99</sub> = 10.5 Ml/d.

Figure B2.5 Flows in the Afon Aled at Bryn Aled Gauging Station (1990-2015)

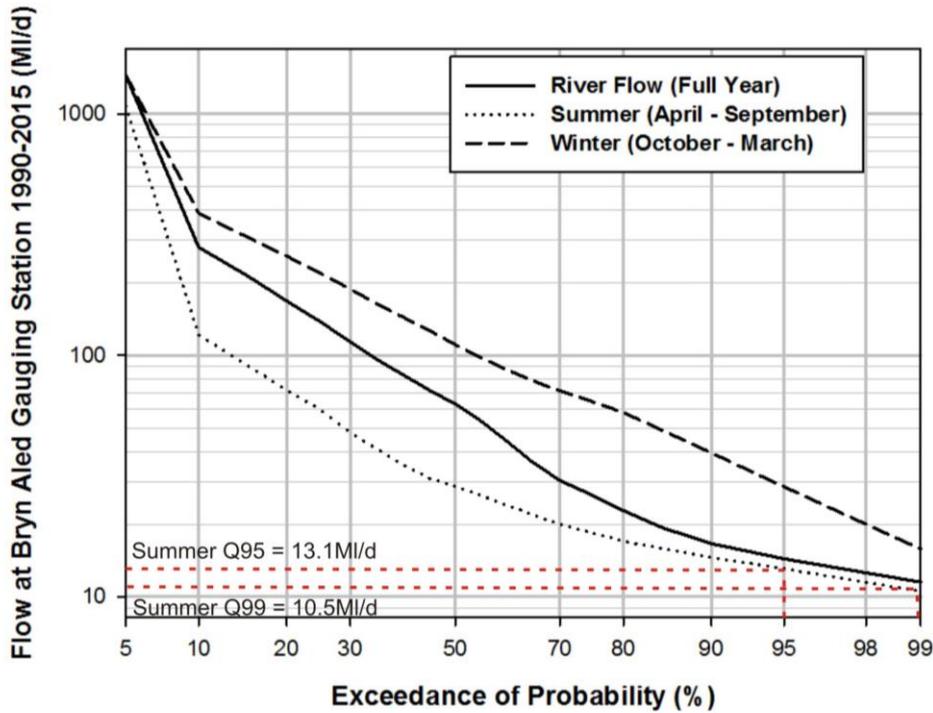
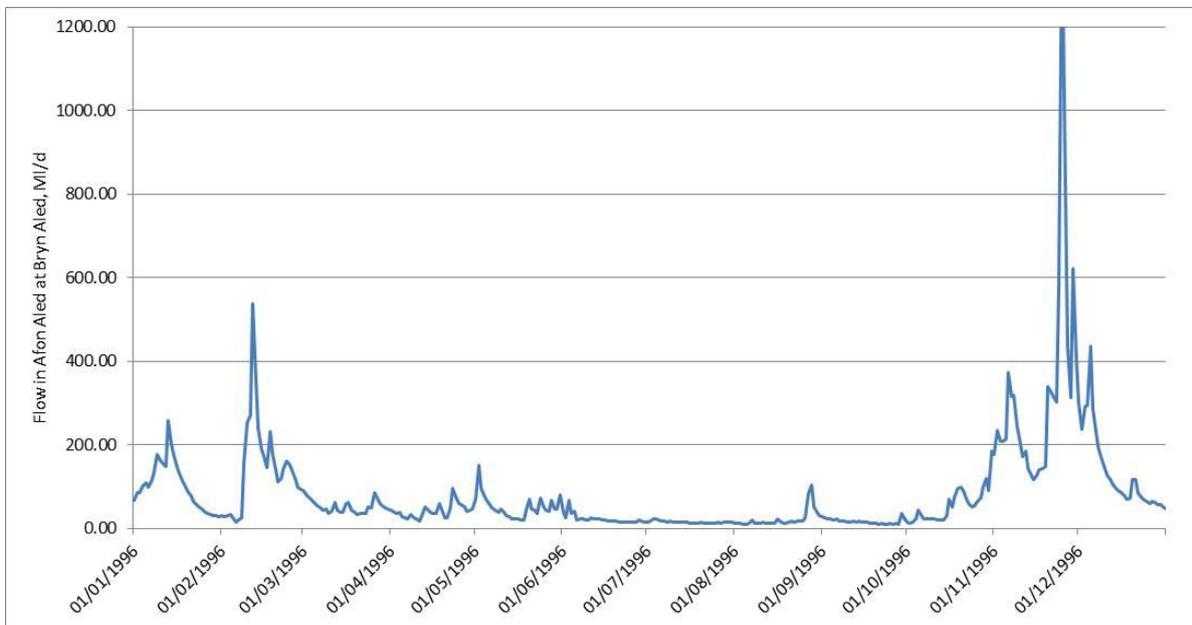


Figure B2.6 Afon Aled at Bryn Aled Gauging Station (1996)



Afon Elwy

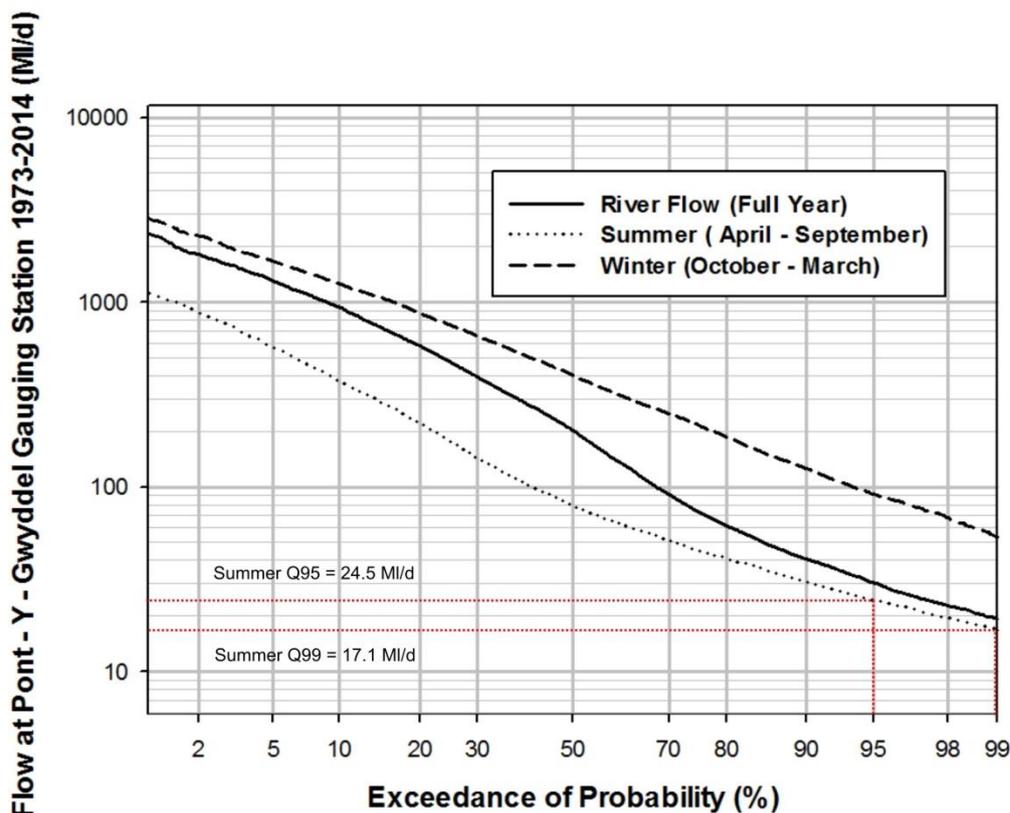
NRW continuously monitor river flow on the Afon Elwy at the Pont-y-Gwyddel flow gauging station which is 14.7km downstream of Aled Isaf Reservoir. The flow record extends from 1973 to the present. The Pont-y-Gwyddel gauging station is a velocity-area station with 1m wide Crump weir blocks set within a 10m wide archway to achieve low flow sensitivity. **Table**

B2.4 gives the key flow statistics for this location, and the flow duration curve is shown in Figure B2.7.

**Table B2.4 Summary of Recorded Mean, Maximum and Minimum Daily Flow in the Afon Elwy at Pont-y-Gwyddel gauging station (November 1973- December 2014)**

Percentage of time river flow equalled or exceeded	Mean daily flow MI/d, per month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
Maximum flow	5111.4	5978.9	3475.0	2980.8	1399.7	5106.2	3611.5	1958.7	4121.3	6404.0	8156.2	3881.1	8156.2
10% (high flow)	1508.5	1183.3	872.6	606.3	346.2	239.4	161.6	236.9	472.0	1008.3	1270.4	1499.6	937.4
50%	532.8	365.8	266.7	191.9	102.0	67.0	48.6	58.4	90.1	266.1	1471.9	552.8	202.5
80%	290.1	196.6	146.1	81.9	58.1	41.0	32.1	28.7	40.3	104.1	239.3	266.1	61.7
90%	204.9	145.8	111.0	60.4	46.0	33.4	26.8	23.1	26.8	72.1	162.4	197.3	40.7
95% (low flow)	129.9	114.2	90.1	51.0	40.2	27.2	23.1	18.7	22.3	53.4	119.2	153.9	30.4
99% (extreme low flow)	84.4	83.2	62.7	42.4	33.2	19.9	14.9	14.8	17.7	28.5	79.1	88.1	19.7
Minimum flow	67.8	63.4	45.4	28.9	29.9	14.9	8.3	7.4	10.6	17.4	57.2	75.8	7.4

**Figure B2.7 Flows in the Afon Elwy at Pont-y-Gwyddel Gauging Station (1973-2014)**



Contributing sub-catchment areas at key points in the Afon Aled and Afon Elwy catchments are shown in Table B2.5.

**Table B2.5 Afon Aled and Afon Elwy – Sub-catchment Areas**

Watercourse	Location	Grid Reference	Sub-catchment Area (km <sup>2</sup> )
Afon Aled	Immediately downstream of Aled Isaf Reservoir outflow	SH915599	11 km <sup>2</sup>
Afon Aled	Upstream of the Afon Aled – Afon Deunant confluence	SH956674	39 km <sup>2</sup>
Afon Deunant	Afon Deunant upstream of the Afon Aled – Afon Deunant confluence	SH957674	18 km <sup>2</sup>
Afon Aled	Bryn Aled flow gauge	SH958701	70 km <sup>2</sup>
Afon Aled	Lower Reach 2	SH954715	72 km <sup>2</sup>
Afon Elwy	Upstream of the Afon Elwy – Afon Aled confluence	SH953715	118 km <sup>2</sup>
Afon Elwy	Pont-y-Gwyddel Gauging Station	SH952717	194 km <sup>2</sup>

## 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 the Aled Isaf 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 a length of the Afon Aled and comprises three distinct hydrological reaches as identified on **Figure B1.1**:

- Reach 1 is the 10.1km stretch of the Afon Aled as it flows between Aled Isaf Reservoir and the confluence with Afon Deunant. The upper section of Reach 1 is a steep channel in an upland gorge. Typical river channel width in this section is 8.0m to 9.5m. After 4km, the gradient eases and the channel meanders through a modest floodplain on the floor of a steeply incised valley. Typical river channel width in this section is 11m to 15m. The dominant land cover in the catchment area of the lower reach is improved or semi-improved grassland with trees continuously lining the river bank. A notable feature of the lower reach is the bedrock water fall and bedrock steps that form an impassable barrier to fish travelling upstream.
- Reach 2 is the 3km stretch of the Afon Aled between the confluence with the Afon Deunant and the Bryn Aled intake.
- Reach 3 is the 1.6km stretch of the Afon Aled as it flows between the Bryn Aled intake and the confluence with the Afon Elwy. The short lower reach is the same channel form as Reach 2. Channel-forming high river flows are not influenced by the Bryn Aled intake. There is, however, a significant step-change in low river flows during times of abstraction at the Bryn Aled intake, particularly when supported by regulation releases from Aled Isaf Reservoir.

The Afon Aled flows into the Afon Elwy 1.6km downstream of the Bryn Aled intake. The Afon Elwy is a larger river system than the Afon Aled and any changes in the outflow regime from Aled Isaf Reservoir due to the operation of this drought permit are likely to be a low proportion

of winter flow downstream of the confluence. The impact of this drought permit downstream of the confluence with the Afon Elwy is therefore considered as negligible, and this watercourse has been excluded from further assessment.

During periods of low effective rainfall, the majority of flow in the Afon Aled is supported by controlled releases from Aled Isaf Reservoir. During such periods, flow accretion from the surrounding catchment is low and contribution from tributaries to the Afon Aled, including the Afon Deunant, is minor.

The potential hydrological impacts of the drought permit option have been assessed for each of the two reservoirs and three separately identified river reaches of the Afon Aled, as summarised in **Table B2.8** at the end of this section.

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

### ***B.2.2.2 Hydrological Impact Assessment***

#### Llyn Aled Reservoir

In this option, water will be transferred by pumping from Aled Isaf Reservoir to Llyn Aled Reservoir, so that Llyn Aled Reservoir will refill more quickly compared to the baseline, following a severe drawdown period. This would only be implemented once Aled Isaf itself has begun to refill, following a period of autumn rainfall events, probably from November to February inclusive.

In order to assess the potential impacts of this option, we have obtained daily time series of modelled catchment inflows for both Llyn Aled and Aled Isaf reservoirs, along with daily time series of modelled regulation, compensation and fisheries releases from Aled Isaf. These data series were provided by Welsh Water and relate to a baseline model run using their water resources model of the Aled catchment, covering the period 1<sup>st</sup> January 1920 to 31<sup>st</sup> December 2015. We have used these data series to prepare water balance spreadsheet models to calculate daily reservoir storage volumes and daily total outflow rates from Aled Isaf Reservoir to the Afon Aled, both for the baseline case and with the proposed drought option implemented in selected drought years. The spreadsheet models include the following key assumptions:

- Release rates through the flood valves are made during the period 1<sup>st</sup> September to 24<sup>th</sup> January inclusive each year. Release rates are variable depending on reservoir level but are assumed to be in the range 5Ml/d to 7.5Ml/d between levels of 10.5m to 13.5m, and 7.5Ml/d to 34Ml/d between levels of 13.5m and 15m (top water level). Note that these rates have been estimated based on inspection of a plot of reservoir release rates against reservoir levels; accurate flood release rates are not known.
- A daily transfer of 22Ml/d from Llyn Aled Reservoir to Aled Isaf Reservoir when the level in Aled Isaf Reservoir is between 8m and 10m (this is in line with normal operational practice).

- A pumped transfer from Aled Isaf Reservoir to Llyn Aled Reservoir of 19.5M/d is implemented on 1<sup>st</sup> November in selected drought years, and continues (subject to a minimum level of 10m in Aled Isaf Reservoir) until Llyn Aled Reservoir is full.
- The selected drought years are the two years in the inflow records with the lowest combined inflows during the months of November and December (1933 and 1976), along with 1995 which has the tenth lowest combined inflow total for November and December. (Other years with low inflows in the same period were excluded as Aled Isaf Reservoir had already filled by 1<sup>st</sup> November, and/or storage in Llyn Aled Reservoir was recovering well at that time).

Note that the catchment inflows used for this analysis are modelled rather than measured data. These have been estimated by transposing average daily flow from NRW’s modelled inflows for the nearby Alwen catchment.

**Table B2.6** summarises the minimum water levels and overall duration of reservoir drawdown in Llyn Aled Reservoir, for the selected drought years, both for the baseline model and the ‘with drought option’ scenario.

**Table B2.6 Modelled Impact on Llyn Aled Reservoir of Pumped Transfer**

Year	Baseline			With pumped transfer 19.5Ml/d				
	Minimum storage (Ml)	Minimum water level (mAOD)	Overall duration of period below top water level (days)	Minimum storage (Ml)	Minimum water level (mAOD)	Change in minimum water level from baseline (%)	Overall duration of period below top water level (days)	Change in duration of period below top water level from baseline (%)
1933	1182	3.79	200	1182	3.79	0%	82	-59%
1976	1024	3.42	173	1024	3.42	0%	102	-41%
1995	1322	4.11	139	1322	4.11	0%	82	-41%

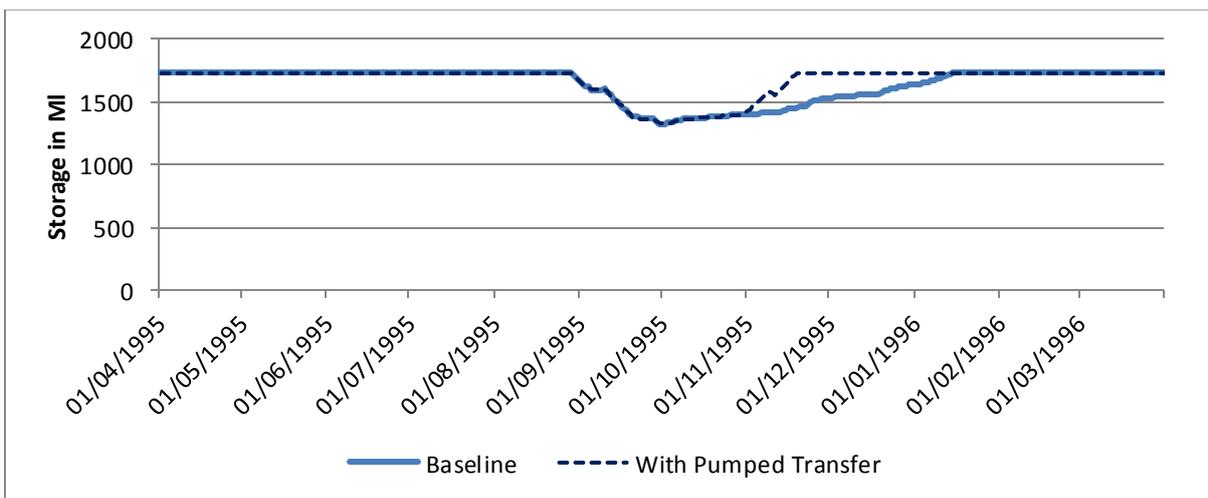
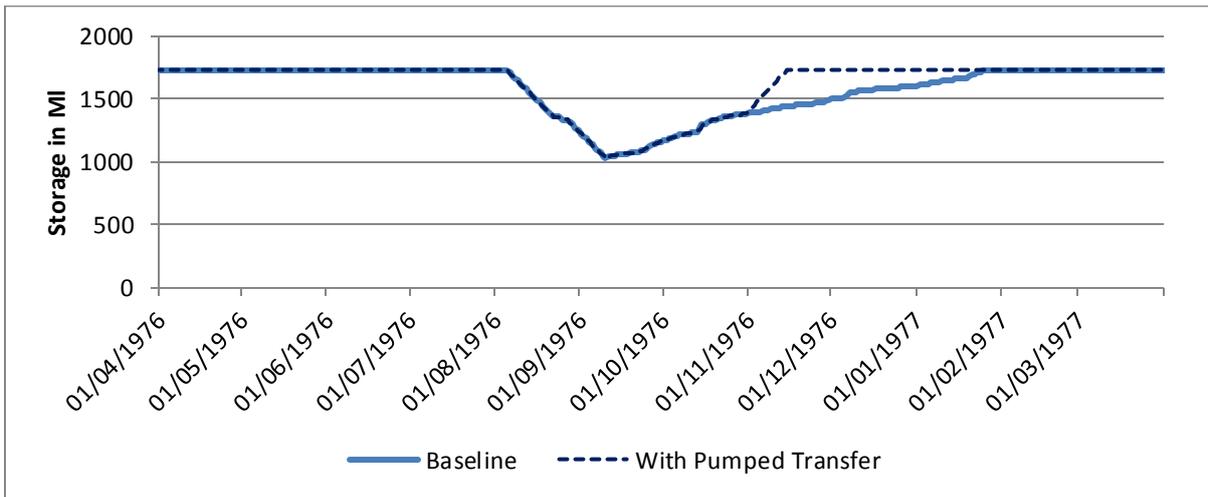
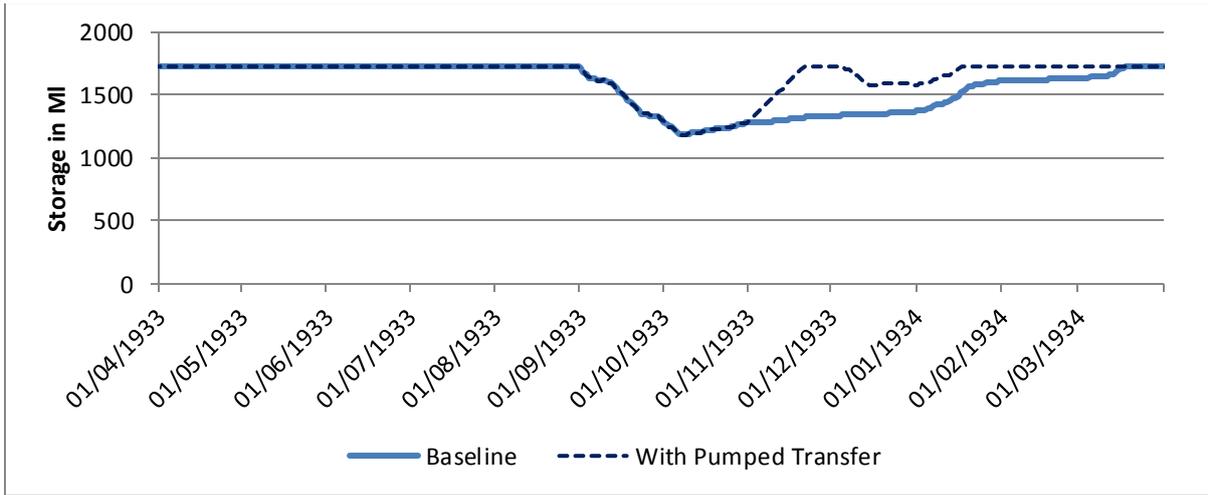
In the model output with the pumped transfer implemented on 1<sup>st</sup> November in the selected drought years of 1933, 1976 and 1995, the length of time that Llyn Aled Reservoir is below top water level is reduced by between 57 – 118 days (between 41% and 59% of the overall drawdown duration). This is a beneficial change in the overall duration for which the reservoir is below top water level during a severe drought. There is no change to the minimum water levels as a result of the drought permit. Therefore the hydrological impact of this drought option on Llyn Aled Reservoir is assessed as being **minor beneficial**.

The number of days for which the pumped transfer from Aled Isaf to Llyn Aled is estimated to take place is between 15 to 21 days, based on this model output.

**Figure B2.8** shows the modelled reservoir storage during each of the selected drought years, both for the baseline model run and the ‘with drought option’ scenario.

**Figure B2.8 Modelled Storage in Llyn Aled Reservoir – Baseline and with**

**pumped transfer drought option – 1933, 1976 and 1995**



### Aled Isaf Reservoir

In this option, water will be transferred by pumping from Aled Isaf Reservoir to Llyn Aled Reservoir, to refill Llyn Aled Reservoir following a prolonged drawdown period. This will only be implemented once Aled Isaf Reservoir itself has begun to refill, typically from November onwards. However, the length of time before storage in Aled Isaf Reservoir reaches top water levels could potentially be increased, and the minimum water levels decreased, due to the volume of water transferred to Llyn Aled Reservoir during the implementation of the drought permit.

The impact of the drought option on Aled Isaf Reservoir was assessed using the water balance models as outlined for Llyn Aled Reservoir above.

**Table B2.7** summarises the minimum water levels and overall duration of reservoir drawdown in Aled Isaf Reservoir, for the selected drought years, both for the baseline model and the ‘with drought option’ scenario.

**Table B2.7 Modelled Impact on Aled Isaf Reservoir of Pumped Transfer**

Year	Baseline			With pumped transfer 19.5 Ml/d				
	Minimum storage (Ml)	Minimum water level (m AOD)	Overall duration of period below top water level (days)	Minimum storage (Ml)	Minimum water level (m AOD)	Change in minimum water level from baseline (%)	Overall duration of period below top water level (days)	Change in duration of period below top water level from baseline (%)
1933	174	9.70	283	174	9.70	0%	283	0%
1976	188	9.88	234	188	9.88	0%	234	0%
1995	179	9.76	212	162	9.54	-2.3%	210	-0.4%

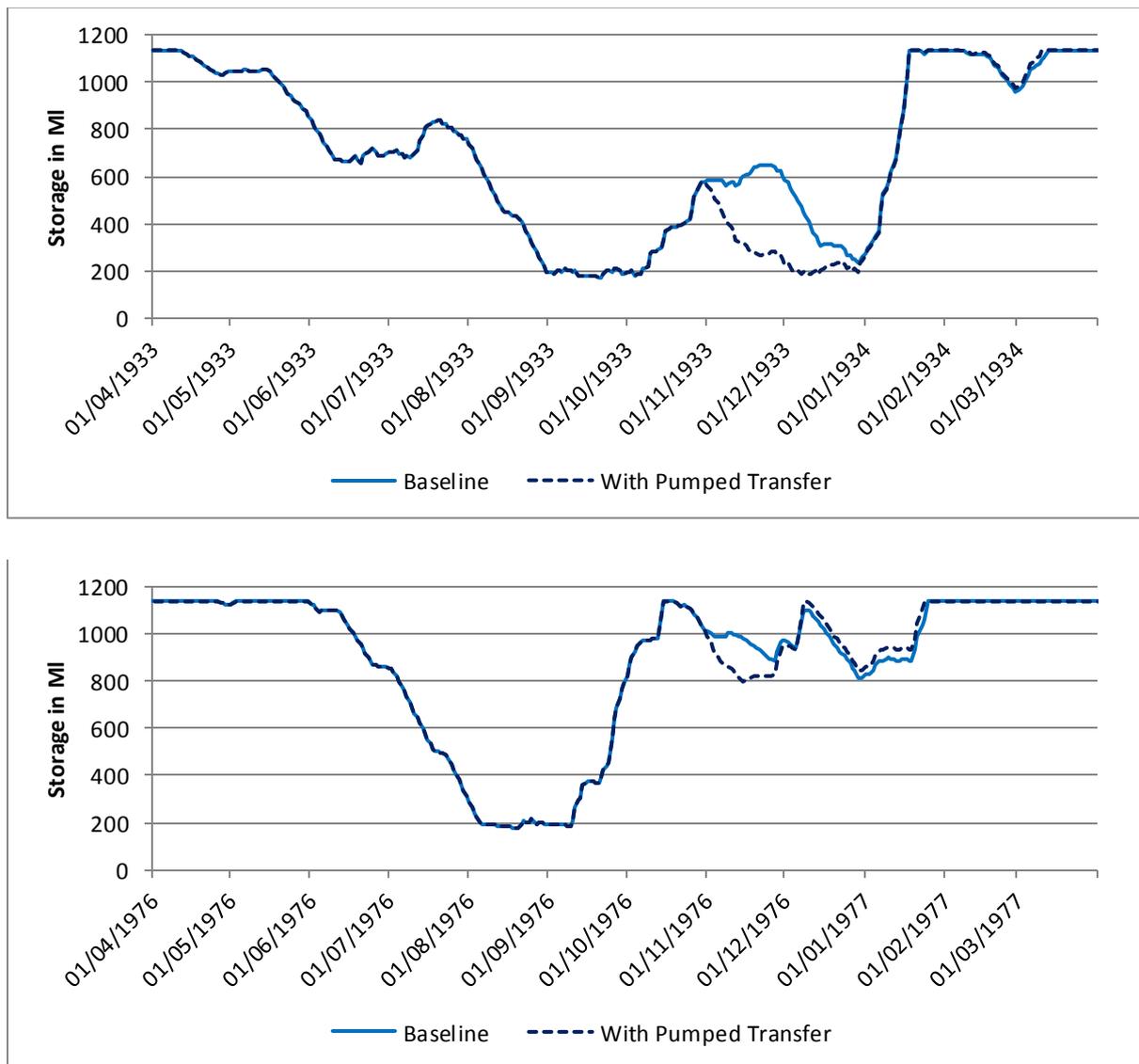
In the model output with the pumped transfer implemented on 1<sup>st</sup> November 1995, the length of time that Aled Isaf Reservoir is below top water level is reduced slightly by 2 days; this is likely to be due to some reduction in the daily flood release rates as levels are generally lower than in the baseline (and which marginally outweigh the volume of the pumped transfer to Llyn Aled Reservoir). However, in the model output for 1933 and 1976 the duration below top water level is unchanged as a result of the drought permit.

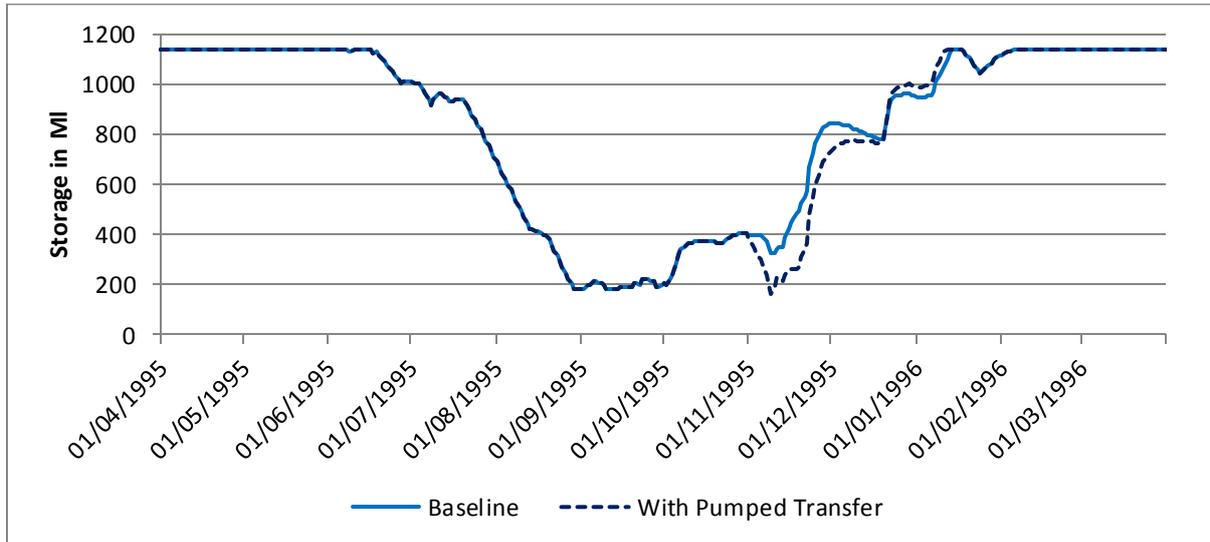
In 1995, the impact of the pumped transfer is a small reduction in minimum water levels in Aled Isaf Reservoir of 22cm (2.3%). However, in 1933 and 1976 there was no change in the minimum water levels as a result of the drought permit (as the minimum levels occurred prior to the implementation of the pumped transfer). Comparing the paired percentage change in both minimum water level and drawdown duration for each year against the hydrological assessment matrix for reservoirs in Appendix A, the impact would be assessed as **none** for 1933 and 1976, and **negligible** for 1995.

Therefore the hydrological impact of this drought option on Aled Isaf Reservoir is assessed overall as being **negligible**.

**Figure B2.9** shows the modelled reservoir storage during each of the selected drought years, both for the baseline model run and the ‘with drought option’ scenario. Note that in each of the drought years assessed, the storage in the drought option scenario is slightly higher than in the baseline scenario in the period following the pumped transfer; this is due to the impact of overflows from Llyn Aled Reservoir commencing earlier due to the faster refill from the pumped transfer.

**Figure B2.9 Modelled Storage in Aled Isaf Reservoir – Baseline and with pumped transfer drought option – 1933, 1976 and 1995**





### Reach 1 – Afon Aled (Aled Isaf Outflow to Afon Deunant confluence)

Under this option there are no proposed changes to the compensation release and regulation release regime from Aled Isaf Reservoir. However, as a result of the pumping from Aled Isaf Reservoir to Llyn Aled Reservoir, there are reductions in the modelled daily flood release rates from Aled Isaf Reservoir, due to lower water levels when compared to the baseline case.

From the baseline modelled data set, the year-round median value ( $Q_{50}$ ) of the reservoir outflow is 23.4Ml/d (1920-2015), however during the period that Aled Isaf is refilling after significant drawdown the outflow can be lower as the release rates through the flood valves depend on reservoir level. Inspection of the model output indicates that daily outflow rates are reduced by up to 12.2Ml/d due to the impact of the pumped transfer (although this reduction occurs in 1976 when the baseline total outflow is around 25Ml/d or above, representing a percentage reduction of less than 50%). On some occasions particularly during the dry November/December period of 1933 the outflow drops by up to 6.7Ml/d to the compensation rate of 2.27Ml/d only, as modelled reservoir levels have dropped below the level of the lowest flood release valve. This represents a reduction of about 75% in the total reservoir outflow on these occasions, however this only occurs for about 12 days in the model output. This effect is less severe in 1976 and 1995 as minimum storage is generally higher, although a reduction to compensation release only does occur for about 5 days in the 1995 modelled output. For consistency with the standard hydrological assessment matrices used to assess Welsh Water's drought options, we have also considered the maximum (12.2Ml/d) reduction against the modelled  $Q_{50}$  flow statistic of 23.4Ml/d but this still represents a 52% reduction. (The total outflow from Aled Isaf Reservoir in the baseline model is generally close to the  $Q_{50}$  flow statistic during the period of the pumped transfer implementation in 1976.) The year-round  $Q_{95}$  low flow statistic is determined by the statutory compensation release of 2.27Ml/d and therefore would not be reduced, as Welsh Water would continue to maintain this flow.

The hydrological impact of the drought order on Reach 1 has therefore been assessed as **moderate** for up to around 2 weeks during the period November to February, when reservoir flood releases are effectively reduced to zero due to reservoir storage dropping below the level of the lowest flood release valve with the drought permit in place. Further down the reach, however, significant flow accretion would be expected during the winter refill period during which this drought option would be implemented, and so the impact would be reduced.

#### Reach 2 – Afon Aled (Afon Deunant confluence to Bryn Aled intake)

The impact expected in Reach 2 is a decrease in flow of up to 12.2Ml/d for up to around 2 weeks, due to flow from Aled Isaf Reservoir at the top of Reach 1 being limited to compensation only as a result of the pumped transfer leading to lower reservoir levels, thus reducing the flow to Reach 2 during this period. At such times, however, there would naturally be considerable flow accretion in the downstream reach below the Afon Deunant confluence, so that the flow reduction would be relatively less than in Reach 1 during this period.

Based on flow apportionment by catchment area (see **Table B2.5**), flow in Reach 2 would be approximately 81% of the flow at Bryn Aled flow gauge, so that the median and low flow statistics would be estimated at around 50.9Ml/d (year-round  $Q_{50}$ ) and 11.7Ml/d (year-round  $Q_{95}$ ). A reduction of 12.2Ml/d in the  $Q_{50}$  flow in the Afon Aled to 38.7Ml/d would therefore represent a reduction of 24%. The  $Q_{95}$  flow value would not be reduced, as it consists of the compensation release of 2.27Ml/d plus an estimated 9.46Ml/d from flow accretion in Reach 1 and the Afon Deunant tributary.

The impact of the drought permit in Reach 2 has therefore been assessed as being **minor** for a period of up to around 2 weeks during the period November to February inclusive. The timing of the pumped transfer during the winter period when Aled Isaf Reservoir is refilling would indicate that flows are in fact likely to be higher than the  $Q_{50}$  value, however a precautionary principle has been applied to the assessment for Reach 2 in categorising the impacts consistently with the hydrological assessment matrix for winter / upland sites.

#### Reach 3 – Afon Aled (Bryn Aled intake to Afon Elwy confluence)

At  $Q_{50}$  flow conditions, a reduction in outflows of up to 12.2Ml/d from Aled Isaf Reservoir to compensation only would reduce flow at Bryn Aled to 51.6Ml/d, a reduction of about 19%. There would be no reduction in the year-round low flow value ( $Q_{95}$ ) at the downstream Bryn Aled flow gauge (compensation release of 2.27 plus estimated catchment flow accretion downstream of the reservoir of 12.14Ml/d would result in a similar flow value of 14.4Ml/d). The timing of the pumped transfer during the winter period when Aled Isaf is refilling would indicate that flows are in fact likely to be higher than the  $Q_{50}$  value, however a precautionary principle has again been applied and the hydrological impact on this reach has been assessed as being **minor** for up to about 2 weeks during the period November to February inclusive.

### B.2.2.3 Hydrological Impact Summary

The two Aled catchment reservoirs and three downstream river reaches have been considered. There is a **minor beneficial** impact of this drought permit on water levels in Llyn Aled, and a **negligible** negative impact on Aled Isaf Reservoir. The impact on the three river reaches has been assessed as **moderate** (Reach 1) and **minor** (Reaches 2 and 3). The three impacted reaches are shown in **Table B2.8** and establish the full in-channel zone of influence of the drought permit for environmental sensitivity screening (see **Figure B1.1**).

**Table B2.8 Hydrological Reaches Identified in the Study Area**

Hydrological Reach	Reach boundary		Reach length	% flow reduction		Hydrological Impact
	Upstream	Downstream		Year-round Q <sub>50</sub>	Year-round Q <sub>95</sub>	
Llyn Aled Reservoir	n/a	n/a	n/a	n/a	n/a	<b>Minor beneficial</b>
Aled Isaf Reservoir	n/a	n/a	n/a	n/a	n/a	<b>Negligible</b>
1 Afon Aled	Aled Isaf Reservoir Outflow	Afon Deunant confluence	10.1 km	52%	0%	<b>Moderate</b>
2 Afon Aled	Afon Deunant confluence	Bryn Aled intake	3.0 km	24%	0%	<b>Minor</b>
3 Afon Aled	Bryn Aled intake	Afon Elwy confluence	1.6 km	19%	0%	<b>Minor</b>

## **B3 PHYSICAL ENVIRONMENT ASSESSMENT**

### **B.3.1 Geomorphology**

Three River Habitat Survey (RHS) sites are present in Reaches 1 and 2 (sites 432, 3432 and 6432). The channel planform in Reach 1 (sites 432 and 6432) varies from irregular meanders to sinuous, and is formed in boulder clay and alluvium and underlain by early Silurian (Wenlock stage) lithology. The channel in Reach 2 is recorded as being straight (site 3432) and is formed in boulder clay and underlain by late Silurian (Ludlow stage) lithology. The channel substrate is predominantly cobble with some gravel/pebble, although gravel / pebble is dominant in some sections of middle Reach 1. Channel banks are composed of earth. Rippled flow is predominant throughout. Bankfull width increases down the reaches, and varies from 8m to 11m, while banktop height varies down the reach from 1.5m in upper Reach 1 to 1m in Reach 2.

Anthropogenic modification varies throughout Reaches 1 and 2, with Habitat Modification Scores (HMS) illustrating only slight modification. Site 432, in upper Reach 1 has an HMS of 70, due to poaching and the presence of a reinforced bank. Site 6432, in lower Reach 1, is pristine, with an HMS of 0. Reach 2 is the most modified reach with several reinforced banks, although HMS is still low at 90. Bankside tree cover is continuous in the upper Reach 1, decreasing down the reach to semi-continuous at the end of Reach 2.

### **B.3.2 Water Quality**

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

To support the assessment of potentially sensitive environmental features (see Section 5 of the main report), an understanding has been developed of the water quality of the rivers within the zone of influence of the drought permit, including trends over time and with respect to river flow. For WFD classification, the Environment Agency has set out<sup>2</sup> following UKTAG evidence<sup>3</sup> 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 permit implementation have been identified within the main macrophyte growing season

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

<sup>3</sup> 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

(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 Afon Aled within the extent of influence of the drought permit there are two NRW water quality sampling sites, two in Reach 1 (Aled Isaf Outflow to Afon Deunant confluence) and one in Reach 3 (Bryn Aled intake to Afon Elwy confluence) (**Table B3.1**). Data are available for these sites (2006 to 2015) and include measurements of a suite of parameters. No data is available for Reach 2 (Afon Deunant confluence to Bryn Aled intake).

Where data is lacking the assessment has been undertaken using professional judgement. Values at the limit of detection were halved in line with standard NRW practice.

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

Reach	Site Name	EA Site Code	Grid reference
1	Afon Aled downstream Llyn Aled Isaf	2666	SH9152059870
1	Afon Aled upstream of Afon Deunant	2682	SH9559067380
3	Afon Aled Pont Yr Aled	2688	SH9552070450

Reach 1 – Afon Aled (Aled Isaf Outflow to Afon Deunant confluence)

Water quality analysis for this reach (affected by a moderate hydrological impact) has been undertaken based on the data available at the water quality monitoring sites listed in **Table B3.1**.

pH and Temperature

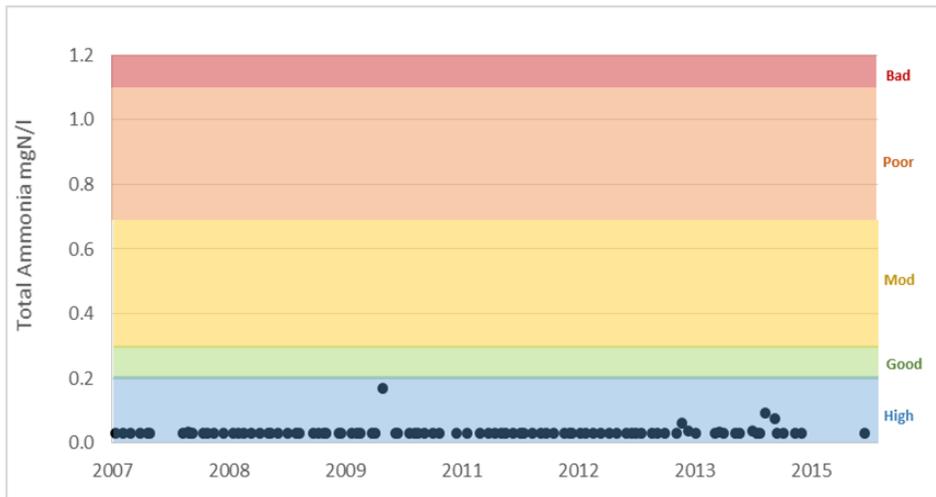
The average pH at Afon Aled D/S of Llyn Aled Isaf over the ten year review period was 7.5 and the maximum water temperature was 18.9°C. The average pH at Afon Aled U/S of confluence with Afon Deunant over the ten year review period was 7.6 and the maximum water temperature was 17.9°C.

Total Ammonia Concentration

Total ammonia concentrations on the Afon Aled D/S of Llyn Aled Isaf was reviewed and data presented in **Figure B3.1** against the relevant WFD standards for an upland low alkalinity river<sup>4</sup>.

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

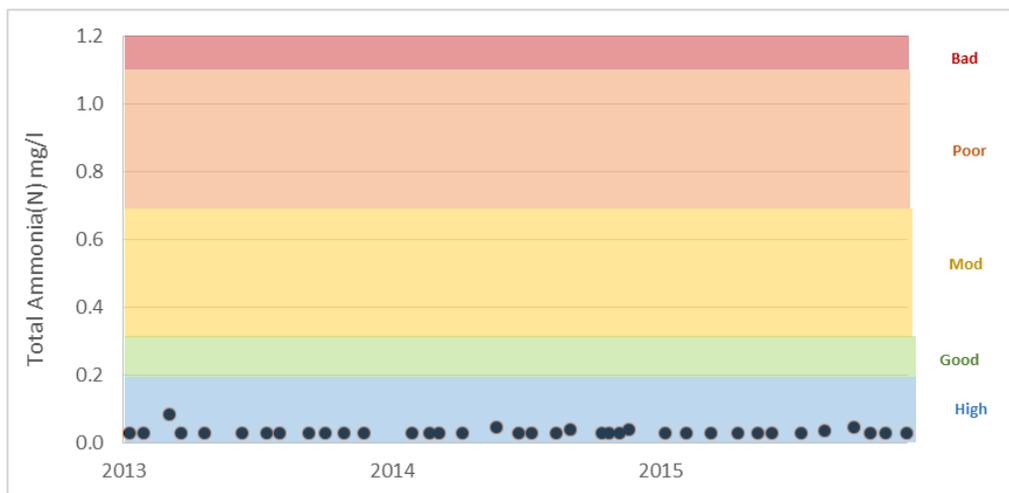
**Figure B3.1 Total Ammonia at Afon Aled D/S of Llyn Aled Isaf, Incorporating Appropriate WFD Status Bands**



Total ammonia concentrations on the Afon Aled D/S of Llyn Aled Isaf (see **Figure B3.2**) were all consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l).

Total ammonia concentrations on the Afon Aled U/S of confluence with Afon Deunant was reviewed and data presented in **Figure B3.2** against the relevant WFD standards for an upland low alkalinity river<sup>5</sup>.

**Figure B3.2 Total Ammonia at Afon Aled D/S of Llyn Aled Isaf, Incorporating Appropriate WFD Status Bands**



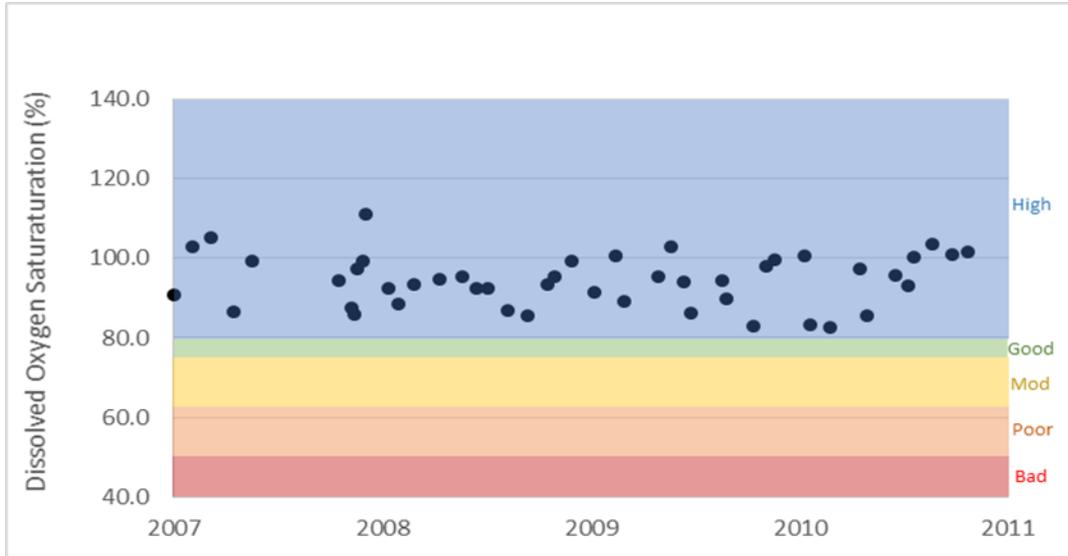
Total ammonia concentrations on the Afon Aled U/S of confluence with Afon Deunant (see **Figure B3.2**) were all consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l).

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

Dissolved Oxygen Saturation

Dissolved oxygen saturation at the Afon Aled D/S of Llyn Aled Isaf was reviewed and data are presented in **Figure B3.4** against the relevant WFD standards for an upland low alkalinity river<sup>6</sup>.

**Figure B3.3 Dissolved Oxygen Concentrations on the Afon Aled D/S of Llyn Aled Isaf, Incorporating Appropriate WFD Status Bands**



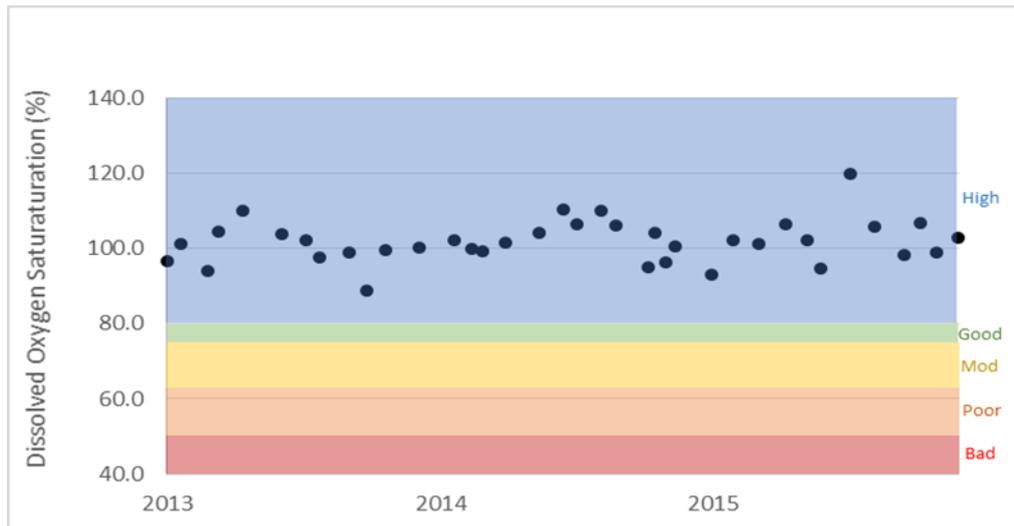
Dissolved oxygen saturation measurements at the Afon Aled D/S of Llyn Aled Isaf were all consistent with the WFD standard to support high status for fish and invertebrates (80%).

Dissolved oxygen saturation at the Afon Aled U/S of confluence with Afon Deunant was reviewed and data are presented in **Figure B3.3** against the relevant WFD standards for an upland low alkalinity river<sup>7</sup>.

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

<sup>7</sup> The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9.

**Figure B3.3 Dissolved Oxygen Concentrations on the Afon Aled U/S of Confluence with Afon Deunant, Incorporating Appropriate WFD Status Bands**



Dissolved oxygen saturation measurements at the Afon Aled U/S of confluence with Afon Deunant (see **Figure B3.3**) were all consistent with the WFD standard to support high status for fish and invertebrates (80%).

Reach 2 – Afon Aled (Afon Deunant confluence to Bryn Aled intake)

No monitoring data is available for Reach 2 (affected by a minor hydrological impact)

Reach 3 – Afon Aled (Bryn Aled intake to Afon Elwy confluence)

Water quality analysis for this reach (affected by a minor hydrological impact) has been undertaken based on the data available at the water quality monitoring sites listed in **Table B3.1**.

pH and Temperature

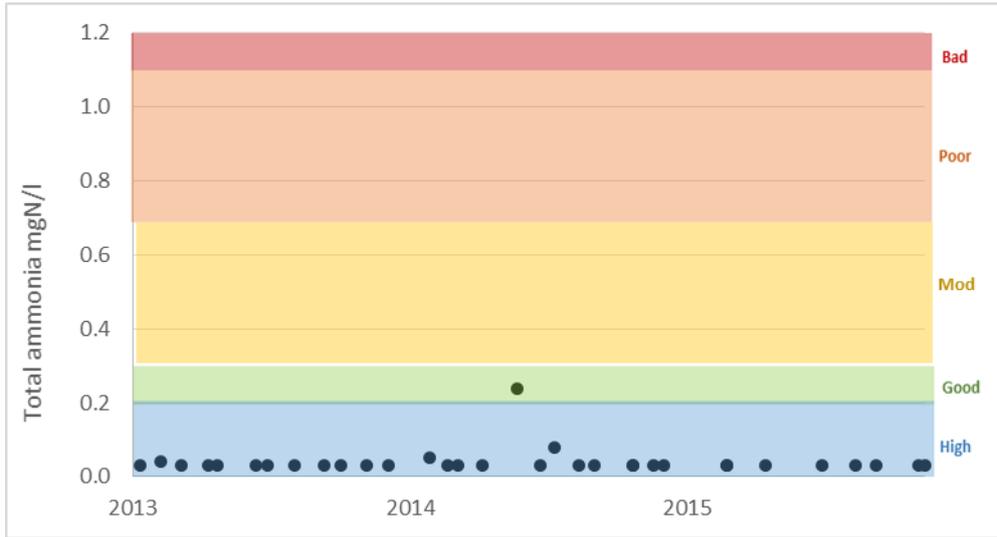
The average pH at Afon Aled at Pont Yr Aled over the ten year review period was 7.6 and the maximum water temperature was 16.9°C.

Total Ammonia Concentration

Total ammonia concentrations on the Afon Aled at Pont Yr Aled was reviewed and data presented in **Figure B3.4** against the relevant WFD standards for an upland low alkalinity river<sup>8</sup>.

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

**Figure B3.4 Total Ammonia at Afon Aled at Pont Yr Aled, Incorporating Appropriate WFD Status Bands**

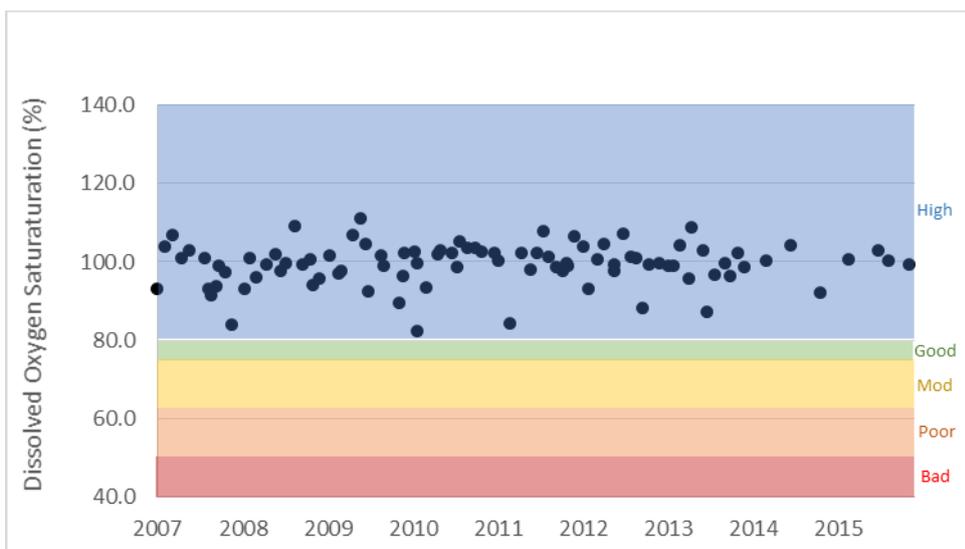


Total ammonia concentrations on the Afon Aled at Pont Yr Aled (see **Figure B3.4**) were all consistent with the WFD standard to support high status for fish and invertebrates (0.2mg/l).

Dissolved Oxygen Saturation

Dissolved oxygen saturation at the Afon Aled at Pont Yr Aled was reviewed and data are presented in **Figure B3.5** against the relevant WFD standards for an upland low alkalinity river<sup>9</sup>.

**Figure B3.5 Dissolved Oxygen Concentrations on the Afon Aled at Pont Yr Aled, Incorporating Appropriate WFD Status Bands**



Dissolved oxygen saturation measurements at the Afon Aled at Pont Yr Aled (see **Figure**

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

**B3.5)** were all consistent with the WFD standard to support high status for fish and invertebrates (80%).

### *Water Quality Summary*

Assessment of risk of water quality deterioration as a result of the Aled Isaf drought permit has been undertaken considering the water quality as well as the nature of the hydrological impact within Reaches 1-3. Dissolved oxygen saturations and total ammonia concentrations were indicative of a high water quality status at all sites in Reaches 1 and 3. Therefore, the risk of water quality deterioration linked to total ammonia and dissolved oxygen is assessed as **low** for Reach 1 and Reach 3 and **assumed low** for Reach 2.

## **B.3.3 Environmental Pressures**

### **B.3.3.1 Flow Pressures**

No significant abstractions other than the three Welsh Water abstractions are located within the zone of influence: 24/66/5/5/S which abstracts 6.8 Ml/day; 24/66/5/6/S which abstracts 25.9 Ml/day and 24/66/5/7 which abstracts 27.3 Ml/day.

### **B.3.3.2 Water Quality Pressures**

There is one sewage treatment works (STW) at Llansannan Sewage Treatment Works discharging into the Afon Aled or tributaries (Table B3.3). Due to the size and location of this discharge it is considered of negligible risk.

**Table B3.2 Summary of Water Quality Pressures**

<b>Discharge Name</b>	<b>Permit Number</b>	<b>Flow: Daily total (Ml/day)</b>	<b>Flow: DWF (Ml/day)</b>	<b>BOD: 5 Day ATU (mg/l)</b>	<b>Ammoniacal Nitrogen as N (mg/l)</b>	<b>Suspended Solids at 105 C (mg/l)</b>	<b>Water Quality Pressure</b>
Llanddeusant Sewage Treatment Works	SH3494084620	0.144	0.048	Not specified	0	55	Negligible
Alaw Water Treatment Works, Llanerchymedd, Ynys Mon, Gwynedd	SH3744085380	2.5	0	0	0	0	Negligible
Alaw Water Treatment Works, Llanerchymedd, Ynys Mon, Gwynedd	SH3138082070	0.144	0.048	0	0	65	Negligible

## B4 PHYSICAL ENVIRONMENT IMPACT SUMMARY

Potential impacts on the physical environment associated with the drought permit to pump water from Aled Isaf to Llyn Aled are summarised in **Table B4.1**

**Table B4.1 Summary of Potential Changes to the Physical Environment of the Impacted Reaches from Implementation of the Aled Isaf / Llyn Aled Pumped Transfer Drought Permit**

<b>Llyn Aled Reservoir</b>	
Level of Llyn Aled Reservoir <i>Minor impacts (minor beneficial)</i>	<ul style="list-style-type: none"> <li>The hydrological impact of this option is assessed as being minor (beneficial).</li> </ul>
<b>Aled Isaf Reservoir</b>	
Level of Aled Isaf Reservoir <i>Negligible impacts during the period November to February inclusive</i>	<ul style="list-style-type: none"> <li>The hydrological impact of this option is assessed as being negligible due to a decrease in minimum water levels of up to 1.9%.</li> </ul>
<b>Afon Aled (Reach 1) – downstream of Aled Isaf Reservoir</b>	
Flows in the Afon Aled <i>Moderate impacts for up to about 2 weeks during the period November to February inclusive</i>	<ul style="list-style-type: none"> <li>The impact on Reach 1 has been assessed as moderate, with no reduction in year round Q<sub>95</sub> and a 51% reduction in year round Q<sub>50</sub>.</li> </ul>
Water quality in the Afon Aled <i>Low risk during the period November to February</i>	<ul style="list-style-type: none"> <li>Low risk of deterioration linked to dissolved oxygen and ammonia</li> </ul>
<b>Afon Aled (Reach 2) – downstream of Afon Deunant</b>	
Flows in the Afon Aled <i>Minor impacts for up to about 2 weeks during the period November to February inclusive</i>	<ul style="list-style-type: none"> <li>The impact on Reach 2 has been assessed as minor with a 0% reduction in year round Q<sub>95</sub> and a 23% reduction in year round Q<sub>50</sub>.</li> </ul>
Water quality in the Afon Aled <i>Low risk (assumed) during the period November to February</i>	<ul style="list-style-type: none"> <li>Low risk of deterioration linked to dissolved oxygen and ammonia</li> </ul>
<b>Afon Aled (Reach 3) – downstream of Bryn Aled</b>	
Flows in the Afon Aled <i>Minor impacts for up to about 2 weeks during the period November to February inclusive</i>	<ul style="list-style-type: none"> <li>The impact on Reach 3 has been assessed as minor with a 0% reduction in year round Q<sub>95</sub> and a 19% reduction in year round Q<sub>50</sub>.</li> </ul>
Water quality in the Afon Aled <i>Low risk during the period November to February</i>	<ul style="list-style-type: none"> <li>Low risk of deterioration linked to dissolved oxygen and ammonia</li> </ul>

## B5 CUMULATIVE IMPACTS

The focus of this EAR is the Aled Isaf 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 Aled Isaf-Llyn Aled Reservoir Drought Permit with other Drought Options**

Organisation	Potential In-combination Impacts	Further Consideration Required (Yes/No)
Welsh Water - other drought options in the Clwyd Coastal WRZ	<u>8012-2 (Reduced compensation from Aled Isaf Reservoir)</u> – This option would only be implemented in the winter once Aled Isaf Reservoir has refilled. No in-combination effects are anticipated as the two drought options would not be occurring at the same time.	No
	<u>8012-4 (Relax annual licences on Afon Aled and Plas Uchaf)</u> – The effects of this option are not likely to extend into the winter period when levels in Aled Isaf and Plas Uchaf reservoirs have recovered, and therefore no in-combination effects with option 8012-6 are anticipated.	No
	<u>8012-5 (Relax Llannerch boreholes annual licences)</u> – The effects of this option are not likely to extend into the winter period when levels in Aled Isaf Reservoir have recovered, and therefore no in-combination effects with option 8012-6 are anticipated.	No
Natural Resources Wales - Drought options in the Aled catchment	No previous drought order applications have been made in the North Wales region.	No



# **APPENDIX C**

## **ENVIRONMENTAL FEATURES**

### **ASSESSMENT METHODOLOGY**

## **A.1 ENVIRONMENTAL FEATURES ASSESSMENT METHODOLOGIES**

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

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

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

Assessment sheets are included for the following features:

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

## **FLOW PRESSURES**

### **Potential Effects**

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

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

### **Definition of Risk**

#### **Continuously flowing watercourses**

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

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

#### **Ephemeral watercourses**

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

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

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

**Data Requirements**

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

**Assessment Methodology and Uncertainty**

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

**Groundwater abstractions**

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

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

#### **Surface water abstractions – continuously flowing watercourses**

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

#### **Surface water abstractions – ephemeral watercourses**

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

#### **All abstractions**

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

## WATER QUALITY PRESSURES

### Potential Effects

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

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

### Definition of Risk

#### Continuously flowing watercourses

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

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

#### Ephemeral watercourses

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

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

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

**Data Requirements**

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

**Assessment Methodology and Uncertainty**

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

consent conditions (Dry Weather Flow, BOD, ammonia (N), total phosphorous)<sup>1</sup>.

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

**Continuously flowing watercourses**

- 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).
- 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).
- 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 <sup>a</sup>	< 0.2mgN/l	Minor	Moderate
	≥ 0.2mgN/l	Moderate	Major

<sup>a</sup> Standards are WFD high/good threshold for ammonia (N) of 0.2mg/l for upland low alkalinity rivers<sup>2</sup>.

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

<sup>b</sup> Standards are WFD high/good threshold for ammonia (N) of 0.3mg/l for lowland high alkalinity rivers<sup>3</sup>.

- 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 <sup>c</sup>	< 1mg/l	Minor	Minor
	1-3mg/l	Minor	Moderate
	≥ 3mg/l	Moderate	Major

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

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

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

<sup>1</sup> 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.

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

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

<sup>4</sup> 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<sup>5</sup>.

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 <sup>e</sup>	< 0.2mgN/l	Minor	Moderate
	≥ 0.2mgN/l	Moderate	Major

<sup>e</sup> 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<sup>6</sup>.

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

<sup>f</sup> 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<sup>8</sup>.

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

<sup>g</sup> 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<sup>9</sup>.

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).

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

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

<sup>7</sup> Note that “Lowland low alkalinity” is a category that only exists for SRP standards, and not for total ammonia or BOD.

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

<sup>9</sup> 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

<p><b>Potential Effects</b></p> <p>For WFD river waterbodies within the zone of influence of the drought option, where screening of the drought option has identified that the fish element of biological status is <i>High</i> or <i>Good</i>, the potential impact is to be investigated. This investigation is specific to the risk of deterioration below the <i>Good</i> status band to the <i>Moderate</i> status band, as advised by NRW / Environment Agency.</p>
<p><b>Definition of Impacts</b></p> <p>In order to define the potential WFD status impacts for fish in a readily understandable manner, a series of criteria have been defined. The assessment will use the following criteria, based on the potential severity of the drought option impacts during an ongoing drought.</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• Negligible: A negligible impact is one where the predicted impact will not result in a detectable change in the fish population.</li> </ul>
<p><b>Data Requirements</b></p> <p>Fish status baseline assessment requires data from standard NRW / Environment Agency monitoring programmes in the potentially impacted zone, and preferably in a control site outside of the zone of influence. Fish data should include species presence, abundance and density. Environmental supporting data should include habitat availability, hydrology (flow, velocity, wetted area (width and depth) as follows:</p> <ul style="list-style-type: none"> <li>• Relevant study area (as identified in the screening report)</li> <li>• 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</li> <li>• Meteorology (where flow data insufficient) from available NRW / Environment Agency rain gauges</li> <li>• Habitat data for the monitoring sites, which may include recent RHS or Habscore surveys</li> <li>• Routine NRW / Environment Agency water quality monitoring data (dissolved oxygen, BOD, ammonia, pH, hardness, water temperature, conductivity) representative of the study area.</li> </ul>

### 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

<p><b>Potential Effects</b></p> <p>For Water Framework Directive (WFD) river waterbodies within the zone of influence of the drought option, where screening of the drought option has identified that the aquatic macroinvertebrate component of ecological status is <i>High</i> or <i>Good</i>, the potential impact is to be investigated. This investigation is specific to the risk of deterioration below the <i>Good</i> status band to the <i>Moderate</i> status band.</p>
<p><b>Definition of Impacts</b></p> <p>In order to define the potential WFD status impacts for aquatic macroinvertebrates in a readily understandable manner, a series of criteria have been defined. The assessment will use the following criteria, based on the potential severity of the drought option impacts during an ongoing drought.</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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 +/- 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.</li> <li>• 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.</li> <li>• Negligible: A negligible impact is one where the predicted impact will not result in a detectable change in the macroinvertebrate community.</li> </ul>
<p><b>Data Requirements</b></p> <p>The baseline for macroinvertebrates will be established from existing data together with a comparison of species flow preference and taxon abundance. The analysis will provide an assessment of the community type and its sensitivity.</p> <p>Macroinvertebrate status baseline assessment requires data from standard NRW / Environment Agency monitoring programmes in the potentially impacted zone, and preferably in a control site outside of the zone of influence. Macroinvertebrate data should include the LIFE and BMWP scores, together with abundance and density data where available. Environmental supporting data should include habitat availability, hydrology (flow, velocity, wetted area (width and depth) and other environmental variables as follows:</p> <ul style="list-style-type: none"> <li>• Relevant study area (as identified by screening)</li> <li>• 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</li> <li>• Meteorology (where flow data insufficient) from available NRW / Environment Agency</li> </ul>

rain gauges

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

### **Assessment Methodology and Uncertainty**

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

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

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

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

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

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

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

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

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

**NOTABLE SPECIES, DESIGNATED SITES AND OTHER SENSITIVE FAUNA AND FLORA**

**Potential Effects**

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

**Definition of Impacts**

In order to define the potential impacts for sensitive ecological features in a readily understandable manner, a series of criteria have been defined. The significance of impacts upon the sensitive ecological feature will be identified following the Institute of Ecology and Environmental Management (CIEEM) Ecological Impact Assessment (EclA) guidance<sup>10</sup>. 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

<sup>10</sup> 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		
<b>Atlantic salmon <i>Salmo salar</i> and Brown/Sea trout <i>Salmo trutta</i></b>			
Spawning	<ul style="list-style-type: none"> <li>Clean and unconsolidated gravels typically in the transitional area between pools and riffles where the flow is accelerating and depth is decreasing</li> </ul>	-	Deposition of silt Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth
Nursery (fry and parr life stage)	<ul style="list-style-type: none"> <li>Shallow areas with a low water velocity and pebble substrate, often at the margins of riffles</li> </ul>	<ul style="list-style-type: none"> <li>Deep and/or high velocity habitats.</li> </ul>	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth Increased risk of entrainment into water intake Deterioration in water quality
Adults	Deep habitats that provide shelter including one or more of the following: <ul style="list-style-type: none"> <li>submerged structures</li> <li>undercut banks</li> <li>overhanging vegetation &lt; 50cm above the water surface</li> <li>water surface turbulence causing a broken surface</li> <li>Deep pools downstream of obstacles and sufficient water quantity through structures to enable passage across obstacles.</li> </ul>	<ul style="list-style-type: none"> <li>Open and shallow habitats, but will use these during migration to reach spawning gravels.</li> <li>Habitats upstream of significant obstructions.</li> </ul>	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
<b>Brook lamprey <i>Lampetra planeri</i></b>			
Spawning	<ul style="list-style-type: none"> <li>Clean, unconsolidated spawning gravels with suitable sheltering areas, usually located at the tail end of pools where flows are increasing.</li> </ul>	-	Deposition of silt Reduction in velocity, depth or wetted width resulting in exposure of river bed Increased water velocity and depth
Nursery	<ul style="list-style-type: none"> <li>Areas of sandy silt with slow water velocity, often in the margins of watercourses, above the estuary.</li> <li>Variation in depth between 2 cm and 30 cm (&gt;15cm is optimal) with a relatively high organic content.</li> </ul>	-	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

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

Habitat Preferences		Unfavourable Habitat	Potential Impacts	
Type/ Age Class	Description			
Nursery	<ul style="list-style-type: none"> <li>Shallow, stony riffles</li> </ul>		Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed	
			Increased water velocity and depth	
			Increased risk of entrainment into water intake	
			Deterioration in water quality	
Adult	<ul style="list-style-type: none"> <li>Sheltered sections created by woody debris, tree roots, leaf litter, macrophyte cover or larger stones.</li> </ul>		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	
<b>European eel, <i>Anguilla anguilla</i></b>				
Juvenile (< 30cm)	<ul style="list-style-type: none"> <li>Wetland habitats within 30km of tidal limit with high diversity and cover of vegetation, soft substrates and high productivity.</li> </ul>	<ul style="list-style-type: none"> <li>Low productivity watercourses with dominance of coarse substrates and low macrophyte cover and diversity.</li> <li>Habitats upstream of significant obstructions.</li> </ul>	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed	
			Increased water velocity and depth	
			Increased risk of entrainment into water intake	
			Deterioration in water quality	
Adult (> 30cm, female > 45cm)	<ul style="list-style-type: none"> <li>Deep, slow flowing watercourses and wetland habitats within 80km of tidal limit with high diversity and cover of vegetation, soft substrates and high productivity.</li> </ul>		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	
<b>Barbel <i>Barbus barbus</i></b>				
Spawning	<ul style="list-style-type: none"> <li>Run/glide flow</li> <li>Less than 50cm deep</li> <li>Velocities greater than 0.5m/s</li> <li>Substrate composed of clean and uncompacted gravel</li> </ul>	-	Deposition of silt	
			Reduction in velocity, depth or wetted width resulting in exposure of river bed	
			Increased water velocity and depth	
Nursery	<ul style="list-style-type: none"> <li>Marginal shallow bays set back from or within margins of main channel</li> <li>Depths between 1cm and 30cm</li> <li>No discernible to minimal flow</li> <li>Substrate composed of &gt; 30% gravel and sand with low silt content</li> <li>Lack of or very little riparian shading</li> </ul>			Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
				Increased water velocity and depth
				Increased risk of entrainment into water intake
			Deterioration in water quality	
Adults	<ul style="list-style-type: none"> <li>Commonly associated with stretches of clean gravel and macrophyte beds, showing a preference to relatively fast-flowing stretches in the middle reaches of larger rivers.</li> <li>The species also occupies deep water habitats at the foot of weirs,</li> </ul>		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
<b>Fine-lined pea mussel, <i>Pisidium tenuilineatum</i> and depressed river mussel <i>Pseudanodonta complanata</i></b>			
All life stages	<ul style="list-style-type: none"> <li>Fine sediments of lowland rivers and canals,</li> </ul>	<ul style="list-style-type: none"> <li>High velocity watercourses with coarse substrates.</li> </ul>	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed
<b>White-clawed crayfish <i>Austropotamobius pallipes</i></b>			
All life stages	<ul style="list-style-type: none"> <li>Slow-flowing sections of stony rivers</li> <li>Boulder riffles in chalk or clay streams</li> <li>Submerged tree roots</li> <li>Debris dams</li> <li>Crevices in old or damaged submerged brickwork, stonework, cracked concrete or rotten wooden structures</li> <li>Un-mortared stone revetting which protects banks from erosion</li> <li>Stands of submerged and emergent aquatic plants</li> <li>Old gravel workings and chalk pits</li> <li>Good water quality</li> </ul>	<ul style="list-style-type: none"> <li>Uniform clay channels</li> <li>Areas of deep or soft silt</li> <li>Dense filamentous algae</li> <li>Narrow fast-flowing channels</li> <li>Areas of sand and gravel, or bedrock, which are lacking in cobble or boulder (though they may feed in or commute through these areas)</li> <li>Pebble or cobble shingle regularly exposed by changing river levels</li> <li>Areas of armoured bed where the substrate is compacted by the river flow</li> <li>Acidic streams or ochreous drainage</li> <li>Poor water quality or salinity</li> </ul>	Reduction in velocity, depth and/or wetted width, possibly resulting in exposure of river bed Increased water velocity and depth Increased risk of entrainment into water intake Transfer of non-native species or disease Deterioration in water quality



# **APPENDIX D**

# **ENVIRONMENTAL FEATURES**

# **ASSESSMENT**

## D1 INTRODUCTION

This appendix presents information regarding the environmental features associated with the Llyn Aled drought permit. Baseline data and the impact assessments are presented for the environmental features that form part of the scope of the assessment (established by the screening exercise described in Section 3.2.2 of the EAR and results of which are summarised in Section 5.2). The features assessment presented in full below is summarised in Section 5.3 of the EAR.

Points of interest referred to throughout the text in Section 5 are indicated in **Figure D1.1**.

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

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

The ecological assessment has been undertaken recognising the Institute of Environmental Management and Assessment (IEMA)<sup>12</sup> and the Chartered Institute of Ecology and Environmental Management (CIEEM) study guidelines<sup>3</sup>. 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 river reaches for the Llyn Aled 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 Invasive Flora and Fauna
- Section D.5 Landscape and Recreation

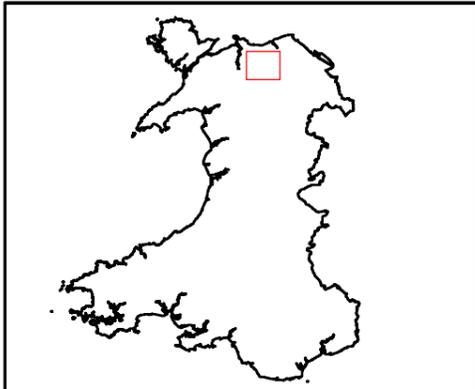
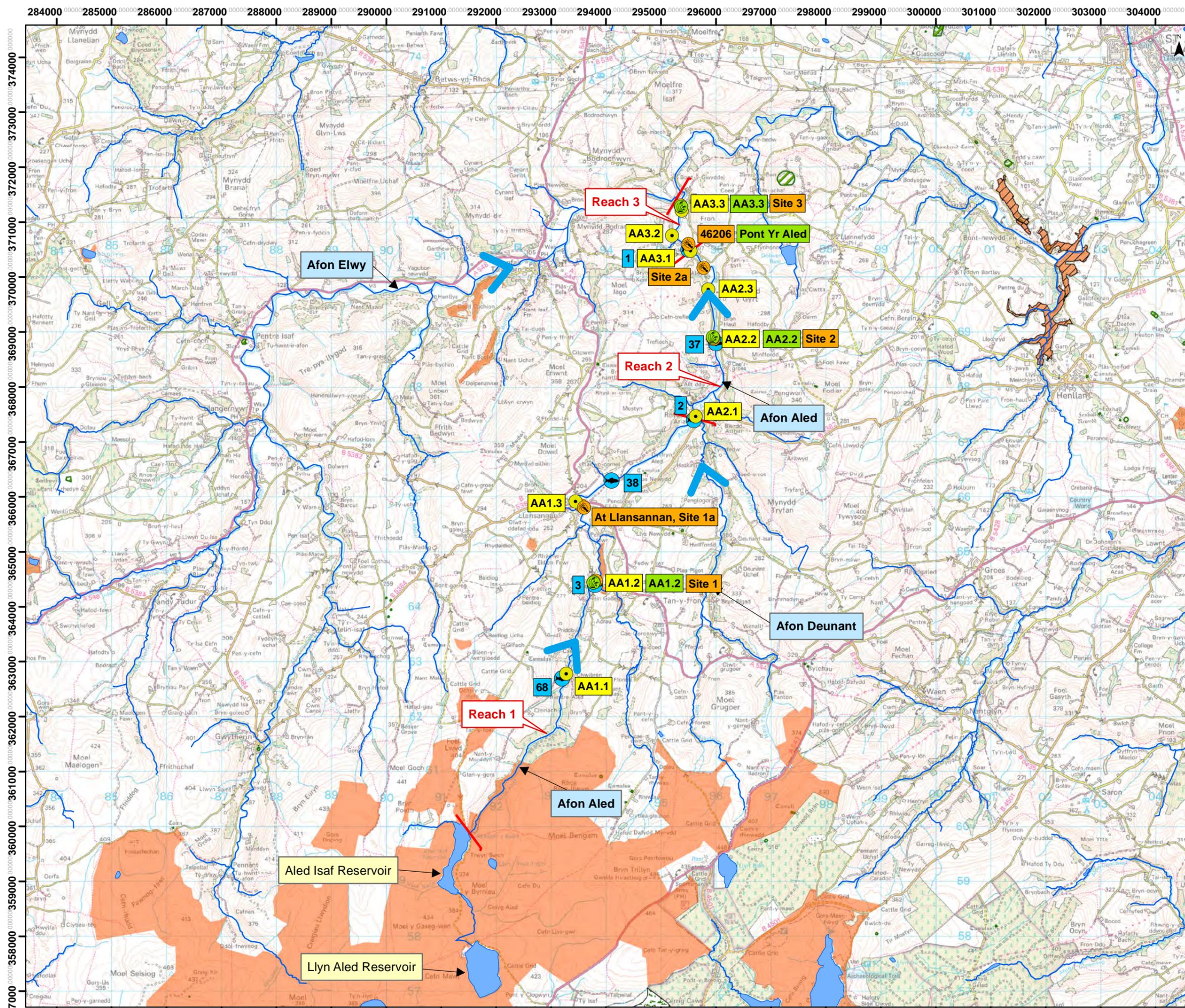
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<sup>1</sup> IEMA (2004) Guidelines for Environmental Impact Assessment.

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

<sup>3</sup> CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland.

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



1:65,000  
 Note: All locations are approximate  
 This drawing incorporates Ordnance Survey Information  
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Project Title: **Welsh Water Drought Plan  
 Environmental Assessment**

Figure Title: **Environmental Features: 8012-6  
 Transfer water from Aled Isaf Reservoir  
 to Llyn Aled Reservoir**

Figure Number: **Figure D1.1**      Date: **February 2019**

## D2 DESIGNATED SITES

### D.2.1 Coed Llys-Aled SSSI

#### D.2.1.1 Baseline

Designated due to high botanical importance. The woods represent one of the best examples in Clwyd of broadleaf woodland at medium altitudes and rainfall conditions. The woodland predominantly consists of sessile oak *Quercus petraea* with occasional rowan *Sorbus aucuparia*. The woodland close to the Afon Aled has a more varied tree canopy with sessile oak *Quercus petraea*, ash *Fraxinus excelsior*, in addition to wych elm *Ulmus glabra* and alder *Alnus glutinosa*.

#### D.2.1.2 Assessment

Upland oak woodland is considered to be highly water dependent however the habitat is typically dependent of rainfall and groundwater. The woodland habitats present in the Coed Llys-Aled SSSI are not dependent on the Afon Aled and are therefore not susceptible to impacts arising from the implementation of the Llyn Aled Drought permit; impacts to the designated features of the SSSI are assessed as negligible.

### D.2.2 Coed Nant-y-Merddyn-Uchaf SSSI

#### D.2.2.1 Baseline

The site is of interest for the semi-natural broadleaf woodland with a high proportion of sessile oak *Quercus petraea*. The woodland is dominated by a variety of broadleaved trees and shrubs including sessile oak *Quercus petraea*, downy birch *Betula pubescens*, ash *Fraxinus excelsior*, wych elm *Ulmus glabra* and hazel *Coryllus avellana*.

#### D.2.2.2 Assessment

Upland oak woodland is considered to be highly water dependent however the habitat is typically dependent of rainfall and groundwater. The woodland habitat present in the Coed Nant-y-Merddyn-Uchaf SSSI are not dependent on the Afon Aled and are therefore not susceptible to impacts arising from the implementation of the Llyn Aled Drought permit; impacts to the designated features of the SSSI are assessed as negligible.

### D.2.3 Mnydd Hiraethog SSSI

#### D.2.3.1 Baseline

Mnydd Hiraethog SSSI is one of the four remaining extensive tracts of sub-montane heather, *Calluna vulgaris* heath in the former county of Clwyd. The site is of interest for a number of key features:

- Dry Heath

- Blanket Bog
- Mixture of other associated heath and mire habitats
- Upland Breeding Bird assemblage
- Assemblage of Nationally Rare and Scarce bryophytes
- Assemblage of Nationally Rare and Scarce invertebrates

### D.2.3.2 Assessment

Blanket bogs, wet heath, and mire habitats are sensitive to changes in water level however these habitats are not considered to be in hydrological connectivity with the impacted reaches of the Afon Aled, Llyn Aled reservoir, or Aled Isaf reservoir. Therefore, these habitats will not be affected by implementation of the drought permit.

Features of the SSSI including dry heath, breeding bird assemblage, and invertebrate assemblage are not considered to be dependent on the Afon Aled or reservoirs and are therefore not susceptible to impacts arising from implementation of the drought permit and are consequently not considered further in this assessment.

The SSSI contains a number of rare bryophyte species including the slender green feather moss *Hamatocaulis vernicosus*. Slender green feather moss is designated under the Wildlife and Countryside Act 1981 (Schedule 8) and Habitats Directive Annex 2 - non-priority species. The notable bryophytes at the site are typically associated with base rich wet flushes and fens so are susceptible to changes in water level but are not dependent on the Afon Aled or reservoirs.

**Table D2.1 Summary of Impacts on SSSI Designated Sites and Species**

Feature	Impact	Significance of Impact
<b>Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence</b>		
Coed Llys-Aled SSSI	<ul style="list-style-type: none"> <li>• The features for which the site is designated are not dependant on the Afon Aled.</li> </ul>	<b>Negligible</b>
Coed Nant-y-Merddyn-Uchaf SSSI	<ul style="list-style-type: none"> <li>• The features for which the site is designated are not dependant on the Afon Aled.</li> </ul>	<b>Negligible</b>
Mynydd Hiraethog SSSI	<ul style="list-style-type: none"> <li>• No water dependant features are located within the zone of hydrological influence</li> </ul>	<b>Negligible</b>

## D3 WFD STATUS AND COMMUNITY ASSESSMENT / NOTABLE SPECIES

### D.3.1 Macrophytes

#### D.3.1.1 Baseline

No baseline macrophyte monitoring information was received from Natural Resources Wales (NRW) for Reach 1 in the Aled - above Deunant (GB110066054930) water body. Reaches 2 and 3 are located in the WFD Cycle 2 waterbody GB110066059770 (Aled - Elwy to Deunant). No recent baseline macrophyte data was provided for this waterbody, however data is available for a survey in 2002 by NRW for the site Pont Yr Aled, which is located in Reach 3, approximately 500m downstream of the Bryn Aled abstraction. Whilst no data is available for impacted Reaches 1 and 2, the macrophyte communities present are assumed to be similar to the community identified at the Pont Yr Aled and typical in upland rivers of this type.

Welsh Water commissioned APEM to undertake macrophyte monitoring in Reaches 1-3 (one location per reach)<sup>4</sup>. The sampling was completed in summer 2017. A total of three surveys were completed following UKTAG recommendations that all macrophyte samples are taken in the period June to September, inclusive.

Welsh Water also commissioned Ricardo Energy & Environment to undertake macrophyte monitoring in Reaches 1-3 (one location per reach)<sup>5</sup>. Sampling was completed in summer 2018 with a total of three surveys undertaken.

Considering the temporal constraints on the baseline information, which are not considered to be sufficient to characterise the whole watercourse, care must be taken in their interpretation. In particular, the age of some the data is of concern. In addition to the possible changes to environmental conditions and therefore macrophyte communities over time, the changes in macrophyte survey methods for the development of the LEAFPACS classification system (i.e. expanded recorded taxa list, particularly in relation to riverine bryophytes) in the intervening period mean that the data available may not represent as complete a record of the macrophyte community as would be gathered by current macrophyte monitoring protocols.

The description and assessment provided below is based on the assumption that the data available provides a relatively reliable representation of the likely communities present within the impacted reaches.

Macrophyte analysis results were provided by NRW, APEM and Ricardo Energy & Environment, using the standard LEAFPACS2 methodology<sup>6</sup> 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

<sup>4</sup> ApeM (2018) Dwr Cymru Welsh Water Drought Plan Monitoring 2017 to 2018: Aled Isaf and Llyn Aled, July 2018

<sup>5</sup> Ricardo (2018) Aled & Aled Isaf Drought Plan Environmental Monitoring Report, November 2018.

<sup>6</sup> WFD-UKTAG (2014) UKTAG river assessment method – macrophytes and phyto-benthos (River LEAFPACS2).

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

**Table D3.1 Macrophyte Biotic Indices Scores within the Hydrological Zone of Influence**

Site	Reach	Grid Reference	Year	RMNI	NTAXA	NFG
Pont Yr Aled	3	SH9550070600	2002	5.19	11	5.11
AA1.2	1	SH9377764443	2017	4.52	6	3.0
AA2.2	2	SH9593768931	2017	5.10	12	7.0
AA3.3	3	SH9536671387	2017	5.52	11	7.0
AA1.2	1	SH9377164440	2018	4.78	10	4.0
AA2.2	2	SH9594768909	2018	5.15	16	9.0
AA3.3	3	SH9536571281	2018	5.28	11	6

On average a total of 11 macrophytes were recorded across all sites within the impacted reaches (Table D3.1). The RMNI scores derived from this data describes macrophyte communities of moderate nutrient levels. The macrophyte communities are dominated by bryophytes including the presence of a number of nutrient tolerant species such as *Fontinalis antipyretica* and *Platyhypnidium ripariodes* which were recorded with cover values of 5-10% and 10%-25% respectively. Total cover of algae is an indication of acute nutrient releases, with high cover values coinciding with sudden increases in nutrient levels. In these surveys the algal community consists of *Lemanea fluviatilis*, and *Cladophora aegagropila* two species considered a normal part of the flora in oligo-mesotrophic upland streams and rivers, and not typical of algal blooms associated with high nutrient levels. These communities do not provide any evidence for acute nutrient increases at time of the surveys.

### D.3.1.2 Assessment

The assessment of impacts on the macrophyte community should be considered in the context of the watercourse under a baseline of drought conditions. Baseline data indicates that the macrophyte community in the hydrological zone of influence of the drought permit is bryophyte dominated and is likely to be adapted to moderate flow velocities (RMHI and MFR scores were not available). Reduction in flows could affect macrophyte communities in a

number of ways:

- Reduction in velocity favouring species adapted to slower flow conditions.
- Decreased wetted width and / or depth resulting in desiccation of marginal macrophytes.

Due to the timing of implementation of the drought permit in November to February there will be minimal changes to community composition as it is outside of the macrophyte growing season. Therefore there will be no changes to growth rates due to water quality changes or temperature and no impacts relating to proliferation of filamentous algae.

Riverine bryophytes (i.e. the species comprising the macrophyte communities recorded in the impacted reaches) are generally well adapted to tolerate desiccation and rewetting and communities can take a long time to react to changes in environmental conditions<sup>7</sup>. Considering the short implementation period of the drought permit, hydrological impacts are unlikely to be significant enough to alter the composition/condition of the bryophyte component of the macrophyte community.

Following implementation of the drought permit the flows in Reach 1 are anticipated to be at compensation flow for up to an additional 99 days. Given this period will not coincide with the peak growing season this is not anticipated to result in significant impacts on the macrophyte community.

Therefore, considering the limited sensitivity of the communities present within the reach and the and the limited duration of hydrological and water quality impacts, the impact of the drought permit on macrophytes communities in Reach 1 is expected to be **negligible**, short term, and reversible. Impacts in Reaches 2 and 3 will be similar to Reach 1 but with a lower magnitude, therefore, impacts are expected to be **negligible**.

### Summary

The potential impacts of the Llyn Aled drought permit on the macrophyte community are summarised in **Table D3.2**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Section 4.3 of the main report) and the sensitivities of the macrophyte community. The impacts presented in **Table D3.2** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

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

**Table D3.2 Summary of Impacts on Macrophyte Community**

Feature	Impact	Significance of Impact
<b>Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence</b>		
Macrophytes	<ul style="list-style-type: none"> <li>Decreased wetted width and / or depth resulting in desiccation of marginal macrophytes</li> <li>Decrease in flow affecting macrophyte community composition</li> </ul>	<b>Negligible</b>
<b>Reach 2 – Afon Aled, Afon Deunant confluence to Bryn Aled intake</b>		
Macrophytes	<ul style="list-style-type: none"> <li>Decreased wetted width and / or depth resulting in desiccation of marginal macrophytes</li> <li>Decrease in flow affecting macrophyte community composition</li> </ul>	<b>Negligible</b>
<b>Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence</b>		
Macrophytes	<ul style="list-style-type: none"> <li>Decreased wetted width and / or depth resulting in desiccation of marginal macrophytes</li> <li>Decrease in flow affecting macrophyte community composition</li> </ul>	<b>Negligible</b>

There is a risk of short-term deterioration in status of the macrophyte component of the Aled - above Deunant (GB110066054930) and Aled - Elwy to Deunant (GB110066059770). Impacts of drought permit implementation on the macrophyte communities of the impacted reaches have been summarised as negligible (uncertain). Consequently, the macrophyte component of these waterbodies is considered to be at **negligible** risk of short-term deterioration.

## D.3.2 Macroinvertebrates

### D.3.2.1 Baseline

No recent baseline macroinvertebrate monitoring information (within the last 10 years) was received from Natural Resources Wales (NRW) for Reach 1 in the Aled - above Deunant (GB110066054930) water body. Reaches 2 and 3 are located in the WFD waterbody GB110066059770 (Aled - Elwy to Deunant). Baseline macroinvertebrate data has been provided for this waterbody by NRW which consists of macroinvertebrate data collected from one site, Pont Yr Aled (Site number: 46206), which is located approximately 500m downstream of the Aled Isaf abstraction. Whilst no data is available for Reaches 1 and 2 it is assumed to be similar to the community identified at the Pont Yr Aled sampling site.

Welsh Water commissioned APEM to undertake macroinvertebrate sampling in reaches 1-3 (two sites per reach)<sup>8</sup>. The sampling was completed in spring, summer and autumn (three occasions) of 2017. A total of 18 samples were collected across the three reaches and the three seasons.

Welsh Water commissioned Ricardo Energy & Environment to undertake macroinvertebrate sampling in reaches 1-3 (two sites per reach)<sup>9</sup>. Sampling was completed in summer 2018 and a total of five out of six samples were collected across the three reaches. The sixth sample was unobtainable within reach 3 due to access constraints at the time of sampling. Sampling was conducted by following the standard NRW protocol involving a three minute kick / sweep sample encompassing all the available instream habitats in proportion to their occurrence. For data collected prior to 2012 macroinvertebrates were identified to family level, from 2012 onwards macroinvertebrate were identified to species or mixed taxon level. These datasets were used to calculate a series of standard biotic indices: Biological Monitoring Working Party (BMWP) scores; Average Score Per Taxon (ASPT) scores; Lotic Invertebrate Flow Evaluation (LIFE); and number of taxa (NTAXA).

LIFE scores are used to assess how sensitive a macroinvertebrate community is to change in flow. Family LIFE scores are provided for all available data. See **Table D3.3** for interpretation of scores.

BMWP is primarily used to monitor the impact of organic water quality but also responds to other pressures such as habitat reduction, siltation and toxic pollutants. High BMWPs are associated with good water and habitat quality. Comparisons between sites with BMWP scores must be used with caution as change to river type can have considerable influence over BMWP score. ASPT is derived from BMWP and provides the average BMWP sensitivity score of all the taxa found in the sample's macroinvertebrate assemblage. This index provides a more reliable means of comparing macroinvertebrate community quality between sites whilst also reducing the influence of sampling artefacts such as variable sampling effort. As such ASPT is

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<sup>8</sup> ApeM (2018) Dwr Cymru Welsh Water Drought Plan Monitoring 2017 to 2018: Aled Isaf and Llyn Aled, July 2018

<sup>9</sup> Ricardo (2018) Aled & Aled Isaf Drought Plan Environmental Monitoring Report, November 2018.

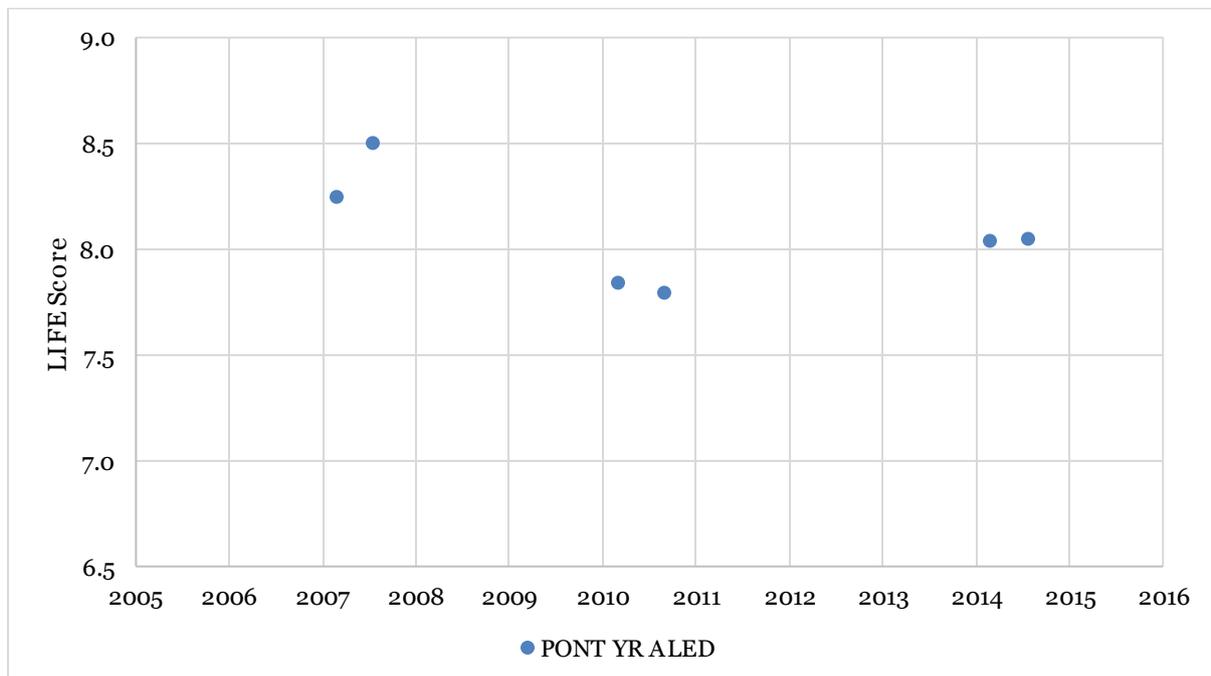
used as the primary means of assessing macroinvertebrate response to water quality in this assessment. As a guide ASPT scores above 5 represent macroinvertebrate communities living in good water quality. Scores below 5 indicate water quality stress on the macroinvertebrate community.

**Table D3.3: Interpretation of Macroinvertebrate Community LIFE Scores**

LIFE score	Invertebrate community flow sensitivity
7.26 and above	High sensitivity to reduced flows
6.51 – 7.25	Moderately sensitive to reduced flows
6.5 and below	Low sensitivity to reduce flows

LIFE scores obtained from the site Pont Yr Aled are displayed in **Figure D3.1**. The scores range from 7.8 to 8.5 across the monitoring period. This describes a macroinvertebrate community which is highly sensitive to reduced flows and therefore is consistent with that found in fast flowing water.

**Figure D3.1 Observed Family LIFE scores within Reach 3 of the Afon Aled**

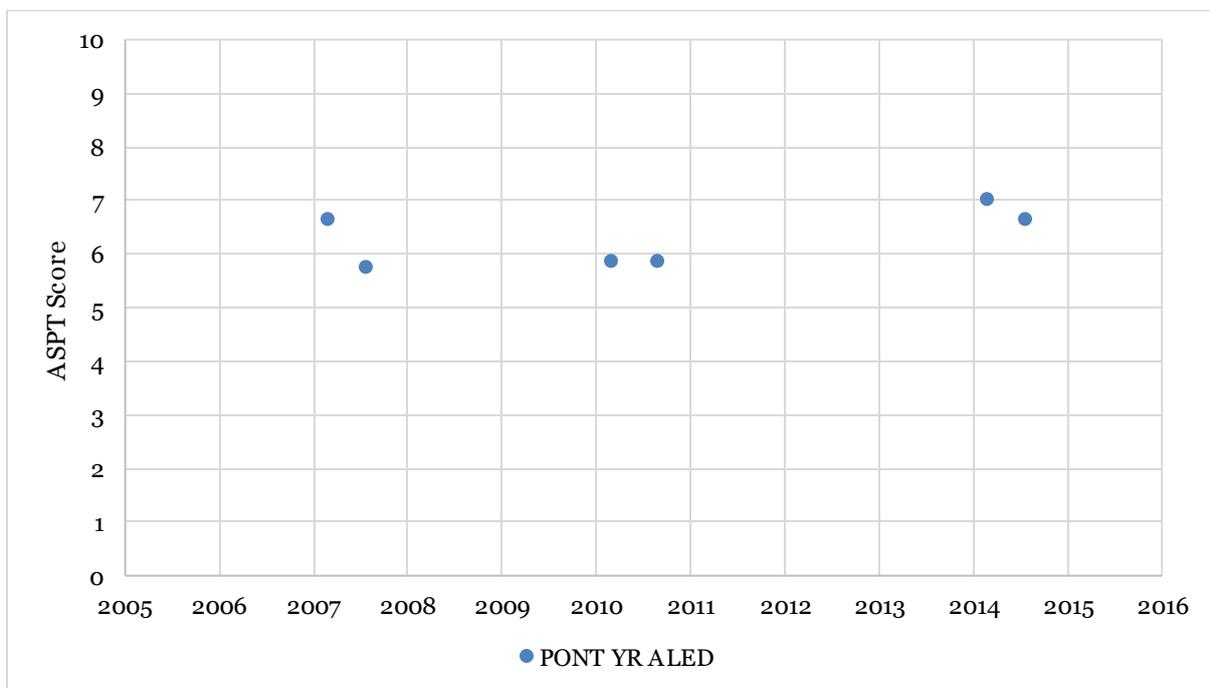


BMWP is primarily used to monitor the impact of organic water quality but also responds to other pressures such as habitat reduction, siltation and toxic pollutants. High BMWPs are associated with good water and habitat quality. Comparisons between sites with BMWP scores

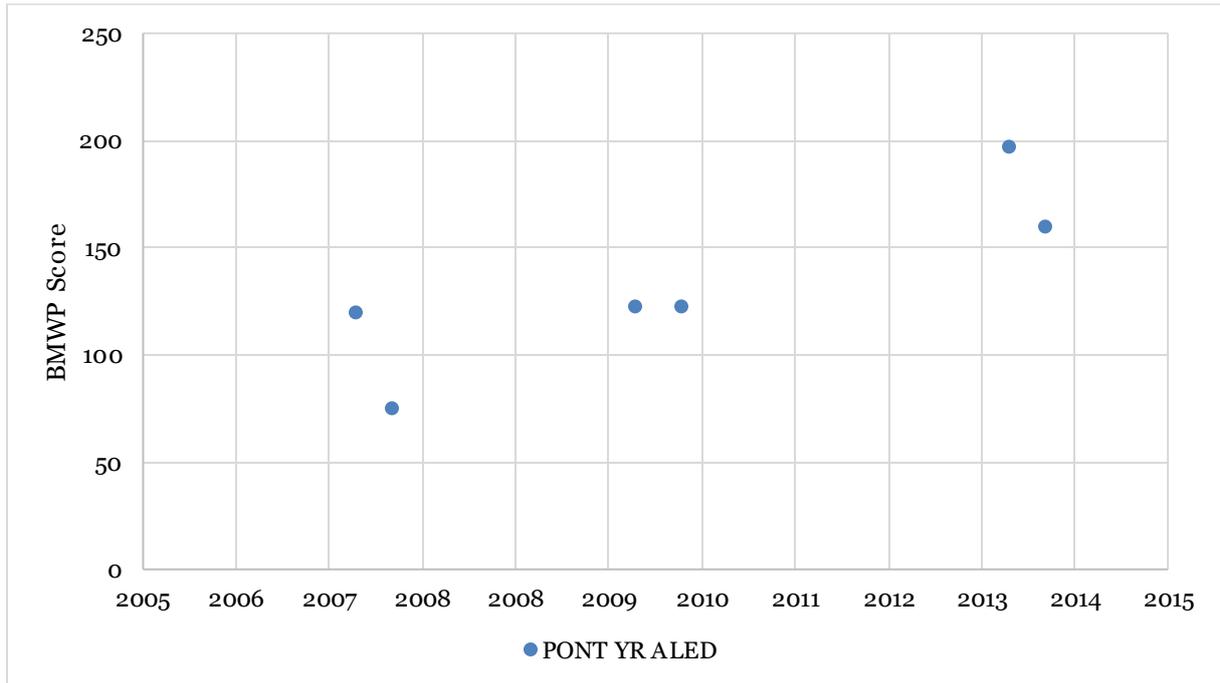
must be used with caution as change to river type can have considerable influence over BMWP score. ASPT is derived from BMWP and provides the average BMWP sensitivity score of all the taxa found in the sample’s macroinvertebrate assemblage. This index provides a more reliable means of comparing macroinvertebrate community quality between sites whilst also reducing the influence of sampling artefacts such as variable sampling effort. As such ASPT is used as the primary means of assessing macroinvertebrate response to water quality in this assessment. As a guide ASPT scores above 5 represent macroinvertebrate communities living in good water quality, scores above 6 are indicative of rivers of exceptionally good quality. Scores below 5 indicate water quality stress on the macroinvertebrate community.

ASPT and BMWP scores from the site Pont Yr Aled are displayed in **Figure D3.2** and **Figure D3.3**. The ASPT score obtained from Pont Yr Aled range from 5.77 to 7.04 across the monitoring period. This reflects a macroinvertebrate community which is consistent with that found in good to high water quality. In this upland water body with no apparent water quality pressures influencing the water course this community meets expectation. This community is exemplified by the presence of a number of highly pollution sensitive species including a stonefly *Chloroperla torrentium*, Silver Sedge *Odontocerum albicorne*, and in 2014 the Blue-winged Olive *Serratella ignita*.

**Figure D3.2 Observed ASPT scores from Reach 3 of the Afon Aled**



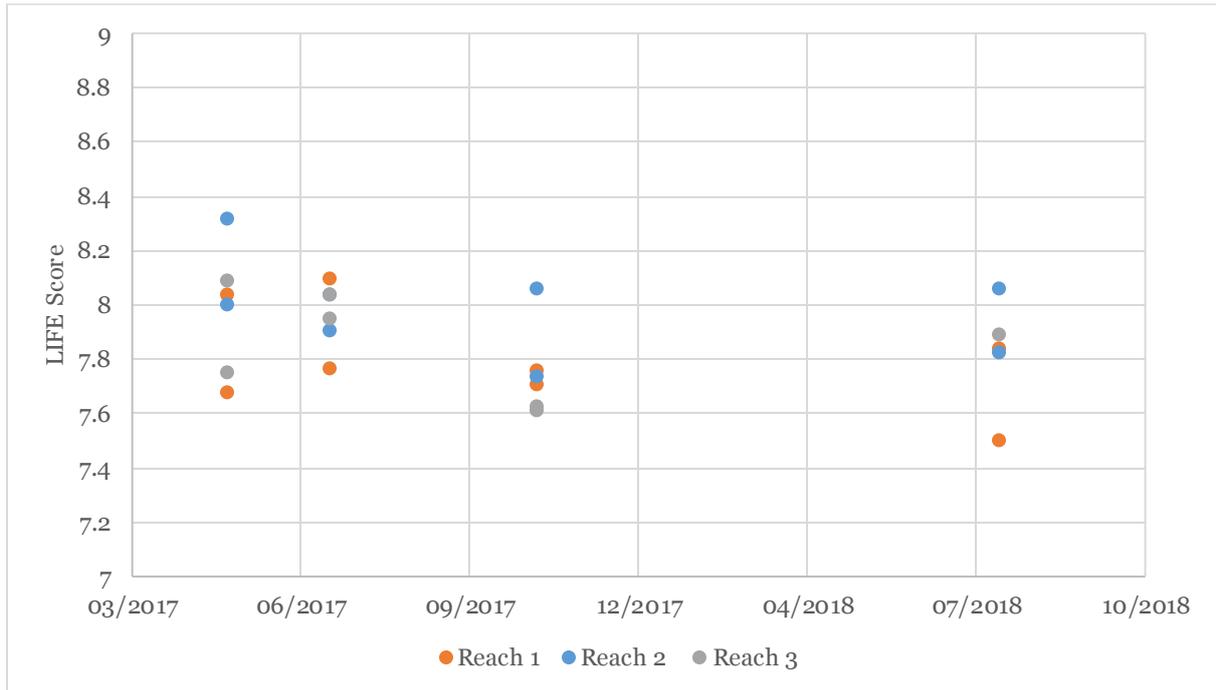
**Figure D3.3 Observed BMWP scores from Reach 3 of the Afon Aled**



Macroinvertebrate data collected by APEM yielded very similar results to NRW’s historical monitoring (see Figure 3.3 to Figure 3.5). Macroinvertebrate assemblages were typical of relatively fast-flowing, unpolluted, gravel-bottomed streams. Family LIFE scores ranged from 7.61 to 8.32 across the monitoring period, which is indicative of a community that is highly sensitive to reduced flows and is therefore consistent with what is expected in faster flowing water. ASPT scores ranged from 5.80 to 6.88 and BMWP ranged from 116 to 196, across the monitoring period. These scores reflect a community which is consistent with that found in good to high water quality.

Data collected by Ricardo Energy & Environments sampling also yielded results that concur with both NRW’s and APEM’s sampling (see **Figure D3.4** to **Figure D3.6**). Family LIFE scores ranged from 7.50 to 8.06, which is indicative of a community that is highly sensitive to reduced flows and therefore consistent with what is expected in faster flowing water. ASPT scores ranged from 6.11 to 6.65 and BMWP scores ranged from 102 to 133 across the sampling period. These scores reflect a community which is consistent with that found in good to high water quality.

**Figure D3.4 Observed LIFE scores from Reach 1 - 3 of the Afon Aled**



**Figure D3.5 Observed ASPT scores from Reach 1 - 3 of the Afon Aled**

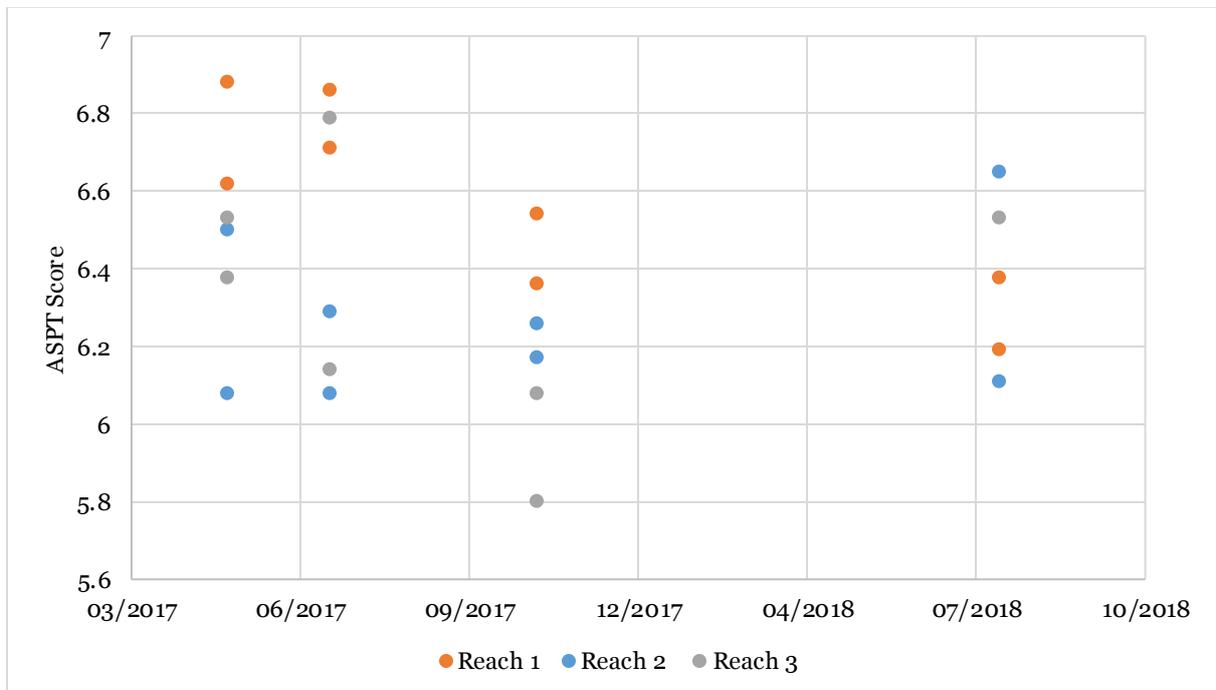
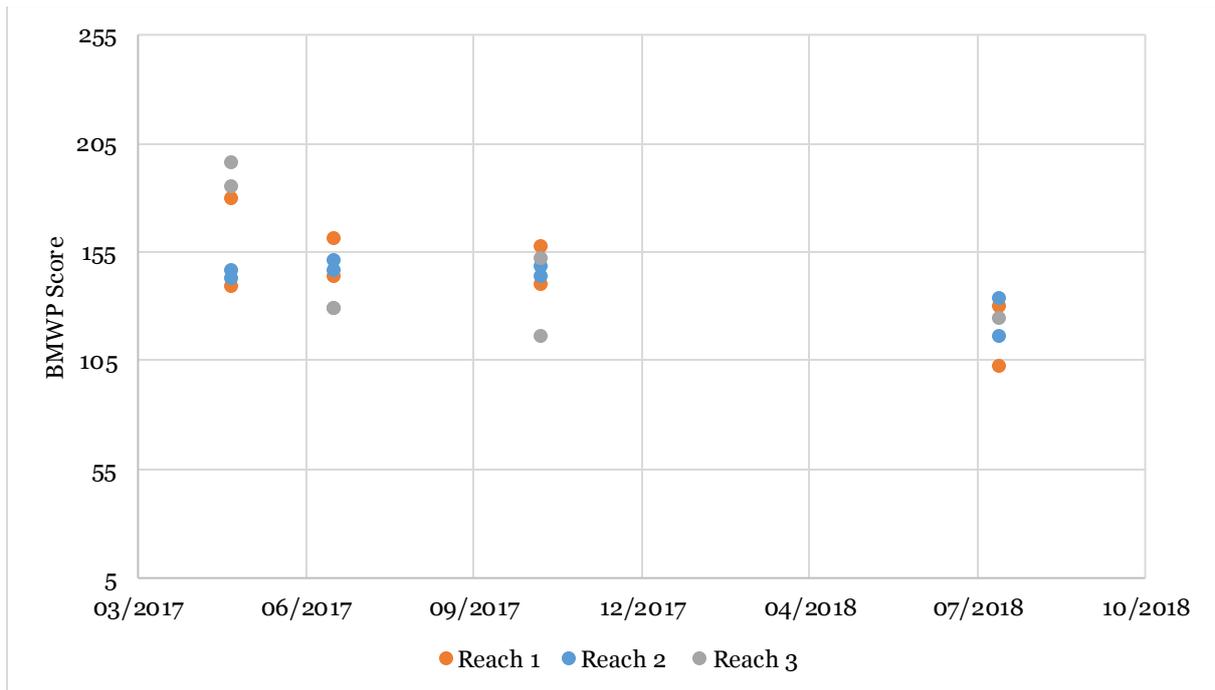


Figure D3.6 Observed BMWP scores from Reach 1 - 3 of the Afon Aled



### Notable species

No records of white clawed crayfish *Austropotamius pallipes* were present in the data included returned for any of the waterbodies potentially affected by the drought permit. Consequently, white clawed crayfish are assumed to be absent from the impacted reaches of the drought permit and are not considered further as part of this assessment.

The absence of freshwater pearl mussel *Margaritifera margaritifera* has previously been confirmed (Adrian Fowles, CCW, pers. comm.)<sup>10</sup>, therefore, it is not considered further in this assessment.

Macroinvertebrate monitoring undertaken by APEM and Ricardo Energy & Environment recorded one diving beetle species of Notable status found in each season of sampling (spring, summer and autumn).

### **D.3.2.2 Assessment**

The hydrological impact in Reach 1 of the Afon Aled is assessed as moderate; implementation of the drought permit will manifest as a reduction of up to 52% in the year round Q<sub>50</sub> value.

Baseline data describes a macroinvertebrate community in the impacted reaches which is highly sensitive to reduced flows, with a high proportion of species preferring fast flowing waters. It is possible 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

<sup>10</sup> Cascade Consulting (2007). Environmental Monitoring Plan for Aled Isaf Reservoir (N7). Technical report to Dwr Cymru Welsh Water

which favour slower flows. Although this effect will be limited due to the short duration and timing of the impacts. Reproduction may also be impacted as effects of this drought permit will occur in the winter period. In the autumn period changes to flow may influence macroinvertebrate species with a spring emergence, as the majority of these species lay their eggs in autumn with the eggs overwintering in the watercourse and therefore recruitment may be reduced. Reduction in wetted width or depth may result in desiccation of temporary habitats and depending on the rate of flow reduction may cause stranding of invertebrates in marginal habitats.

There are considered to be negligible risk to changes in dissolved oxygen and ammonia concentrations (See **Appendix B** Section B.3.2 Water Quality assessment) as a result of implementation of the drought permit. Therefore, no changes to community composition relating to these factors are anticipated.

Typically, invertebrate communities can recover rapidly from short term flow impacts as a result of immigration from upstream habitats. In the context of Reach 1, recovery of the invertebrates will be negatively affected by the lack of upstream communities which are located in reaches which are not negatively impacted by the drought permit. However, invertebrate recovery will also involve aerial recolonization and refugium-use strategies. As such, invertebrate recovery following the cessation of the drought permit and return to standard compensation flow will likely be rapid. Impacts of the drought permit in Reach 1 are therefore expected to be **minor adverse**, temporary, and reversible. Due to the reduced hydrological impacts and short duration, impacts of the drought permit in Reaches 2 and 3 are assessed as **negligible**.

Summary

The potential impacts of the Llyn Aled drought permit on the macroinvertebrate community are summarised in **Table D3.4**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Section 4.3 of the main report) and the sensitivities of the macroinvertebrate community. The impacts presented in **Table D3.4** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

**Table D3.4 Summary of Impacts on Macroinvertebrate Community**

Feature	Impact	Significance of Impact
<b>Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence</b>		
<b>Macroinvertebrates</b>	<ul style="list-style-type: none"> <li>Reduction in species diversity and abundance as a result of reduced recruitment.</li> <li>Reduction in species diversity as a result of the loss of flow-sensitive taxa</li> </ul>	<b>Minor</b>
<b>Reach 2 – Afon Aled, Afon Deunant confluence to Bryn Aled intake</b>		
<b>Macroinvertebrates</b>	<ul style="list-style-type: none"> <li>Reduction in species diversity and abundance as a result of reduced recruitment.</li> <li>Reduction in species diversity as a result of the loss of flow-sensitive taxa</li> </ul>	<b>Negligible</b>

Feature	Impact	Significance of Impact
<b>Reach 3 – Afon Aled, from Bryn Aled intake to Afon Elwy confluence</b>		
<b>Macroinvertebrates</b>	<ul style="list-style-type: none"> <li>• Reduction in species diversity and abundance as a result of reduced recruitment.</li> <li>• Reduction in species diversity as a result of the loss of flow - sensitive taxa</li> </ul>	<b>Negligible</b>

There is a risk of short-term deterioration in status of the macroinvertebrate component of the Aled - above Deunant (GB110066054930) and Aled - Elwy to Deunant (GB110066059770). Impacts of drought permit implementation on the macroinvertebrate communities of the impacted reaches have been summarised as **minor** in Reach 1 and **negligible** in Reaches 2 and 3. Consequently, the macroinvertebrate component of the Aled - above Deunant and Aled - Elwy to Deunant waterbodies are considered to be at **minor** and **negligible** risk of short-term deterioration respectively.

### D.3.3 Fish

#### D.3.3.1 Baseline

##### Existing Data

No NRW fish survey data were available for the Aled Isaf Reservoir. Anecdotal evidence suggests the lake contains coarse fish populations, including (not limited to) perch and pike.

NRW fish survey data from six sites encompassing Reaches 1-3 have been analysed as part of this assessment (see **Table D3.5**). The sites have not been sampled consistently either across years or in terms of methodology, however, recent data (post 2015) is available for all reaches of the hydrological zone of influence and the geographical coverage of the monitoring locations gives a useful insight into the likely species assemblage. In addition to the NRW data, Welsh Water commissioned APEM to undertake five quantitative surveys of the Afon Aled in 2017<sup>11</sup>, consisting of two sites in Reach 1, three sites in Reach 2 and one site in Reach 3. Lamprey specific surveys were also carried out as part of the APEM surveys.

The data made available consists of density estimates for 0+ and >0+ Atlantic salmon *Salmo salar* and brown / sea trout *Salmo trutta* from quantitative and semi-quantitative electric fishing surveys. Observations of incidental catches of other fish species are available for some years, whilst lamprey specific survey data is available for 2017 only (APEM data).

**Table D3.5 NRW Fish Survey Data within the Hydrological Zone of Influence**

Hydrological Reach	NRW Site Ref	River	NGR	Sampling Method and Years (Q = Quantitative, SQ = Semi-quantitative)
1	3	Afon Aled	SH93806440	SQ: 2003, 2009 & 2015
	38	Afon Aled	SH94106630	SQ: 2003, 2009, 2015 & 2018
	68	Afon Aled	SH93206270	SQ: 1997, 2018
2	2	Afon Aled	SH95606740	SQ: 1997, 2003 and 2009
	37	Afon Aled	SH96006880	SQ: 2003, 2009 and 2015
3	1	Afon Aled	SH9553970484	Q: 2001-2005 SQ: 1997, 2001-2011, 2013, 2015, 2016 & 2018

The 'Aled - Elwy to Deunant' waterbody (GB110066059770) was assessed as being at high status for fish in 2015.

##### Species Composition

Nine fish species have been recorded within the potential zone of influence; Atlantic salmon and bullhead *Cottus gobio* (both Environment Act (Wales) Section 7 and Habitats Directive Annex II species), brown / sea trout (Environment Act (Wales) Section 7 species), European

<sup>11</sup> Apem (2018) Dwr Cymru Welsh Water Drought Plan Monitoring 2017 to 2018: Aled Isaf and Llyn Aled, July 2018

eel *Anguilla anguilla* (Environment Act (Wales) Section 7 species and IUCN Red List ‘Critically Endangered’), sea lamprey *Petromyzon marinus* (Environment Act (Wales) Section 7 and Habitats Directive Annex II species), river/brook lamprey *Petromyzontidae* sp., minnow *Phoxinus phoxinus*, stone loach *Barbatula barbatula* and stickleback *Gasterosteiformes* sp., river / brook lamprey ammocoetes of the *Petromyzontidae* family are indistinguishable in the field<sup>12</sup>, and have therefore not been identified to species level.

### Atlantic Salmon

The available data suggest that juvenile salmon are present throughout Reaches 1 - 3 and the long-term dataset for Site 1 in Reach 3 suggests considerable natural variation in juvenile salmon densities. Combined NFC grades<sup>13</sup> for fry and parr densities at this site ranged from A (excellent) to F (fishless) over the period 1997 to 2018 (see **Table D3.6**). APEM surveys in 2017 recorded both fry and parr in Reach 3 only, however the 2018 NRW surveys recorded juvenile salmon in Reach 1 and 3, indicating recruitment continues throughout much of the hydrological zone of influence.

**Table D3.6 Juvenile Atlantic Salmon NFC Grades (Fry 0+ and Parr 1+ Combined) for NRW sites in Reaches 1 - 3**

Sample year	Combined 0+ and 1+ NFC Grade					
	Reach 1			Reach 2		Reach 3
	NRW Site 3	NRW Site 38	NRW Site 68	NRW Site 2	NRW Site 37	NRW Site 1
1997	D	-	-	D	-	D
2001	-	-	-	-	-	D
2002	-	-	-	-	-	C
2003	C	A	-	C	C	D
2004	-	-	-	-	-	C
2005	-	-	-	-	-	A
2006	-	-	-	-	-	B
2007	-	-	-	-	-	D
2008	-	-	-	-	-	C
2009	D	C	-	C	B	A
2010	-	-	-	-	-	B
2011	-	-	-	-	-	C
2013	-	-	-	-	-	A
2014	-	-	-	-	-	C
2015	E	D	-	-	D	D

<sup>12</sup> Harvey J & Cowx I (2003). Monitoring the River, Brook and Sea Lamprey, *Lampetra fluviatilis*, *L. planeri* and *Petromyzon marinus*. Conserving Natura 2000 Rivers Monitoring Series No.5, English Nature, Peterborough.

<sup>13</sup> 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).

Sample year	Combined 0+ and 1+ NFC Grade					
	Reach 1			Reach 2		Reach 3
	NRW Site 3	NRW Site 38	NRW Site 68	NRW Site 2	NRW Site 37	NRW Site 1
2016	-	-	-	-	-	E
2018	-	D	F	-	-	C

Despite significant variation in juvenile Atlantic salmon densities across sites and years, the available data suggest that Reaches 1 – 3 provide important juvenile nursery habitat. Therefore, it must be assumed that the hydrological zone of influence also constitutes an essential migratory corridor for migrating adult and smolt-stage Atlantic salmon.

Bullhead

Density and individual length data were not made available for bullhead so a detailed account of the status of this species within the hydrological zone of influence is not possible, however, incidental catches during NRW salmonid surveys suggest that bullhead are present in Reaches 1 – 3, whilst APEM surveys in 2017 also recorded bullhead throughout the hydrological zone of influence.

Lamprey Species

Unidentified lamprey species have been recorded during NRW salmonid surveys at Sites 1 and 3 (Reaches 1 and 3), whilst APEM surveys recorded river/brook lamprey in Reach 1, 2 and 3. A suspected record of a sea lamprey (post-juvenile life stage) was recorded in the lower reach of Reach 1. A precautionary approach is used in the following assessment assuming that brook, river and sea lamprey are present in throughout the hydrological zone of influence.

Brown / Sea trout

The available data suggest that juvenile brown/sea trout are present throughout Reaches 1 – 3. The long-term dataset for Site 1 in Reach 3 suggests relatively minor natural variation in fry and parr densities with NFC C and D Grades recorded in most years from 1997 to 2018. Reaches 1 to 3 recorded Excellent (Grade A) grades in 2015, whilst the most recent data from 2018 recorded Good (Grade B) to Excellent (Grade A) grades in Reach 1 (see **Table D3.7**).

**Table D3.7 Juvenile Brown/Sea Trout NFC Grades (Fry 0+ and Parr 1+ Combined) for NRW Sites in Reaches 1 - 3**

Sample year	Combined 0+ & 1+ NFC Grade					
	Reach 1			Reach 2		Reach 3
	NRW Site 3	NRW Site 38	NRW Site 68	NRW Site 2	NRW Site 37	NRW Site 1
1997	D	-	-	D	-	D
2001	-	-	-	-	-	D
2002	-	-	-	-	-	C
2003	D	C	-	C	D	D
2004	-	-	-	-	-	C
2005	-	-	-	-	-	C
2006	-	-	-	-	-	B
2007	-	-	-	-	-	D
2008	-	-	-	-	-	D
2009	B	A	-	B	C	C
2010	-	-	-	-	-	D
2011	-	-	-	-	-	C
2013	-	-	-	-	-	D
2014	-	-	-	-	-	C
2015	A	A	-	-	A	A
2016	-	-	-	-	-	E
2018	-	B	A	-	-	D

Anecdotal evidence from local angling clubs suggests sea trout migrate as far upstream as Reach 1<sup>14</sup>. A precautionary approach assumes that the anadromous life form of the species spawns alongside non-migratory brown trout throughout Reaches 1 – 3.

European eel

Density data were not made available for European eel, however, incidental catches during NRW salmonid surveys suggest that the species is present in low densities throughout Reaches 1 – 3. APEM survey data in 2017 recorded European eel in Reach 1 only, whilst NRW surveys in 2018 recorded the species in Reach 1 and 3, indicating the species remains reasonably distributed throughout the hydrological zone of influence. In terms of size ranges, the APEM surveys in 2017 recorded both elver (juvenile) and yellow (post juvenile) life stages of eel, indicating the species are able to migrate as far upstream as Reach 1.

<sup>14</sup> Wild Trout Wales & Environment Agency Wales (2007). Advisory Visit - 14th June 2007 - River Afon Aled – North Wales. On Behalf of Rhyll & St Asaph AA

### Other Species

Density data were not made available for minor species (minnow, stone loach and stickleback), however, incidental catches during NRW salmonid surveys suggest that these species are present in low densities in Reach 1 (stone loach only) and Reach 3 (stickleback and minnow).

### Data Limitations

There is some uncertainty surrounding the status of a number of the protected fish species present, including lamprey species and bullhead. The following assessment should therefore be interpreted with caution.

### Ecological value of fisheries receptors

Atlantic salmon, sea and river lamprey, and bullhead are Environment Act (Wales) Section 7 and Habitats Directive Annex II species, and are considered to be of National importance. Brown/sea trout (Environment Act (Wales) Section 7 species) and European eel (Environment Act (Wales) Section 7 and IUCN Red List 'Critically Endangered' species) are also considered to be of National importance. Minnow, stone loach and stickleback are considered to be of Local importance only.

### **D.3.3.2 Assessment**

#### Aled Isaf

There is potential for an increase in duration of habitat loss as a result of the increase in time at which the reservoir will be below top water level. The reduction in the overall area of littoral habitat could result in an increase in competition for resources and stress, resulting in a reduction in fish health during an extended refill period. The hydrological impact on Aled Isaf has been assessed as moderate adverse and the impact on coarse fish is considered to be of high magnitude, short-term, temporary and reversible. The impact of habitat loss on coarse fish and rainbow trout is therefore considered to be **minor adverse** from November to February.

#### Afon Aled

Hydrological variability in rivers can have a significant influence on the distribution of fish. When sudden or 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)<sup>15,16</sup>,

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<sup>15</sup> 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

<sup>16</sup> 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.

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reduced water quality and reduced reproductive success, growth and condition<sup>17</sup>.

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. spawning and juvenile life stages) most susceptible during the potential November to February impact period. It should be noted that the Llyn Aled drought permit is related to winter refill of Llyn Aled Reservoir and, would occur in the period November to February. This option has no impact on low flows as compensation flows would not be reduced, however, a relatively sudden and significant (approximately 52%) reduction at flows around  $Q_{50}$  may be expected in Reach 1.

It should also be noted that this option would allow winter refill of Llyn Aled Reservoir thereby ensuring the availability of the water bank for fisheries releases in the next year in order to benefit salmonid migration during the summer and autumn.

### Atlantic Salmon and Brown/Sea Trout

#### *Atlantic Salmon and Sea Trout Migration*

Atlantic salmon are known to be present in Reaches 1 – 3, whilst sea trout are also considered to be present as far upstream as Reach 1. Both species of migratory salmonids are considered to utilise spawning habitat throughout the hydrological zone of influence. The majority of Atlantic salmon migration into the Afon Aled is likely to occur from October to December with the bulk of sea trout migration occurring slightly earlier in the year and there is the potential for a drought permit to impact these migrations. The majority of out-migrating smolt would be likely to migrate between mid-March and mid-May depending on water temperature, and this life stage is unlikely to be affected by a drought permit. Adult and smolt-stage Atlantic salmon and adult sea trout migration is linked to flow increases and river flow is considered to be a primary cue. If the Llyn Aled drought permit was applied during the autumn (November), the reduction in river flow experienced downstream of the Bryn Aled intake may result in delayed adult migration.

The impact on adult salmonid migration is considered to be of medium magnitude in Reach 1 and low magnitude in Reaches 2 and 3, short-term, temporary and reversible. The impact on adult Atlantic salmon and sea trout migration is considered to be **moderate adverse** in Reach 1 and **minor adverse** in Reaches 2 and 3.

#### *Water Quality*

Atlantic salmon and brown/sea trout are susceptible to poor water quality and particularly dissolved oxygen and water temperature; however, water quality impacts have been assessed as low. The impact on Atlantic salmon and sea trout is therefore considered to be **minor adverse** in Reaches 1 – 3.

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<sup>17</sup> 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.

### *Atlantic Salmon and Brown/Sea Trout Spawning and Juvenile Habitat*

There is the potential for reduced flows in Reaches 1 - 3 to result in a decrease in river levels and wetted width. There is therefore the potential for a loss or degradation of gravel spawning and juvenile habitat. Provided minimum low flows are available, juvenile Atlantic salmon and brown/sea trout are likely to relocate to areas of suitable habitat if river levels decrease, however, competition and stress would increase. If gravels containing redds and/or eggs (likely to occur from November to January) 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 spawning and juvenile Atlantic salmon and brown/sea trout habitat is therefore considered to be **moderate adverse** in Reach 1 and **minor adverse** in Reaches 2 and 3.

#### Bullhead

Bullhead are likely to be present throughout Reaches 1 - 3. Spawning and egg incubation takes place from March to May and therefore the most sensitive life stages would not be impacted by this drought permit but the species is known to be flow sensitive and reduced flows are known to impact bullhead populations. However, the reduction in flow is of a short duration (<12 days) and whilst mortality is likely to increase through predation in particular during this period, the impact at the population scale is expected to be limited. The impact is therefore considered to be of low magnitude, short-term, temporary and reversible. The impact on bullhead is therefore considered to be **minor adverse** in Reach 1 and **negligible** in Reaches 2 and 3.

#### Lamprey Species

##### *Migration of river and sea lamprey*

Mature river lamprey migrate upstream into freshwater in the autumn (from October to December<sup>18</sup>). River lamprey ammocoetes metamorphose after three to five years in freshwater and then descend to estuarine and marine environments between July and September in smaller rivers **Error! Bookmark not defined.**; outside of the drought permit implementation period. Upstream migration requires a reasonable flow of water to aid passage past natural and non-natural in-channel barriers. Low flows may limit upstream passage and hinder downstream passage, leaving both migratory life stages exposed to predation and ultimately a reduction in recruitment. The impact is therefore limited to the upstream adult migratory life stage, and is considered to be of medium magnitude, short-term, temporary and reversible. The impact on adult river lamprey migration is therefore considered to be **moderate adverse** in Reach 1 and **minor adverse** in Reaches 2 and 3.

Mature sea lamprey migrate upstream into freshwater in April and May prior to spawning; outside of the drought permit implementation period. Sea lamprey ammocoetes

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<sup>18</sup> Maitland PS (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura2000 Rivers Ecology Series No.5. English Nature, Peterborough

metamorphose after approximately five years in freshwater and then descend to marine environments between July to September<sup>19</sup>, also outside of the drought permit implementation period. Impacts to sea lamprey are therefore considered **negligible**.

#### *Juvenile (ammocoete and transformer) brook, river and sea lamprey habitat*

Spawning and egg incubation would not be affected by this drought permit but juvenile habitat may be impacted. There is the potential for reduced flow in Reach 1 in particular 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 the potential for a loss or degradation of this habitat. Provided minimum low flows are available, juvenile lamprey may relocate to areas of suitable habitat if river levels decrease, however, competition and stress would likely increase. The impact is therefore considered to be of medium magnitude, short-term, temporary and reversible. The impact on juvenile lamprey habitat is therefore considered to be **moderate adverse** in Reach 1 and **minor adverse** in Reaches 2 and 3.

#### *Water quality*

Water quality impacts (e.g. reduced dissolved oxygen and increased water temperature) are not expected to have a significant impact on lamprey species which are not particularly sensitive to these effects. The impact on brook and river lamprey is therefore considered to be **negligible** in Reaches 1 – 3.

#### European Eel

Elver enter rivers in early spring and a general upstream migration occurs throughout the summer and autumn. Elver migration is unlikely to be impacted by this drought permit. The downstream migration of mature (silver) eel tends to occur between September and December in most rivers and is linked to increased flow, and there is the potential for interaction with this drought permit. European eel of a wide age range are likely to be present in low densities throughout Reaches 1 - 3 but the species is relatively tolerant of low flows and poor water quality, and is considered resilient to reduced flow conditions. The impact on downstream silver eel migration is therefore considered to be of medium magnitude, short-term, temporary and reversible. The impact on downstream silver eel migration is therefore considered to be **moderate adverse** in Reach 1 and **minor adverse** in Reaches 2 and 3.

#### Other Species

Minnow, stone loach and stickleback typically spawn during spring/summer and are therefore unlikely to be affected by the drought permit. The rheophilic (require flowing water) minnow and stone loach are however susceptible to impacts associated with pronounced changes in river flow, whilst stickleback are eurytopic (tolerant of lotic and lentic environments) and considered more robust to flow changes. Stickleback are therefore not considered to be

<sup>19</sup> Maitland PS (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura2000 Rivers Ecology Series No.5. English Nature, Peterborough

adversely affected by the drought permit. A reduction in flow could result in increased mortality of minnow and stone loach due to higher densities of fish being subject to a greater risk of increased predation. The impacts are therefore considered to be of low magnitude, short-term, temporary and reversible (minnow and stone loach only). The impact on other fish species (minnow and stone loach only) is therefore considered to be **minor adverse** in Reaches 1-3.

Summary

The potential impacts of the Llyn Aled drought permit on the fish community are summarised in **Table D3.8**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Section 4.3 of the main report) and the sensitivities of the fish community. The impacts presented in **Table D3.5** 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**

Species	Impact	Significance of Impact
<b>Reach 1 – Afon Aled (Aled Isaf Outflow to Afon Deunant confluence)</b>		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	<b>Moderate</b>
	• Reduced water quality	<b>Minor</b>
	• Reduction in spawning and juvenile survival due to habitat loss.	<b>Moderate</b>
Bullhead	• Increase in mortality due to habitat loss.	<b>Minor</b>
Lamprey species	• Delays and potential cessation of adult river and sea lamprey migration due to decreased flows.	<b>Moderate</b>
	• Loss of juvenile habitat as a result of reduced river levels.	<b>Moderate</b>
	• Reduced water quality	<b>Negligible</b>
European eel	• Increased mortality due to habitat loss.	<b>Moderate</b>
Other species	• Increased mortality due to habitat loss.	<b>Minor</b>
<b>Reach 2 - Afon Aled (Afon Deunant confluence to Bryn Aled intake)</b>		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	<b>Minor</b>
	• Reduced water quality	<b>Minor</b>
	• Reduction in spawning and juvenile survival due to habitat loss.	<b>Minor</b>
Bullhead	• Increase in mortality due to habitat loss.	<b>Negligible</b>
Lamprey species	• Delays and potential cessation of adult river and sea lamprey migration due to decreased flows.	<b>Minor</b>
	• Loss of juvenile habitat as a result of reduced river levels.	<b>Minor</b>
	• Reduced water quality	<b>Negligible</b>
European eel	• Increased mortality due to habitat loss.	<b>Minor</b>
Other species	• Increased mortality due to habitat loss.	<b>Negligible</b>
<b>Reach 3 - Afon Aled (Bryn Aled intake to Afon Elwy confluence)</b>		
Atlantic salmon and brown/sea trout	• Delays and potential cessation of adult salmon and sea trout migration due to reduced flows.	<b>Minor</b>
	• Reduced water quality	<b>Minor</b>
	• Reduction in spawning and juvenile survival due to habitat loss.	<b>Minor</b>
Bullhead	• Increase in mortality due to habitat loss.	<b>Negligible</b>
Lamprey species	• Delays and potential cessation of adult river and sea lamprey migration due to decreased flows.	<b>Minor</b>

	<ul style="list-style-type: none"> <li>• Loss of juvenile habitat as a result of reduced river levels.</li> <li>• Reduced water quality</li> </ul>	<p><b>Minor</b></p> <p><b>Negligible</b></p>
European eel	<ul style="list-style-type: none"> <li>• Increased mortality due to habitat loss.</li> </ul>	<b>Minor</b>
Other species	<ul style="list-style-type: none"> <li>• Increased mortality due to habitat loss.</li> </ul>	<b>Negligible</b>

There is a risk of short-term deterioration in status of the fish components of the Aled - above Deunant (GB110066054930) and Aled - Elwy to Deunant (GB110066059770), the waterbodies were classified as high for fish in Cycle 2, including the interim 2018 classification. Impacts of drought permit implementation on the fish communities of the impacted reaches have been summarised as major (Reach 1) to minor (Reaches 2 - 3), short-term, temporary and reversible. Consequently, the fish component of the Aled - above Deunant (GB110066054930) and Aled - Elwy to Deunant (GB110066059770) is considered to be at major and minor risk, respectively of short-term deterioration.

### **D.3.4 Phytobenthos**

#### **D.3.4.1 Baseline**

No baseline phytobenthos monitoring information was received from Natural Resources Wales (NRW) for the Afon Aled or Aled Isaf Reservoir. Considering the absence of baseline information care must be taken in interpretation of the assessment and should be seen as indicative only.

#### **D.3.4.2 Assessment**

Impacts on the phytobenthos assemblages could occur due to the operation of the drought permit, including changes in community composition due to: decreases in flow; changes to grazing pressure. Due to the short lifecycle of algal species, phytobenthos communities can respond rapidly to environmental change and a response in phytobenthos community composition to the reduction in flows due to the drought permit would be expected.

WFD EQR metrics for phytobenthos (TDI4 in DARLEQ)<sup>20</sup> are designed to detect differences in nutrient levels, particularly SRP. Implementation will occur during winter so any potential changes in SRP concentrations are not expected to affect the phytobenthos community in terms of TDI scores and associated WFD status as growth rates will be minimal during this period.

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.

The impacts of the drought permit on phytobenthos communities is therefore assessed as **negligible** for Aled Isaf and Reaches 1 - 3. All impacts are deemed short term and reversible.

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<sup>20</sup> WFD-UKTAG (2014) Phytobenthos: Phytobenthos for Assessing River and Lake Ecological Quality (River DARLEQ2)

Summary

The potential impacts of the Llyn Aled drought permit on the phytobenthos community are summarised in **Table D3.9**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Section 4.3 of the main report) and the sensitivities of the phytobenthos 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 Phytobenthos Community**

Feature	Impact	Significance of Impact
<b>Reach 1 – Afon Aled, Aled Isaf to Afon Deunant confluence</b>		
Diatoms	<ul style="list-style-type: none"> <li>Decrease in flow affecting phytobenthos community composition</li> <li>Decreased wetted width and / or depth resulting in desiccation of phytobenthos</li> </ul>	<b>Negligible</b> (uncertain)
<b>Reach 2 - Afon Aled (Afon Deunant confluence to Bryn Aled intake)</b>		
Diatoms	<ul style="list-style-type: none"> <li>Decrease in flow affecting phytobenthos community composition</li> <li>Decreased wetted width and / or depth resulting in desiccation of phytobenthos</li> </ul>	<b>Negligible</b> (uncertain)
<b>Reach 3 - Afon Aled (Bryn Aled intake to Afon Elwy confluence)</b>		
Diatoms	<ul style="list-style-type: none"> <li>Decrease in flow affecting phytobenthos community composition</li> <li>Decreased wetted width and / or depth resulting in desiccation of phytobenthos</li> </ul>	<b>Negligible</b> (uncertain)

There is a risk of short-term deterioration in status of the macrophyte and phytobenthos component of the Aled - above Deunant (GB110066054930) and Aled - Elwy to Deunant (GB110066059770). Impacts of drought permit implementation on the phytobenthos communities of the impacted reaches have been summarised as negligible (uncertain). Consequently, the phytobenthos subcomponent of these waterbodies is considered to be at **negligible** risk of short-term deterioration.

## D4 INVASIVE FLORA AND FAUNA

### D.4.1 New Zealand Pigmyweed

#### D.4.1.1 Baseline

Anecdotal reports were received of New Zealand pigmyweed (*Crassula helmsii*) in NRW assets in the region. The species is known to be present in and around Llyn Brenig reservoir, located 5km east of Aled Isaf. The UK New Zealand pigmyweed occurs in a variety of habitats including ponds, lakes, canals, and ditches as well as on damp mud on the margins of ponds and reservoirs. The species can tolerate a wide range of environmental conditions, from basic to acidic and oligotrophic to eutrophic<sup>21</sup>. Where it occurs it can form dense mats shading out native vegetation and choking watercourses. Distribution occurs through vegetative means; full plants can grow from very small vegetative fragments.

Welsh Water commissioned Ricardo Energy & Environment to conduct a total of three surveys, which were undertaken between 30 July and 1 August 2018. The surveys included a visual inspection of the shore of Llyn Aled and Aled Isaf Reservoirs and at nine sites along the Afon Aled. In addition to the Ricardo Energy & Environment surveys, APEM conducted macrophyte surveys at Aled Isaf, paying special attention to the presence/absence of *Crassula helmsii*. No *Crassula helmsii* was found at any of the sites, on any of the Welsh Water commissioned surveys.

#### D.4.1.2 Assessment

Due to its preference for slow flowing water bodies New Zealand pigmyweed is likely to be absent from the impacted reaches of the Afon Aled and is not considered further for the impacted river reaches. The transfer water from the Aled Isaf reservoir to Llyn Aled does not have the potential to increase the range of the species as it is absent from Aled Isaf and Llyn Aled.

#### Summary

The potential impacts of the Llyn Aled drought permit on invasive species are summarised in **Table D5.1**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability). The impacts presented in **Table D4.1** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

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<sup>21</sup> Lansdown R. V. (2015) GB Non-Native Species Secretariat Factsheet: New Zealand Pigmyweed, *Crassula helmsii*. Available at <http://www.nonnativespecies.org/factsheet/downloadFactsheet.cfm?speciesId=1017>, Accessed 25 October 2016.

**Table D4.1 Summary of Impacts on Invasive Species**

Feature	Impact	Significance of Impact
<b>Aled Isaf</b>		
New Zealand pigmyweed <i>Crassula helmsii</i>	<ul style="list-style-type: none"> <li>Survey has confirmed that <i>Crassula helmsii</i> is not present in Aled Isaf. Therefore, the pumped transfer will not transfer the species to Llyn Aled and increase the range of the species.</li> </ul>	<b>Negligible</b>

## D5 LANDSCAPE AND RECREATION

### D.5.1 Landscape and Recreation

#### D.5.1.1 Baseline

The upper catchment lies within the Mynydd Hiraethog area and its upland moorland with steep valleys. The open moorlands and lakes are attractive to walking enthusiasts. Land use within the less fertile upper reaches of the study area is predominantly mixed livestock with dairy farming in the lower reaches. Moderate access is provided by footpath and road to the reservoir. Llyn Aled and Aled Isaf reservoirs are popular locations for recreational fishing.

#### D.5.1.2 Assessment

Changes to water levels and wetted width in the Afon Aled directly affect the landscape, fishing and visual amenity value, although this will only be temporary and will be ameliorated once the drought has passed. Therefore, the landscape impacts are assessed with limited data as having a negligible risk.

The hydrological impact on Aled Isaf reservoir has been assessed as moderate adverse, and as such no impact on recreational fishing in Llyn Aled and Aled Isaf is anticipated.

#### Summary

The potential impacts of the Llyn Aled drought permit on landscape and recreation are summarised in **Table D5.1**. The impacts, and their magnitude, have been based on the hydrological impacts (see Section 4.2 of the main report), their influence on the physical environment (including geomorphology, water quality and likely habitat availability) (see Section 4.3 of the main report) and the sensitivities landscape and recreation. The impacts presented in **Table D5.1** represent the worst case impacts of implementing a drought permit, over and above the impacts potentially caused by a natural drought.

**Table D5.1 Summary of Impacts on Landscape and Recreation**

<b>Feature</b>	<b>Impact</b>	<b>Significance of Impact</b>
<b>Reaches 1 – 3</b>		
Landscape	<ul style="list-style-type: none"> <li>Flows during drought conditions will naturally be low therefore the implementation of the drought permit is not expected to lead to any material additional landscape and visual amenity impacts</li> </ul>	<b>Negligible</b>
Recreation	<ul style="list-style-type: none"> <li>Impacts on recreation activities (e.g. angling, canoeing, walking) are not anticipated over those from the natural drought conditions</li> </ul>	<b>Negligible</b>